

ABOUT THE EDITORS



Dr. Parvender Sheoran is presently working as Director at ICAR-Agricultural Technology Application Research Institute, Zone-I, Ludhiana, Punjab. He is recipient of University Gold Medal (1997), ASPEE Gold Medal (1997), ICAR-Swami Sahajanand Saraswall Outstanding Extension Scientist Award (2021); Dr. PS Deshmukh Young Agronomist Award (2018); Australian Award Fellowship (2017); AICRP-Rapeseed Mustard Team Award (2014); CSSRI Best Scientist Award (2018) and Fellow of Indian Society of Weed Science (2018) and Oilseeds Research (2020). Endowed with outstanding academic and research contributions in the field of salinity management, oilseeds agronomy for more than 20 years, he has developed the agronomic package of 7 improved varieties/hybrids of oilseeds crops (mustard, sunflower, linseed and sesame) released at National/State level, 15 farmers' worthy technological recommendations included in PoP of Punjab/Haryana state, published 125+ research articles in high impact Journals, 2 books, 8 book chapters, 31 success stories, 10 technical/extension bulletins, 35 extension articles, 10 extension folder/leaflets, 9 training manuals, 34 invited lectures, 5 radio/TV talks etc. He has also developed a farmer's friendly mobile-app 'Salinity Expert' to aid the traditional extension methods in disseminating the salinity management technologies.



Dr. Pragya Bhaduria is presently working as a Senior Scientist in Livestock Production Management discipline at ICAR-Agricultural Technology Application Research Institute, Zone-IV, Patha, Bihar. She is a gold medalist of JNKVV Jabalpur and obtained her M.Sc (LPM) from Indian Veterinary Research Institute (IVRI), Izatnagar, Bareilly and Ph.D (LPM) from National Dairy Research Institute (NDRI). She also served at Central Avian Research Institute (CARI), Izatnagar and ICAR-ATARI, Zone-1 Ludhiana. In her more than 10 years of extension and research career, she had published 30 original research papers, 50 technical and popular articles, 03 books, 12 book chapters, 15 technical bulletins, 10 success stories and 10 extension literature. She is currently handling 06 Projects as PI and CoPI. Dr. Bhaduria has many laurels in her account such as WPSA Young Scientist Award Travel Grant to Beijing, China, participants of SAARC International Training Programme at CART, Izatnagar, Konwar Virender Singh Memorial All India Best Publication Award, IPSA Ayurved Best Paper Award, Inspiring Lady Veterinarian Award, Young Scientist Award, member screening committee for farmer's awards, editorial board member and many more.



Dr. Sudhir Singh Bhaduria is currently working as a Deputy Commissioner (Crops) at Ministry of Agriculture & Farmers Welfare, New Delhi. He is academically proficient with M. B. A. (Rural Technology & Management), Ph. D. (Agronomy), D. Sc. (Scholar), Bachelor of Law (LL. B.), Diploma in Software Applications, P. G. Diploma in Agro Informatics, Logistics & Supply Chain Management with more than 25 Years of vast experience. Dr. Sudhir worked at the National Dairy Development Board, Anand & its various subsidiaries. His parent organisation is Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior. Dr. Sudhir has worked as Director, Board of Management at Centre for Agribusiness Incubation and Entrepreneurship, Gwalior. He is Fellow of Society of Applied Biotechnology and Honorary Fellow of the Society of Life Sciences. He is reviewer of International Journal of Management and Social Studies. He is honored as Advisory Board Member of Yuvinicubated and KITES Education Foundation. He has published more than 100 research papers and articles and is recipient of several awards, including Life Time Achievement Award for his contribution in Agriculture, agribusiness and allied activities.



Dr. Rayees Ahmad Shah born in 1979 inside Waterkhani village is a permanent resident of Village Drugmulla, District Kupwara (Jammu and Kashmir), graduated in B. Sc. (Agriculture) & obtained postgraduate degree in M. Sc. (Agronomy) with first class and secured his Ph. D. in Agronomy. He served in the Department of Sheep Husbandry, Government of Jammu and Kashmir from 2005 to 2007, in the Department of Agriculture, Government of Jammu and Kashmir from 2007 to 2008, in the Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir from 2008 to 2013 and in the University of Kashmir, Hazratbal Srinagar since 2013. He has to his credit a number of research papers published in National and international scientific journals. Dr. R. A. Shah authored nine books viz., Fundamentals of Agronomy, Farming Systems & Sustainable Agriculture, Fundamentals of Botany, Rainfed Agriculture & Watershed Management, Introductory Biology, Crop Physiology, Current Trends in Fodder Production, Recent Scientific Advances in Sugarcane Cultivation, Advances in Veterinary Research for Sustainable Development of Livestock Sector. These books have been widely welcomed and appreciated by students and teachers. Dr. Shah is member of many professional societies having 17 years of experience in the field of agricultural science and extension.



Dilpreet Publishing House
Ariana Publishers & Distributors

H.O.: F-198, Vishnu Garden, New Delhi-110 016
Tel.: (011) 25981909; Mobile: 9212116769, 9717228223
B.O.: H.No. 63, Raj Bagh Extn., (Near Child Care School),
Srinagar, J&K; Mobile: 9797157440
E-mail: dilpreetpubhouse@gmail.com

ISBN 978-93-91995-10-2



9 789391 995102
₹ 695.00

MULTIDISCIPLINARY PORTRAIT OF AGRICULTURE CONCEPT & PRACTICES

MULTIDISCIPLINARY PORTRAIT OF AGRICULTURE

CONCEPT & PRACTICES

(An anthology of delivered lectures during 21 Days National Orientation Course "Teaching Learning Evaluation Technology Programme")
(April 5 to 25, 2023)



Editors

Parvender Sheoran
Pragya Bhaduria
Sudhir Singh Bhaduria
Rayees Ahmad Shah



Multidisciplinary Portrait of Agriculture:

CONCEPT & PRACTICES

(An anthology of delivered lectures during 21 Days National Orientation Course
"Teaching Learning Evaluation Technology Programme")
(April 5 to 25, 2023)

Editors

Parvender Sheoran

Pragya Bhaduria

Sudhir Singh Bhaduria

Rayees Ahmad Shah

In Collaboration With

ICAR-Agricultural Technology Application Research Institute, Zone-1, Ludhiana, Punjab
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh

National Agriculture Development Cooperative Ltd. Baramulla, J & K



Dilpreet Publishing House

Ariana Publishers & Distributors
New Delhi-110 018 (India)

Citation:

Sheoran Parvender, Bhaduria Pragya, Bhaduria Sudhir Singh and Shah Rayees Ahmad. 2023.
Multidisciplinary Portrait of Agriculture: Concept & Practices. ICAR-Agricultural Technology Application Research Institute, Zone-1, Ludhiana, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, National Agriculture Development Cooperative Ltd. Baramulla, INDIA

Copyright ©2023

ICAR-ATARI-Ludhiana, RVS KVV-Gwalior and NADCL-Baramulla. All rights reserved. No part of this publication may be reproduced, or transmitted, in any form or by any means, without permission from the copyright holders.

Declaration:

This book contains information obtained from authentic and highly reliable sources, however there is no liability of the same on account of the editors.

Published by:

ICAR-Agricultural Technology Application Research Institute, Zone-1, Ludhiana, Punjab
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh
National Agriculture Development Cooperative Ltd. Baramulla, J & K



DILPREET PUBLISHERS & DISTRIBUTORS

H.O.: F-198, Vishnu Garden, New Delhi - 110018
Tel.: (011) 25981009; Mobile: 9212116769
E-mail: dilpreetpubhouse@gmail.com

Sole Distributor:

ARIANA PUBLISHERS & DISTRIBUTORS

H.O.: F-198, Vishnu Garden, New Delhi - 110018
Tel.: (011) 25981009; Mobile: 9212116769
E-mail: arianapub_dist@in.com

B.O.: H.No. 63, Raj Bagh Extn., (Near Child Care School), Srinagar, J & K
E-mail: dilpreetpubhouse@gmail.com

ISBN 978-93-91995-10-2

Printed by: Milan Enterprises, New Delhi.

Acknowledgement:

For Charitable Financial Assistance for Publication of the Manuscript the Editors are extremely obliged
To



National Agriculture Development Cooperative Ltd. Baramulla

Established Under UT Jammu & Kashmir Self-Reliant Co-operative Act, 1999

Mobile: 09469951802 Email: naagdevcoopltd2018@gmail.com

Preface

In the present context, innovative online learning programmes for faculty members have been served to be beneficial not for the individual alone, but to the institution without disturbing their routine working ecosystem. In view of that, ICAR- Agricultural Technology Application Research Institute, Zone-I, Ludhiana organised a **21 Days National Orientation Course on “Teaching Learning Evaluation Technology Programme” through online mode during 05th up to 25th April 2023** in collaboration with Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), Gwalior and National Agriculture Development Cooperative Ltd (NADCL) Baramulla (J&K) as a joint venture keeping the present need of teaching, research and extension system.

As we know, the individual as well the organisational growth can be achieved, when there is periodic update and bridging of existing knowledge gap of agri-professionals in various fields of agricultural sciences is of utmost important. This can offer better output in term of generation of quality agri-professionals, better work efficiency, real-time reporting of the data that will be helpful in making valid, actionable interpretations to achieve real developmental goals. In today's hyper-competitive scenario, limitless learning, advance education, extension and research system needs a multi-disciplinary approach to help professional to achieve their targets and work passion. To inculcate this, one should be familiar with recent development and research gap in one's own field as well as other related allied fields. These kind of broad-spectrum training programs provides a way of visionary learning which gives a major focus on burning issues and important topics of diverse perspectives.

As the National Agricultural Research System (NARS) of the country from its inception is actively involved in planning, monitoring and execution of teaching, research and extension through the vast network of State Agricultural Universities, ICAR Research Institutes and Front-Line Extension System. In order to bridge the gap between these institutions particularly in knowledge management for the national importance programmes and schemes implemented by Government of India, like Skill India programme, Atamnirbhar Bharat, Barat Ka Amrit Mahotsava, Sankalp se Siddhi, Jal Sakti Abhiyan, Kisan Kalyan Abhiyan, Sri Anna, Poshan Abhiyan etc. In these kinds of programs, collaborative efforts from research and education system are needed for their effective implementation at grass

root level. It can only possible through proper and timely knowledge sharing and as well resource utilization at common platform to enhance the efficacy of these programmes to achieve the desired goal. On the other hand, research organisation as well as education institutes should also widen their horizon with respect to their activities targeted towards achievements of these goals of national importance through generation of quality research output and manpower for the same. At the same time timely dissemination of research in the form of product, information and knowledge to the different stakeholders. The extension approaches should also be more farmer centric and participatory, product and market oriented. So, the present NARS needs a paradigm shift according to the need of their stakeholders. As in the current scenario, issues and areas of national agenda are not subject specific, but it achieved through multidisciplinary approaches. The recent trends and advancement in the areas of climate change, carbon credit, Farmer Producer Organisation, quality assurance and marketing of agricultural produces, agriculture waste management, fodder scarcity, scope of subsidiary occupation and diversified farming, role of technology in form of advance teaching and training methods and its evaluation, IOT along with basic principle of transfer of technology and statistical tools and techniques are of utmost important to every agri-professionals. The research as well as education system still lacking behind in these emerging areas and thus more research and awareness is needed though revision of research mandates and teaching curriculum. Similarly, the technology evaluation programmes should also be reoriented towards farmer's perspective rather than academic significance. Moreover, advance teaching and training methods should be adopted for better time and resource utilization for maximum clientele. It will certainly help the different stakeholders related to agriculture system to gain a wider perspectives and fruitful knowledge of different discipline along in depth updating of their subject knowledge.

We assume that this book is designed by keeping all these facts of teaching, research as well as extension functionaries that can add value to their existing knowledge and work profile. Ultimately, it will help in establishing a more collaborative professional relationship. We hope this publication served to be fruitful to all the readers whether they are students, extensionist, researchers, academician that will fit to their job profile and enhance their current knowledge.

Editors

Contents

S. No	Title	Author(s)	Page No.
1.	For personal and professional development- education needs to be more innovative	R. K. Majumder	1
2.	The emerging role of teachers in higher education under nep 2020: opportunities & challenges	Bilal Kaloo	9
3.	Adult teaching and learning in a non-formal environment: an andragogical exploration	Samrat Sikdar	16
4.	ICT applications in extension teaching and technology adoption	Amandeep Singh, Gurpreet Kour Tulla and Y S Jadoun	21
5.	Harnessing social media for teaching and learning purposes	Komal and Sumit Kumar	39
6.	Communication skills and multimedia usage for effective presentation	Girijesh Singh Mahra and R. Roy Burman	48
7.	Importance of communication skills in modern era	Sujeet K. Jha and Y. S. Jadoun	58
8.	Role of IOT in agriculture and dairy sector	Prateek Bhaduria and Komal	67
9.	Methods of data collection, interpretation and report writing	Puspendra Kumar Singh	73
10.	Statistical methods for biological and social sciences data	Amit Kumar Jha, S. S. Tomar, N.M. Gupta and R. K. Vandre	82
11.	Planning execution and analysis of agricultural experiments	Arpan Bhowmik	91
12.	Extension Tools for Dissemination of Research Information & Technologies to Farmers	Suniti Kumar Jha	107

Contents

13.	Planning monitoring and evaluation of capacity development Programmes	Keshava	115
14.	Importance of Evaluating Extension Programmes at Field Level	Sarvejet Kaur, Y.S. Jadoun, Akshith Sai Pabba and Pinky Preeti	123
15.	Impact assessment approaches towards agri interventions	Mukesh Kumar Sinha and Anjani Kumar	141
16.	Methods and challenges for impact assessment of frontline extension programs	Rajesh K Rana	148
17.	Testing and demonstration of technologies: concept and practices	Arvind Kumar	162
18.	New avenues in marketing of agricultural produce	Shiv Raj Singh, A.K. Jha, S.M. Feroze, Rohit Kumar, and Bhola Nath	168
19.	Role of FPO in enhancing farmer's income	Preeti Mamgai, H.K. Mavi and Gurupdesh Kaur	179
20.	Role of food safety and quality assurance in food system	Anuradha Kumari	182
21.	Backyard poultry farming system for rural livelihood enhancement	Reena Kamal, P.C. Chandran, Amitava Dey, Rajni Kumari and Pradeep Ray	195
22.	Self-resilience through diversified commercial poultry farming	Jaydip Jaywant Rokade, Ravi Sruthy and A. K. Tiwari	204
23.	Good Management Practices for Profitable Livestock Farming	Ravikant Nirala, Vinita Yashveer, Ravi Ranjan Kumar Sinha, Archana Kumari	214
24.	Nutritional management for profitable dairy farming	Madhu Suman, Devesh Thakur, Manoj Sharma and Rakesh Ahuja	226

Contents

25.	Forage based balanced ration for sustainable livestock production	Deepak Upadhyay, M. M. Das and S. K. Mahanta	233
26.	Forage conservation through silage making: an inevitable technology for sustainable dairy farming	Aparna and Satbir Singh	244
27.	Scientific cultivation of fodder crops for silage making	Navjot Singh Brar, Simerjeet Kaur and Balbir Singh Khadda	252
28.	Employment opportunities through dairy based enterprises	YS Jadoun, A.K. Thakur, Amandeep Singh, Sarvjeet Kaur and R.K Nirala	257
29.	Biotechnological intervention in animal sciences	Niraj K. Singh	263
30.	Utilization of agricultural residues for its value addition	Surya Tushir, Rajeev Kumar Kapoor and Deep Narayan Yadav	266
31.	Climate Resilient Agriculture: Field Experiences	Ashish Santosh Murai	271
32.	Carbon credit in agriculture perspective	Rohit Gupta and Sanjeev Kumar Kataria	275
33.	Scope and importance of nutri-cereals in current agriculture scenario	Gurupdesh Kaur, Preeti Mamgai and Prerna Kapila	285
34.	Revival of Ancient Grain as Shree Ann for Sustainable Ecosystem	Pragya Bhadauria, Anjani Kumar, Atish Kumar and Amrendra Kumar	290
35.	Assessment approaches for studying the drudgery, energy and nutrition requirements for implementation of sustainable interventions	Nisha Verma, V P Chadhary, PC Jat, A K Prusty, Poonam Kashyap, Alka Verma, Suresh Malik, Chandra Bhanu, Amit Kumar, Dinesh Kumar N Ravisankar and Sunil Kumar	294

36.	An Outline of Inorganic Fertilizers, Herbicides, and Pesticides and Their Effects on Biodiversity in Jammu and Kashmir	Rayees Ahmad Shah	305
37.	Natural Farming for Sustainable Soil Health Management in Climate Change Scenario	Pragya Bhaduria, Anjani Kumar, Rohit Kumar and Amrendra Kumar	314

For Personal and Professional Development- Education Needs To Be More Innovative

Dr. R. K. Majumder

Former Professor, College of Fisheries (CAU-I)

Lembucherra, Tripura

Corresponding author: drrkmcof@gmail.com

Abstract

Education plays a very important role in every aspect of our life. A person who understands the practical applicability of education is successful in his life. Being a student, merely rending the textual things and scoring good marks is not important. What is important is to understand how it is going to make our life beautiful for us and everyone around us. That is why an educated mind and a good heart combine together to create revolutionary changes in the society. Education is about learning skills and knowledge. It helps us to build opinions and have our own point of view on different things in life. The process by which an individual acquires new skills, behaviours or understanding, often in a formal or informal setting is called education.

Introduction

“A good head and good heart are always a formidable combination. But when you add to that a literate tongue or pen, then you have something very special.”

– Nelson Mandela.

Education plays a very important role in every aspect of our life. A person who understands the practical applicability of education is successful in his life. Being a student, merely rending the textual things and scoring good marks is not important. What is important is to understand how it is going to make our life beautiful for us and everyone around us. That is why an educated mind and a good heart combine together to create revolutionary changes in the society. Education is about learning skills and knowledge. It helps us to build opinions and have our own point of view on different things in life. The process by which an individual acquires new skills, behaviours or understanding, often in a formal or informal setting is called education.

The great poet William Butler Yeats once said that “Education should not be the filling of a pail, but the lighting of a fire”. Education, being a social institution serving the needs of society, is indispensable for society to survive and thrive. It should be not only comprehensive, sustainable, and superb, but must continuously evolve to meet the challenges of the fast-changing and unpredictable globalized world. Education is the foundation of our economy. What and how we learn in school determines who we become as individuals and our success throughout our lives. It informs how we solve problems, how we work with others, and how we look at the world around us. In today’s innovation economy, education becomes even more important for developing the next generation of innovators and creative thinkers. However, there is a significant gap between the potential of modern education and what many

students are actually learning. The adoption and exploration of innovative ideas in education is often slow. Instead, many educators still cling to old and increasingly ineffective methods of teaching. Using innovative teaching methods to better serve students and to teach them about the benefits of innovative thinking does so much more than just "fill the pail". It ignites a passion for learning and provides students with the tools they need to succeed in the innovation economy. Despite a good deal of ongoing educational research and innovation, we have not actually seen discernible improvements in either school students' or college graduates' achievements and success in improving their livelihood without government or private jobs. Our present education system hardly inspires the pass outs for taking any challenging task for entrepreneurship. Could it be that our education system is not sufficiently innovative? It is fact that the government jobs are shrinking day by day due to privatization and other reasons, and in this changing situation, only infusion of innovative ideas through degree level education could be the pathfinder for the educated unemployed youths. Education is probably the single most important function in our society today, yet it remains one of the least understood, despite incredible levels of investment from venture capitalists and governments.

Education For Personal Development

"Personality is the sum and organization of those traits which determine the role of the individual in the group." – Robert Park and Earnest Bugess.

The role that education plays in shaping our personality is matchless. Being educated means to elevate our personalities. One's personality development is as important as being educated. Elevated personality pushes us to move forward and outshine in the crowd. But for having a good personality education is very important. There are many such personalities who have set forth their lives as an example for the society like Bill Gates, Stephen Hawkins etc. Through the education, an individual learns that how should we behave with others. People's behaviour gets them respect in the society. A wrong behaviour can spoil the personality of any individual. In educational system, people learn the code of conduct that how to behave with others. An educated person knows that how to act at different places. Education teaches us that what kind of words we should use when we talk to others. An educated individual knows that that we should never use any kind of abusive language with others. Education teaches us that how can we control our emotions. In our society, we have to communicate rightly and behave properly.

Positivity allows a person to deal with difficulties successfully. Education teaches us to be positive. Those people have positive attitude can easily remove hurdles of their ways. Through the education, an individual can develop a positive attitude towards things and people. Education teaches us that everything which exists in this world have some negative aspects as well as some positive aspects. So, we shouldn't ponder over only the negativity in someone, we should also watch and think upon the positive aspects of the things, people or situations. Then we could be able to understand things properly. The person who is able to correct other's

mistakes as well is considered as a good personality. With the help of education an individual can be aware of his personal and political rights. It tells us how to get our rights and also how to respect other people's rights. Education teaches us that everyone is equal in our society. It tells us about our duties also. It teaches us to be a good citizen, treat the woman on equal level, give vote, and acquire the human rights.

Education enhances our knowledge by providing us useful information; "Old information" and "new information". It gets us updated about new information in various fields like technology and new inventions etc. Education also helps us in increasing confidence in various ways like communication, decision making, meeting challenges, receiving feedback and improving self-confidence.

- *Decision Making*– The best decisions are backed by knowledge and When we have deeper understanding of anything then we are in the position of making confident decisions.
- *Meeting Challenges* – Education teaches us that how to manage activities and if any problem arises at the same time-how to solve it confidently.
- *Receiving Feedback* – Teacher's feedback always boosts the confidence in the students. Negative feedback forces student to do better next time and by getting positive feedback students do something new in that area.

Education is central to personality development. Aside from providing a person with the knowledge and skills they need to succeed in life. It can also teach them how to think critically and make informed decisions. Additionally, education can help people develop positive relationships with others. All of these factors can contribute to a person's overall personality development and how they carry themselves in the real world. Personality development is important for students because it helps them do the following:

- *Overcome shyness*: Being confident and comfortable in social situations is an important part of student life. Students who are shy or have low self-esteem often find it difficult to participate in class discussions or make new friends. Personality development can help them overcome these hesitations and build their confidence.
- *Develop better communication skills*: Students need to be able to communicate effectively to participate in class discussions, ask questions and make presentations. Personality development can help students to develop the communication skills they need to be successful in their studies.
- *Build leadership skills*: Leadership is an important quality for success in any field. Students who want to achieve success in their chosen career path need to be able to lead others.

- *Improve problem-solving ability:* Problem-solving is a useful ability in any aspect of life. These skills are critical as kids get older and encounter new challenges in their job and personal lives.
- *Develop a positive outlook on life:* A positive outlook will help students to stay motivated and focused on their goals. It will also help them to deal with stress and setbacks.

Personality development is a life-long process. Education provides us many opportunities and many experiences. When we get different opportunities, we show off our personality and make it even better. Opportunities and experiences both words are interrelated. Opportunity brings to us many new things with new experiences. We take those experiences only when we take up the opportunities rightly as provided by education. Along with all kind of real knowledge and bookish knowledge, teachers also impart moral values in students and from these moral values they learn the healthy habits and try to inculcate to them. Healthy habits like how timely we can do our work, keep the surroundings neat and clean and to do a work in disciplined manner, etc. So, through these healthy habit's education helps us in development of personality. Education teaches us ethics which helps us to go to a right path and adopt the right things. Then we do all the things in a fair manner only to become successful. So, ethics always improves our personality in a positive way.

It's nevertheless to say that education is foundation stone of a great personality.

"Education is the great engine of personal development. It is through education that the daughter of a peasant can become a doctor, that the son of a mine worker can become the head of the mine, that a child of farm workers can become the president of a great nation. It is what we make out of what we have, not what we are given, that separates one person from another". – Nelson Mandela

Education For Professional Development

The professional world is becoming increasingly competitive and is constantly changing, so professional development and continual learning is more important than ever in being successful and achieving career goals. Technologies and best practices are evolving and progressing in every industry, making it crucial for both new and experienced professionals to continue developing their skills and honing their knowledge. Professional development refers to continuing education and career training after a person has entered the workforce in order to help them develop new skills, stay up-to-date on current trends, and advance their career. Many fields require professionals to participate in continuing education and ongoing learning, sometimes as a prerequisite for keeping their job or to maintain their license, designation, or certification.

Education is a learning cycle without an end. It is not going to stop after graduation and starting a career. Continuing education helps career-minded individuals to continually improve their skills and become more professional at their work. Beyond continuing education, professional development can refer to many different types of relevant educational or training opportunities relevant to the professional's work. Even when not required, many professionals who want to excel in their career will voluntarily seek out professional development and learning opportunities.

Why Innovative Education?

Education is sometimes perceived as a sector which is resistant to change, while at the same time it faces a crisis of productivity and efficiency. Technology and other changes in society demand innovation in education. For an individual, a nation, and humankind to survive and progress, innovation and evolution are essential. Innovations in education are of particular importance because education plays a crucial role in creating a sustainable future. Innovation, therefore, is to be regarded as an instrument of necessary and positive change. Any human activity (e.g., industrial, business, or educational) needs constant innovation to remain sustainable. The need for educational innovations has become acute. It is widely believed that countries' social and economic well-being will depend to an ever-greater extent on the quality of their citizens' education: the emergence of the so-called 'knowledge society', the transformation of information and the media, and increasing specialization on the part of organizations all call for high skill profiles and levels of knowledge. Today's education systems are required to be both effective and efficient, or in other words, to reach the goals set for them while making the best use of available resources. According to an Organization for Economic Cooperation and Development (OECD) report, "the pressure to increase equity and improve educational outcomes for students is growing around the world". Yet, more than 72 years later after freedom, we realize that the actual pace of educational innovations and their implementation is too slow as shown by the learning outcomes of both school and college graduates, which are far from what is needed in today's India. It's important for educators to prepare students for the future by empowering them with the foundational skills they need to succeed later in life. By exploring new and better ways to educate students and also teaching the skills students need to become innovators themselves, today's educators can have a tremendous impact on the future of our world. The new century introduced significant changes in didactics and teaching methods. Pedagogy of the twentieth century differs from the pedagogy of the twenty-first century. Since the beginning of the twenty-first century, there have been many changes in the development of national and world education. The most observable phenomenon is now the internalization of society and the penetration of digital technologies into learning. Impacts of innovative education in a society.

As more people have a high quality of life, societies become more prosperous. Using the latest technology to solve social issues also has a strong economic impact. Technological advancements, for example, allow social change groups to think big. With the right equipment, social programs can tackle global and local issues with improved efficiency. Productivity improves as these organizations spend less time dealing with outdated technology and more time focused on social progress. One of the problems of contemporary society is that the educational system must be able to train youths for life, equipping them with not only knowledge and different skills, but in particular teaching them how to confront everyday challenges and problems, and, in turn, how to resolve them. Social progress and advancements in technology have always been closely intertwined. New technology in society can promote a higher quality of life, which in turn creates a community free to pursue scientific advancements. On a socioeconomic level, the impact of innovation is far-reaching and essential for growth. The educational process must be more closely related to the individual's needs, their personal development and the cultural environment in which they live. Young people of any society have to develop not only their cognitive competences, but also cooperativeness and social competences because these are one of the basic conditions for life-long learning and improved employability. To achieve this, flexible forms of learning have to be implemented. The complexity of all the things affecting the youth of today such as the environment, technology, immediately accessible information, etc. requires a well thought-out and quicker response because the social environment in which we live (society, technology, etc.) is changing very rapidly. Therefore, the degree programme of today must prepare students for occupations and social environments, which at this moment don't even exist yet. All these changes in the social environment, in turn, require different, innovative ways of learning and teaching, to which the entire education system must be able to adapt on a paradigmatic level. In the proposed learning and teaching strategy, special attention should be given to increasing the level of interest and motivation in youth.

Innovative Education Versus Entrepreneurship

Innovation is important in entrepreneurship. In the highly competitive world that we live in, innovative ideas are what will separate you from the rest. The goal is not to build just an average startup, but to create an outstanding product, strong brand and to build customer network. Innovation doesn't always mean to create something new as innovators often take something that already exists, improve it, change it, make it better and make it the best for their customers. Innovative ideas are what will make a startup competitive. Being innovative doesn't happen overnight and it requires time and effort to create something truly innovative that will make difference. Innovation and creativity walk hand in hand when we talk about entrepreneurship. Here one can find several ways to look at innovation in order to understand its importance in entrepreneurship, education, ideas execution, knowledge and more.

The current education system in India follows model of rote-based learning, the ‘chalk-and-talk’ system, where the teacher talks endlessly and dictatorially and the student listens passively and submissively has discouraged questioning, discovery, experimentation and application in the school classroom. Boredom, lack of involvement, low confidence and self-belief, and an obsessive fear of failure are the unfortunate results of this unimaginative factory-based model of education. Not surprisingly, downbeat attitudes acquired at an early age have carried into adulthood, resulting in a workforce that is, for the most part, lacking of the temper, desire and energy to create, invent and innovate. In the era of ‘Startup India’, despite the exciting birth of a lot of new businesses, we have not witnessed an equivalent number of original or innovative ideas at scale from India.

Reflecting perhaps years of uncreative education, an almost instinctive urge to copy ideas from outside, seen as a more predictable and dependable way of making money, has precluded hundreds of Indians from investing their time and energy in new and original ideas with a long-term, and possibly, uncertain return. Reversion of this narrow-minded “copying culture” requires faith in one’s own ability to discover and create, as well as the willingness to invest time and effort to produce inventive ideas and solutions relevant for the Indian context. Passion-based creativity, doing something not solely because one wants to make money but because one wants to solve a significant problem, create something of great value or change or shift a paradigm is a rare commodity. It is the passionate creators, inventors and innovators who have opened innumerable doors of possibility and opportunity for the rest of us. To foster a culture of creativity and innovation we should overhaul our educational focus and philosophy. A sorry reality of today’s education is that students find school and college uninteresting. “Why am I learning what I am learning?” and, “I don’t remember anything I learned in school or college” are cheerless statements that one frequently hears in interactions with students. No wonder millions of children drop out from schools and colleges forever keeping their innate creativity under lock and key.

Conclusion

Innovation could help improve the quality of education. It considers what skills are needed to encourage innovation more widely in the economy and whether schools and universities are helping students develop those skills. In the last few decades, innovation in general has been increasingly regarded as a crucial factor in maintaining competitiveness in a globalised economy. Businesses need to innovate in order to keep up with their competition by introducing new products or services, improving the efficiency of their production processes and organisational arrangements, or enhancing the marketing of their activities in order to guarantee their survival. Finally, education should remain relevant in the face of rapid changes to society and the national economy. The education sector should therefore introduce the changes it needs to adapt to societal needs. For example, education systems need to adopt teaching, learning or organisational practices that have been identified as helping to foster

“skills for innovation”. Governments can support this by fostering a climate of entrepreneurship and innovation in education.

It is high time to motivate the students that skill development is the only option left against Government jobs. Therefore, inclusion of value-added courses in the degree level such as ‘Skill development’, ‘Entrepreneurship’, ‘e-marketing’, ‘Value addition’ etc. will encourage the students towards entrepreneurship. Innovation, creation, etc. words are associated with the success of any entrepreneurship. It is essential that the present-day students should be well acquainted with natural resources and their commercial importance. Our curriculum at degree level should be structured in such a way that there is scope for knowing the resources of the region where he or she belongs, project writing on the innovative ideas, skill development etc., which will help the pass-outs to take the challenge to materialize their ideas into an enterprise.

References

- Ananiadou, K. and M. Claro (2009). “21st century skills and competences for new millennium learners in OECD countries”, *OECD Education Working Papers*, No. 41, OECD Publishing, <http://dx.doi.org/10.1787/218525261154>.
- Avvisati, F., G. Jacotin and S. Vincent-Lancrin (2013). “Educating higher education students for innovative economies: What international data tell us”, *Tuning Journal for Higher Education*, Vol. 1/1, pp. 223-240.
- Barret, D. (1998). *The Paradox Process: Creative Business Solutions Where You Least Expect to Find Them*, AMACOM, New York.
- Cerna, L. (2014). “Innovation, governance and reform in education”, CERI Conference background paper, 3-5 November 2014, www.oecd.org/edu/ceri/CERI%20Conference%20Background%20Paper_formatted.pdf.
- Damanpour, C. and S. Gopalakrishnan (1998). “Theories of organizational structure and innovation adoption: The role of environmental change”, *Journal of Engineering and Technology Management*, Vol. 15/1, pp. 1-24.

The Emerging Role of Teacher in Higher Education Under NEP 2020: Opportunities & Challenges

Bilal Kaloo

North Campus, University of Kashmir

Corresponding author: abilal@kashmiruniversity.ac.in

Abstract

The National Education Policy (NEP) 2020 in India has brought about significant changes and reforms in the education system, including higher education. The role of teachers in higher education under the NEP 2020 is evolving, presenting both opportunities and challenges. The NEP 2020 presents opportunities for teachers in higher education to embrace multidisciplinary approaches, incorporate technology, and contribute to the holistic development of students. However, it also brings challenges in terms of skill upgradation, assessment reforms, technology adoption, and managing increased workload. Addressing these challenges through appropriate training, support, and resources will be essential to ensure the successful implementation of the policy and the growth of teachers in the changing higher education landscape.

Introduction

India is ushering to the new destinations of academic excellence. National Education Policy -NEP 2020 is a prudent response to the aspirations of the people of the country at large. In a globalized world, the necessity to prepare the citizens for national and international opportunities demanded a complete transformation of the educational system to realign and revitalize it for contemporary challenges.

The NEP 2020 aims at making “India a global knowledge superpower”. Ministry of Human Resource Development (MHRD) is now renamed as Ministry of Education. NEP 2020 is the third major revamp of the framework of education at national level in India since independence. The two earlier education policies were brought in 1968 and 1986 respectively.

Vision of NEP 2020 and the Changing Landscape of Higher Education

The policy envisions a complete overhaul and re-energizing of higher education system. Policy vision includes

- Moving towards a higher educational system consisting of large, multidisciplinary universities and colleges, with at least one in or near every district, and with more HEIs across India that offer medium of instruction or programmes in local/Indian languages;
- moving towards a more multidisciplinary undergraduate education;
- moving towards faculty and institutional autonomy;
- revamping curriculum, pedagogy, assessment, and student support for enhanced student experiences reaffirming the integrity of faculty and institutional leadership positions through merit appointments and career progression based on teaching,

research, and service;

- establishment of a National Research Foundation to fund outstanding peer-reviewed research and to actively seed research in universities and colleges;

Salient Features of NEP 2020 with regard to higher education.

- **Increase GER to 50 % by 2035**

NEP 2020 aims to increase the Gross Enrolment Ratio in higher education including vocational education from 26.3% (2018) to 50% by 2035. 3.5 Crore new seats will be added to Higher education institutions.

- **Holistic Multidisciplinary Education**

The policy envisages broad-based, multi-disciplinary, holistic Under Graduate education with flexible curricula, creative combinations of subjects, integration of vocational education and multiple entries and exit points with appropriate certification. UG education can be of 3 or 4 years with multiple exit options and appropriate certification within this period. For example, Certificate after 1 year, Advanced Diploma after 2 years, Bachelor's Degree after 3 years and Bachelor's with Research after 4 years.

- An **Academic Bank of Credit** is to be established for digitally storing academic credits earned from different HEIs so that these can be transferred and counted towards final degree earned.

- **Multidisciplinary Education and Research Universities (MERUs)**, at par with IITs, IIMs, to be set up as models of best multidisciplinary education of global standards in the country.

- **The National Research Foundation** will be created as an apex body for fostering a strong research culture and building research capacity across higher education.

- **Institutional Restructuring and Consolidation**

Higher education institutions will be transformed into large, well resourced, vibrant multidisciplinary institutions providing high-quality teaching, research, and community engagement. The definition of the university will allow a spectrum of institutions that range from **Research-intensive Universities** to **Teaching-intensive Universities** and **Autonomous Degree-granting Colleges**.

Affiliation

Affiliation of colleges is to be phased out in **15 years** and a stage-wise mechanism is to be established for granting graded autonomy to colleges. Over a period of time, it is envisaged that **every college** would develop into either an Autonomous degree-granting College or a constituent college of a university. (**Optional**)

Autonomy to Colleges:

- **Stage-wise graded autonomy to colleges** through a transparent system of graded accreditation. Support to become Autonomous Degree Granting College (AC)... becoming Research Intensive or Teaching Intensive Universities if they aspire.
- These three broad categories are not rigid, exclusionary or compartmentalized. Along a continuum.
- Based on PLANS, ACTIONS and EFFECTIVENESS... HEI;s will have freedom to move from one category to another. Appropriate Accreditation System with norms to be used for colleges.
- **Open and Distance Learning (ODL)**

This will be expanded to play a significant role in increasing GER. Measures such as online courses and digital repositories, funding for research, improved student services, credit-based recognition of MOOCs, etc., will be taken to ensure it is at par with the highest quality in-class programmes.

Equity

Entry into quality higher education can open a vast array of possibilities that can lift both individuals as well as communities out of the cycles of disadvantage. **For this reason, making quality higher education opportunities available to all individuals must be among the highest priorities.** This Policy envisions ensuring equitable access to quality education to all students, with a special emphasis on socio-economically disadvantaged groups (SEDGs). Students from socio-economically disadvantaged backgrounds require encouragement and support to make a successful transition to higher education. Universities and colleges will thus be required to set up high-quality support centres and will be given adequate funds and academic resources to carry this out effectively. There will also be professional academic and career counselling available to all students, as well as counsellors to ensure physical, psychological and emotional well-being.

Institutional Development Plan

Each institution will integrate its academic plans ranging from curricular improvement to quality of classroom transaction - into its larger Institutional Development Plan (**IDP**). Each institution will be committed to the holistic development of students and create strong internal systems for supporting diverse student cohorts in academic and social domains both inside and outside formal academic interactions in the classroom.

Credits

Thrust on including credit based courses and projects in areas of community engagement and service, environmental education and value based education. **education, social work and environmental science** departments can come up with innovative credits to meet this need.

Multiple Entry & Exit

Multiple exit and entry points into higher education will be available from 2020-21; the four-year degree programme will be introduced by 2021 for Central universities and for others by 2022.

The New Revision

- A **Certificate** after completing 1 year in a discipline or field including vocational and professional areas, or
- A **Diploma** after 2 years of study, or
- A **Bachelor's Degree** after a 3-year programme.
- A **4-year multidisciplinary Bachelor's programme**, however, **shall be the preferred option** since it allows the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

4-year Bachelor's Degree with Research

HEIs will have the flexibility to offer different designs of Master's programmes: (a) there may be a 2-year programme with the second year devoted entirely to research for those who have completed the 3-year Bachelor's programme; (b) for students completing a 4-year Bachelor's programme with Research, there could be a 1-year Master's programme; and (c) there may be an integrated 5-year Bachelor's/Master's programme. *Undertaking a Ph.D. shall require either a Master's degree or a 4-year Bachelor's degree with Research. The M.Phil. programme shall be discontinued.*

Academic Bank of Credit

- An Academic Bank of Credit (ABC) shall be established which would digitally store the academic credits earned from various recognized HEIs so that the degrees from an HEI can be awarded taking into account credits earned. The 4-year programme may also lead to a degree 'with Research' if the student completes a rigorous research project in their major area(s) of study as specified by the HEI.
- **Academic Bank of Credit to be established** for digitally storing academic credits earned from different HEIs so that these can be transferred and counted towards final degree earned.
- Common Entrance Tests By National Testing Agency (NTA)
- The NEP 2020 positions National Testing Agency (NTA) as a premier testing organisation that will offer high-quality common aptitude test, as well as specialized common subject exams in the sciences, humanities, languages, arts, and vocational subjects, at least twice every year.

Teacher Education

A new and comprehensive **National Curriculum Framework for Teacher Education, NCFTE 2021**, will be formulated by the NCTE in consultation with NCERT. By 2030, the minimum degree qualification for teaching will be a **4-year integrated B.Ed.** degree. Stringent action will be taken against substandard stand-alone Teacher Education Institutions (TEIs).

The key challenges faced by Higher Education Institutions (HEI's) to effectively implement the provisions of NEP 2020 includes the following concerns related to :

Faculty
Resources
Funding
Administrative
Organisational
Attitudinal
Geographical remoteness
Technology
Privatization , Public Philanthropic Partnership..
GER to be doubled from present 26% to 50% by 2035.
Academic Bank of Credits – The Virtual Digital Repository
International Students.
Core/ Vocational. Major/Minor.
Languages/ Medium of Instruction

Many colleges and universities are facing shortage of teaching and non-teaching faculty for smooth conduct of the academic activities. NEP-2020 provisions demand adequate availability of qualified staff to provide quality education to the learners within an ambient academic environment. As envisaged in the policy document, a vibrant ecosystem of research will need augmentation of state of the art infrastructure and facilities to ensure equity of standards in education across all higher educational institutions.

Challenges

- Highly uneven enrolment in colleges across regions and as per streams with urban centric colleges in cities and towns exceeding Pupil Teacher Ratio
- Newly established colleges need time to grow with adequate investments to attain status of Autonomous Degree granting Colleges (AC) status. As such they need continuous support and mentorship to strengthen their academic credentials to meet new benchmarks.
- Demographic/socio-economic/ geographical /regional diversity: India, as a country

is a classic case of composite culture. The complex diversity of living patterns of people living in different topographical habitations has their own pros and cons. As an example the UTs of J&K and Ladakh have their own socio-cultural distinctions. Ladakh hosts a major lot of Schedule Tribe population and Jammu hosting a large share of SC population. Climatic conditions in Ladakh are least conducive for smooth teaching learning activities as tough weather conditions and frequent closure of road connectivity poses challenges.

- Open and Distance Learning will also be revisited to explore inclusion of enriched programme content to cater to the educational needs of learners with quality inputs. As of now, ODL will gear up to take up this challenge and needs lot of investment for its expansion to fit into the newly oriented role.
- To improve research culture, state of the art facilities need to be put at place for motivation of brilliant minds to give their best to raise the standards to match global standards.

The New Emerging Role of Teacher In Higher Education Under NEP 2020

1.	Teaching
2.	Planner (IDP)
3.	Coordinator (Linkages & Collaboration)
4.	Leader (Institutional Autonomy)
5.	Content Developer (Blended learning/ Online learning)
6.	Facilitator (For Student & For Institution)
7.	Curriculum Designer (Customization to tailor the curriculum for diverse learners)
8.	Active Learner (Life Long feature) to update knowledge, skill set & pedagogy
9.	Tech Savvy . Latest ICT tools and software Systems
10.	Social Responsiveness.
11.	Researcher (Quality/Research ecosystem for pressing social concerns)

The primary responsibility of teacher to impart knowledge will always remain a top priority. The role set for the defined and designated tasks under NEP 2020 has to be more accommodative and flexible to adjust the new challenges within the dynamic academic landscape. In order to achieve the stipulated targets of the policy, the higher educational institutions have to come up with a roadmap to plan their actions and interventions meticulously to raise their academic standards in tune with the prescribed benchmarks set by the accreditation agencies. Teacher being at the pivot of the educational institution has to be highly versatile to play active role as planner, coordinator, leader, facilitator, content developer, researcher, community mobilizer etc to successfully negotiate with the diverse spectrum of changing academic scenario of higher education. As an active learner, the pursuit to imbibe and inculcate new knowledge and skills will support and strengthen the teachers to act as torch bearers to lead the academic institutions to new heights of excellence.

References

- https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf <https://www.education.gov.in/nep-new>
Retrieved on 16-05-2023.
- Aithal, P. S., & Aithal, S. (2020). Analysis of the Indian National Education Policy 2020 towards achieving its objectives. *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 5(2), 19-41.
- Dar, R. A., & Ganaie, N. A. (2023). Importance Of NEP 2020 For Changing Role Of Teacher Educators. *Elementary Education Online*, 20(1), 8289-8289.
- Kalyani, P. (2020). An empirical study on NEP 2020 [National Education Policy] with special reference to the future of Indian education system and its effects on the Stakeholders. *Journal of Management Engineering and Information Technology*, 7(5), 1-17.
- Kumar, A. (2021). New education policy (NEP) 2020: A roadmap for India 2.0. *University of South Florida M3 Center Publishing*, 3(2021), 36.
- Kumar, A. (2022). Digital Education: Vision, Perspectives and Problems in Changing Paradigms of NEP-2020.
- Panditrao, M. M., & Panditrao, M. M. (2020). National Education Policy 2020: What is in it for a student, a parent, a teacher, or us, as a Higher Education Institution/University?. *Adesh University Journal of Medical Sciences & Research*, 2(2), 70-79.
- Smitha, S. (2020). National Education Policy (Nep) 2020-Opportunities and Challenges in Teacher Education. *International Journal of Management (IJM)*, 11(11).

Adult teaching & Learning in a Formal/Non-Formal Environment: an Andragogical Exploration

Samrat Sikdar

*College of Agriculture & Life Sciences, Mississippi State University, USA
Corresponding author: s.sikdarextn@hotmail.com*

Abstract

Adult teaching and learning in both formal and non-formal environments requires a different approach compared to pedagogy, which is primarily focused on child education. This approach is known as andragogy, which refers to the methods and principles of teaching adult learners. In both formal and non-formal environments, andragogy recognizes the unique characteristics of adult learners and emphasizes learner autonomy, relevance, collaboration, and practical application of knowledge. Teachers adopting an andragogical approach can facilitate effective adult teaching and learning experiences, empowering adults to achieve their educational goals and contribute to their personal and professional growth.

Introduction

Learning is a process that leads to change, which occurs as a result of experience & increases the potential for improved performance and future learning. It is necessary to understand that learning is a process, not a product. However, because this process takes place in the mind, we can only infer that it has occurred from students' products or performances. It involves change in knowledge, beliefs, attitudes, and behaviours. This change unfolds over time; it is not fleeting but rather has a lasting impact on how students think and act. Learning is not something done to the students, but the students do that themselves. It is the direct result of how students interpret and respond to their experiences — conscious and unconscious, past, and present.

There are few essential characteristics of effective teaching which a successful teacher needs to consider. The clarity of the subject matter needs to be considered while teaching the students. It is necessary to ensure that the subject matter possess organization and structure along with the clear indication of the purpose and direction of the lesson. This is because the students should properly identify the purpose and direction of a particular lesson. Subject matter should also be connected to other instructional topics & units. The teacher should use a variety of teaching methods & techniques. They should use strategies for all learning styles. The teacher should vary instruction within a single class period to improve student attention. It is necessary to incorporate varying levels of cognition within the lessons taught.

It is also highly recommended to demonstrate enthusiasm through physical movements, body gestures, voice inflections, and using props to attract students' interest. Nobody can really deny that enthusiasm is contagious. Enthusiastic teachers create an interest in the subject matter. Educators can demonstrate enthusiasm through physical movements, body gestures, voice inflections, and using props to attract student interest both in formal and non-

formal educational settings. Students should be provided with the opportunities to show their learning. The objectives should be created and shared with students. This criterion should guide the teaching-learning process and be used to evaluate the students' performance. There should be implementation of the task-oriented behaviour, so that the students can receive the directions and they can be guided through proper teaching-learning process. That should be extended to which teaching-learning activities are structured, organized, and guided. It is required to ensure that students are provided directions and guided through the teaching-learning process. Teachers demonstrating this characteristic skilfully and efficiently select/use appropriate teaching methods & techniques.

The teaching principles include acquiring relevant knowledge about the students and using that knowledge as well to inform our course design and classroom teaching. The teaching process should be aligned with 3 major components of instruction i.e., learning objectives, assessments, and instructional activities. Effective teaching also includes articulating explicit expectations regarding learning objectives and policies. That must prioritise the knowledge and skills the instructors choose to focus on. Recognizing and overcoming the expert blind spots is also a part of the principles of effective teaching. Alongside, effective teaching involves adopting appropriate teaching roles to support the predetermined learning goals. It is essential to consider the reflections and feedback received from the learners and refine the courses progressively based on those. Thus, if a teacher aims to deliver a successful teaching to the learners, it is necessary for that teacher to hold the knowledge about the principles of successful teaching and implement those in a correct manner.

It is also important to consider the principles of learning. Students' prior knowledge holds the ability to facilitate or hinder the learning. Students come into our courses with knowledge, beliefs, and attitudes gained in other courses and through daily life. As students bring this knowledge to bear in our classrooms, it influences how they filter and interpret what they are learning. If students' prior knowledge is robust and accurate and activated at the appropriate time, it provides a strong foundation for building new knowledge. However, when knowledge is inert, insufficient for the task, activated inappropriately, or inaccurate, it can interfere with or impede new learning.

The way students organize the knowledge is also relevant in the process of learning and the subsequent application of the knowledge. Students naturally make connections between pieces of knowledge. When those connections form knowledge structures that are accurately and meaningfully organized, students are better able to retrieve and apply their knowledge effectively and efficiently. In contrast, when knowledge is connected in inaccurate or random ways, students can fail to retrieve or apply it appropriately.

The motivation status of the students is also a factor which determines the level of learning of the students. As students enter college and gain greater autonomy over what, when, and how they study and learn, motivation plays a critical role in guiding the direction, intensity, persistence, and quality of the learning behaviours in which they engage. When students find positive value in a learning goal or activity, expect to successfully achieve a desired learning outcome, and perceive support from their environment, they are likely to be strongly motivated to learn.

Students must acquire component skills; practice integrating them and know when to apply what they have learned. Goal-directed practice coupled with targeted feedback enhances the quality of students' learning. Students must develop not only the component skills and knowledge necessary to perform complex tasks, but they must also practice combining and integrating them to develop greater fluency and automaticity. Finally, students must learn when and how to apply the skills and knowledge they learn. As instructors, it is important that we develop conscious awareness of these elements of mastery so as to help our students learn more effectively.

Goal - directed practice coupled with targeted feedback enhances the quality of students learning. Learning and performance are best fostered when students engage in practice that focuses on a specific goal or criterion, targets an appropriate level of challenge, and is of sufficient quantity and frequency to meet the performance criteria. Practice must be coupled with feedback that explicitly communicates about some aspect(s) of students' performance relative to specific target criteria, provides information to help students progress in meeting those criteria, and is given at a time and frequency that allows it to be useful.

Moreover, learners' current level of development interacts with the social, emotional, and intellectual climate of the course to impact learning. Students are not only intellectual but also social and emotional beings, and they are still developing the full range of intellectual, social, and emotional skills. While we cannot control the developmental process, we can shape the intellectual, social, emotional, and physical aspects of the classroom climate in developmentally appropriate ways. In fact, many studies have shown that the climate we create has implications for our students. A negative climate may impede learning and performance, but a positive climate can energize students' learning.

Students must learn to monitor and adjust their approaches to learning in order to become self-directed learners. Learners may engage in a variety of metacognitive processes to monitor and control their learning — assessing the task at hand, evaluating their own strengths and weaknesses, planning their approach, applying, and monitoring various strategies, and reflecting on the degree to which their current approach is working. Unfortunately, students tend not to engage in these processes naturally. When students develop the skills to engage these processes, they gain intellectual habits that not only improve their performance but also their effectiveness as learners.

Not only are these principles research - based, but it was also found that they are-

- **Domain** - independent: They apply equally well across all subject areas, from biology to design to history to robotics; the fundamental factors that impact the way students learn transcend disciplinary differences.

Experience - independent: The principles apply to all educational levels and pedagogical situations. In other words, although the pedagogical implications of a principle will be somewhat different for first - year undergraduate students in a lab environment as opposed to graduate students in a studio environment, the principle still applies.

- **Cross** - culturally relevant: Although the research we identified has been conducted primarily in the Western world, faculty colleagues in other countries have resonated with the principles, finding them relevant to their own classes and students. However, it is important to bear in mind that culture can and does influence how the principles should be applied as instructors design and teach their courses.

Motivation refers to the personal investment that an individual has in reaching a desired state or outcome. In the context of learning, motivation influences the direction, intensity, persistence, and quality of the learning behaviours in which students engage. The importance of motivation, in the context of learning, cannot be overstated. As students enter college and gain greater autonomy over what, when, and how they study and learn, motivation plays a critical role in guiding their behaviours. In addition, because there are many competing goals that vie for their attention, time, and energy, it is crucial to understand what may increase or decrease students' motivations to pursue specific goals related to learning.

Chickering provided a model in 1969 that tries to systematically account for all the developmental changes students experience through the college years. He groups them in seven dimensions, which he calls vectors. They build on each other cumulatively:

- **Developing competence**- This dimension involves intellectual, physical, and interpersonal competence. Intellectual competence includes everything from developing study skills appropriate for college to developing sophisticated critical thinking and problem-solving abilities. Physical competence involves athletic activities, but also the realization on the part of students that they (and not their parents) are now responsible for their health and well-being. Interpersonal competence includes communication, group, and leadership skills. These three competences together give the individual a general sense of confidence that she can successfully deal with challenges that come her way. As Professor Guttman avoids calling on women in class, he might inadvertently hinder the development of their sense of intellectual and interpersonal competence, because this act highlights an assumption that women would not be able to perform as well on the spot.
- **Managing emotions**- This dimension involves being aware of one's own emotions (including anxiety, happiness, anger, frustration, excitement, depression, and so on) as well as expressing them appropriately. The students in the Economics class are clearly in touch with their own emotions but have trouble expressing them in a productive way in the discussion, with the result that the discussion does not explore the content fully and everybody's learning is diminished.
- **Developing autonomy**- This dimension involves disengaging from one's parents, relying more on peers, and finally developing personal autonomy. This process happens through the development of emotional independence (freeing oneself from the need for parental approval) and of instrumental independence (ability to deal with challenges on one's own terms).

- **Establishing identity**- This is the pivotal dimension in Chickering's theory. It builds on the preceding vectors and serves as the foundation for the ones that follow. It culminates in the development of a sense of self. It involves comfort with one's own body and appearance, gender and sexual orientation, and racial and ethnic heritage. Students with a well - developed sense of self feel less threatened by new ideas involving beliefs that conflict with their own. In the economics class, some students appear to be working through such challenges, but they are clearly not mature enough yet to consider alternative points of view without their whole sense of identity feeling threatened.
- **Freeing interpersonal relationships**- This dimension involves achieving mature interpersonal relationships. It necessitates an awareness of differences among people and a tolerance of those differences. The development of meaningful intimacy in the context of a romantic relationship is also part of this vector.
- **Developing purpose**- Once identity is achieved, the question is no longer "Who am I?" but "Who am I going to be?" This dimension involves nurturing specific interests and committing to a profession, or a lifestyle, even when it meets with opposition from others (such as parents).
- **Developing integrity**. This dimension speaks to the tension between self - interest and social responsibility. When navigated successfully, it culminates with the adoption of a set of internally consistent values that guide and direct behaviour.

These developmental vectors involve several social and emotional as well as intellectual processes. How students negotiate these processes shapes how they will grow personally and interact with one other, the instructor, and the content of their courses. It will also influence their level of engagement, motivation, and persistence, as well as their sense of agency and identity in their chosen field. Developmental processes, in other words, have profound implications for learning.

Reference

The book "How Learning Works: 7 Research-based Principles for Smart Teaching" written by Ambrose, S.A., Bridges, M.W., Lovett, M.C., DiPietro, M. & Norman, M.K. is relevant in the above discussion (published by Jossey-Bass, A Wiley Imprint).

ICT Applications in Extension Teaching and Technology Adoption

Amandeep Singh¹, Gurpreet Kour Tulla¹ and Y S Jadoun²

¹Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana, Punjab

²Sanjay Gandhi Institute of Dairy Technology, Bihar Animal Sciences University, Patna, Bihar

Corresponding author: amandeepsingh@gadvasu.in

Abstract

The Information and Communication Technology (ICT) is computer-based technology and telecommunication. Massive growth in the mobile and internet users has led a revolution in the extension and teaching using ICTs. It is used in most of the fields such as e-commerce, e-governance, banking, agriculture, education, medicine, defense, transport, etc. There is a need for the capacity building of stakeholders as well as livestock farmers for development of ICTs and their use respectively. Modern interventions like Remote Sensing and Geographical Information System (GIS) and Artificial Intelligence based ICT tools show a promising future but there is a need to check them for their cost effectiveness and their perceived utility in the Indian rural conditions. Further research should be focused on making the ICT tools more interactive, user friendly and cost effective.

Introduction

Information and Communication Technology (ICT) is an umbrella term that encompasses all communication technologies such as internet, wireless networks, cell phones, satellite communications, digital television etc. Information Communication Technology (ICT) ordinarily refers to computer-based technology and telecommunication. Massive growth in the mobile and internet users has led a revolution in the extension and teaching using ICTs. With Government of India's Digital India Mission and by the provision of economical tariffs by telecom providers to the users have paved way for the internet technology at everyone's doorstep. Improved package of practices are being to the farmers and other stakeholders by the use of mobile apps, expert systems and web portals whereas the regular advisories are provided to them through tele-services, SMS and Remote Sensing based tools. The animals are identified by the use of RFID tags which are helping livestock farmers as well as the resource-based companies for resource disposal. Further, the stakeholders in livestock sector are connected to peers through social media and mobile telephony like Kisan Call Centre and Pashu Palak Tele-Advisory Kendra. The advent of artificial intelligence (AI) and utilization of its tools have further facilitated extension teaching and technology adoption. All of these technologies together weave an '*Information Web*' and are responsible for dissemination of timely information for livestock development.

ICT Applications

Information and communications technology (ICT) is used in most of the fields such as e-commerce, e-governance, banking, agriculture, education, medicine, defence, transport, etc. The use of ICTs in livestock sector dates back to the relay of livestock related programmes on radio and television.

Radio

All India Radio has always been a pioneer in research and development of Radio in India, particular to the farming community. It has conducted many research programmes and was a torch-bearer in Green Revolution in India. A hybrid rice cultivated in Tamil Nadu is also known as Radio Rice. In recent times, AIR has taken a step to come closer to the people, particularly the farming community through narrowcasting though it had a chunk called Farm and Home in its regular terrestrial broadcast. Radio has been witness to the course of development of India as an institution of communication given to catalyse the process of change on the one hand and as an upholder as well as preserver of a vibrant cultural heritage on the other. In the process, it has evolved to its present state, creating many a milestone of history of achievement and accomplishment. The relevance of radio in the process of social change has always been robust primarily because of its innate commitment, at best in tune with the times. Its craft and technique of information dissemination has meticulously kept pace with social realities in its long course of public service, and the impact has been discernible in different realms of life.

Although, All India Radio has been dedicated to the service of farming community, it embarked on the new initiative of narrowcasting to turn the hard-core agriculture programme into the Voice of Farmers i.e. Kisvanvani from 15th February 2004. The programmes are broadcasted across the length and breadth of the country. The thrust of Kisvanvani programme is to educate the farmers on the subjects such as diffusion of innovation, Lab to Land, knowledge and skill of modern and scientific techniques of agricultural practices, horticulture, animal husbandry, poultry farming, fishery, rural banking and self-employment schemes and other allied activates. Kisvanvani encompasses a wide spectrum of formats having almost all the ingredients of a good agriculture programme like *Aaj Ki Khabrein* (news of the day), *Aaj ka Bazar* (today's market), *Aaj Ka Mausam* (weather information), *Aaj Ki Batein* (special mention of the day), *Aaj Ke Kisan* (the farmer of the day- interview based) and *Desh Videsh* (news from the country and abroad).

Television

Television has pioneered the extension activities and imparted efficiency in information dissemination. Since long, television has been the prominent source for the livestock farmers for obtaining need-based information. Keeping in view, the government started DD Kisan, an Indian agriculture 24-hour television channel, which is solely owned by Doordarshan. It was launched on 26 May 2015. DD Kisan is India's first channel dedicated to the farmers. It informs farmers about changes in weather and global markets so that farmers can plan ahead. The 24×7 Kisan Channel telecasts updated information on agriculture and related subject for the benefit of its target audience including cattle rearers, bee keepers, poultry owners, mechanics and craftsmen. This includes information broadcast on the changing weather condition well in advance, and the low cost measures to protect crops and livestock and to enhance produce during such conditions. Advice of scientists is broadcasted periodically for the farmers so that they may know about the diseases, ways to protect livestock from various diseases and on how to increase the yield. The Channel gives information on newer ways of production practices being followed world over and the R&D in the agri-sector across the world. The Channel has a tie up with IMD, IARI, Agricultural Universities, Krish Vigyan Kendras etc.

Community Radio Stations

Community radio is a radio service offering a third model of radio broadcasting in addition to commercial and public broadcasting. Community stations serve geographic communities and communities of interest. They broadcast content that is popular and relevant to a local, specific audience but is often overlooked by commercial or mass-media broadcasters. Community radio stations are operated, owned, and influenced by the communities they serve. On 16 November 2006, the government of India implemented new Community Radio Guidelines, which permit NGOs, educational institutions and agricultural institutions to own and operate community radio stations. Right now, there were 251 operational community radio stations in the country, examples being TNAU, Coimbatore, GBPUAT, Pantnagar, GNDEC, Ludhiana, etc.

Radio Frequency Identification Device (RFID) Technology

RFID is an acronym for “radio-frequency identification.” This technology uses digital data, which is encoded in RFID tags and read by a reader via radio waves. RFID systems consist of three parts: an RFID tag, an RFID reader, and an antenna. A RFID tag contains an integrated circuit and an antenna, which is used to transmit data to the RFID reader, which then converts the radio waves into a practical form of data. This information is transferred through a communications interface to a main computer system, where the data is stored in a database and analyzed later. By placing RFID tags onto agricultural products' packages, farmers can determine the health condition of the product, making it convenient for processing companies to concurrently add information on the tag, such as enterprise codes, the processing date, batch processing, and package weight. RFID has also been used in livestock sector and the examples are detailed below.

Organization	Start Date	Operational Area	Benefits
Chitale Dairy, Pune	August 1996	Pune, Maharashtra	Controlled feeding process, early diagnosis of illness and pedigree analysis of cows and buffaloes resulted in 3-4 times better milk yield than the national average at Chitale Farm. National milk yield for buffaloes is around 800 litre/lactation, at Chitale's farm the productivity is nearly 2,500 litre/ lactation.
ITGI (IFFCO-Tokio General Insurance Co. Ltd.) Pasudhan Bima	August 2009	Gujarat, Maharashtra, Punjab, Rajasthan and Odisha	Using RFID technology enabled IFFCO-Tokio to change the current tagging process and brought a check on insuring non-existent or sick cattle. RFID has helped in correct identification of the animal. Current claim settlement time is around 10 days which is much lesser than earlier time of 30 days to issue insurance policy. Reduction in claims.

Institute of Financial Management and Research (IFMR), Dairy Network Enterprise (DNE) and Ergo-HDFC GIC Ltd.	April 2009	Thanjavur, Tamil Nadu	<p>The online policy disbursal on the same day for covering the farmer without delay once the insurance policy has been purchased.</p> <p>Low premium due to reduction in mortality rate by integrating the insurance schemes vaccination and de-worming of animals.</p> <p>Better animal health management by timely execution of protocol based veterinary and animal husbandry services.</p> <p>Initial economic analysis suggested that the investment cost would be recovered even if fraudulent claims of around 0.5% of the insured animals can be prevented.</p> <p>Cheating by farmers is difficult due to inbuilt mechanism in the system.</p>
IIT-Delhi and NDRI, Karnal	July 2008	NDRI, Karnal	<p>IIT, Delhi has demonstrated the temperature and humidity sensor based mist controller and water trough to control water flow based animal proximity sensor which have been installed in cattle yard for testing.</p> <p>Models are being developed to analyse the animal behaviour.</p>
Lakshya Dairy, Jind, Haryana	November 2010	Jind, Haryana	<p>Record keeping on pedigree, production, reproduction, feed, health and costs.</p> <p>Sound decision-making in selection of animals with greater genetic producing ability to develop a better future herd.</p>
Sangamner Milk Union, Maharashtra	2011	Maharashtra	<p>Performance, in terms of enhancement of productivity, can be calculated</p> <p>Recording of information about the services they provide and their observations about an animal's health is easier than the previous method or manually handwriting reports.</p>

Kopordem Farm at Valpoi, Sattari, North Goa	1996	Goa	Record keeping on pedigree, production, reproduction, feed, health and costs. Sound decision-making in selection of animals with greater genetic producing ability to develop a better future herd. Made the first injectable RFID devices. Tracking animals
Gauseva and Gauchar Vikas Board (GGVB), Gujarat	August 2017	Gujarat	Every piece of history of cows can be recorded and retrievable, and the animal and its products can be traced back to the exact origin for enhanced cattle breeding, disease control, trade, and food safety. Information, such as the animal's date of birth, breed, milk yield, and owner's name, can be written on it by RFID-enabled handheld computer.

Mobile Phone Technology

Mobile technology is the technology used for cellular communication. Mobile technology has evolved rapidly over the past few years. Since the start of this millennium, a standard mobile device has gone from being no more than a simple two-way pager to being a mobile phone, GPS navigation device, an embedded web browser and instant messaging client, and a handheld gaming console. As of January 2021, there were 4.66 billion active internet users worldwide (59.5 percent of the global population). Of this total, 92.6 percent (4.32 billion) accessed the internet via mobile devices. Mobile phones are used for sending SMS, for calls, for using different applications, and for using social media for the input and output of information of information. The few applications of mobile phone technology are detailed below.

a. Mobile Apps

Name of the App	Launched on	Developed By	Use
mKisan	July 2013	NIC, Gol	mKisan is a mobile based extension service aiming to provide information on crops, livestock, market prices and weather based advisories to resource poor farmers.
Kisan Suvidha	March 2016	Department of Agriculture, Gol	Kisan Suvidha mobile app has been developed to help farmers by providing relevant information on current weather and over the next 5 days, information on dealers, market prices, agro advisories, plant protection, IPM Practices etc.

Shetkari Masik App	2014	Department of Agriculture, Maharashtra	The app can be used to download Shetkari Masik magazine and can be read without internet connectivity. “ShetkariMasik” is one of the most popular monthly magazines in the Agriculture sector, published since 1965.
AgriMarket App	2015	Ministry of Agriculture and Farmers Welfare	AgriMarket mobile app can be used to get the market price of crops in the markets within 50 km of the device's location capture by GPS. There is another option to get price of any market and any crop in case a person does not want to use GPS location.
m K R I S H I® AQUA	2015	Tata Consultancy Services – Innovation Lab	It provides an easy tool to seafood growers in stocking, pond management, feed and water test management and sampling in addition to providing weather forecast and graphical records.
IVRI-Pashu Prajanan App	2017	ICAR-IVRI	The major reproductive diseases /disorders covered in the App are Anoestrus, Repeat Breeding, Silent Estrus, Uterine Torsion, Dystocia, Abortion, Uterine Prolapse, Retention of Foetal Membranes, Metritis, Brucellosis, Campylobacteriosis and IBR - IPV. The App additionally provides basic information on Artificial Insemination in cattle and buffaloes. The App is presently available in Hindi, English, Punjabi, Assamese, Bengali, Gujarati, Tamil and Malayalam languages.
IVRI-Shookar Palan App	2018	ICAR-IVRI	This app provides information about the commercial pig farming. The app consists of model bankable projects for ease of the farmers to start the enterprise. The app is currently launched in Hindi. The Punjabi and English version of the app is being developed.
IVRI-Artificial Insemination App	2018	ICAR-IVRI	This app provides information on artificial insemination in case of cattle and buffaloes. The app is developed in English. The app contains a linked software for record keeping and links to watch instructional videos.

IVRI-Waste Management Guide App	2019	ICAR-IVRI	The app provides comprehensive information about management of waste originating from agricultural, livestock and household activities.
Information Network for Animal Productivity & Health (INAPH)	-	NDDB	<ul style="list-style-type: none"> • NDDB has developed an Information Network for Animal Productivity & Health (INAPH), a Desktop/ Netbook / Android Tablet based field IT application that facilitates the capturing of real time reliable data on Breeding, Nutrition and Health Services delivered at farmer's doorstep. • It provides a tool for farmers, field functionaries, Union, Federation, NDDB to assess and monitor the progress of the project.
Pashu Poshan App	2015	NDDB	NDDB has developed android based software that can be used on phones as well as tablets. With the help of this software balanced ration is formulated while optimizing the cost considering animal profile, i.e. cattle or buffalo, age, milk production, milk fat, and feeding regime etc. and milk producers are advised to adjust the quantity of locally available feed ingredients offered to their animals along with mineral mixture.
NDDB AGR	2016	NDDB	An easy and interactive way to understand Good Animal Management Practices and Clean Milk Production. Learn how to handle milk hygienically. The app showcases Good Animal Husbandry practices that are easy to imbibe and follow. It showcases practices on clean milk production, Ration Balancing Programme, Green Fodder and also captures Health related aspects.

b. Social Media

As of April 2021, 50.6 per cent of the world population was active on social media. In 2020, over 50 percent of India's population was accessing social networks. As per the data, the number of active users of Facebook were 2.85 billion, followed by WhatsApp with 2.00 billion, Instagram with 1.3 billion and Twitter with 396 million active users worldwide.

Extension- Advisory and social media

There is anecdotal evidence of the effectiveness of Extension and Advisory Service (EAS) agencies for strengthening innovation networks to adapt to extreme events that impact agricultural production and productivity. EAS agencies are conceptualized as “all the institutions from different sectors that facilitate farmers’ access to knowledge, information, and technologies; their interaction with markets, research, and education; and the development of technical, organizational, and management skills and practices.” Extension advisory and social media are used for sharing knowledge (creation of different groups and pages on social media for dissemination of information to farmers), direct marketing, for peer-to-peer networking as well as for online demonstrations using online farmer friendly platforms.

c. SMS

SMS Portal - mKisan was inaugurated on July 16, 2013. Since its inception more than 2462 crore SMSs have been sent to farmers. SMSs to be sent to the farmers contain information, services and advisories. In 2014, ICAR-NDRI launched “NDRI Messaging Portal”, Messaging-cum-IVRS for Dairy Farmers for six major milk producing states of the country.

d. Kisan Call Centre

Launched by Ministry of Agriculture, Government of India. A countrywide common eleven-digit Toll Free number 1800-180-1551 or 1551 has been allotted for Kisan Call Centres. This number is accessible through mobile phones and landlines. Replies to the farmers’ queries are given in 22 local languages. The farmer dials the help line, a toll-free number, and the graduates provide the initial enquiry. If the queries handled by the graduates are not satisfactory to the farmers or the farmers want more information, the call is forwarded to call center executives. During non-working hours, IVRS based replies are provided.

e. Pashu Palak Tele-Advisory Kendra (PPTAK)

PPTAK is NABARD sponsored project earned by GADVASU, Ludhiana. It is *first of its kind initiative for livestock farmers*. Advisory and information through telecommunications will establish a strong linkage between the farmers and the University all around Punjab. The call center facility of GADVASU will provide impetus to livestock farming in information deficit areas and linking the centre to a Mobile App will further increase its utility.

f. E-Vet Project

Major objective of the e-VET project is to make use of ICT in order to deliver veterinary services to livestock farmers in rural areas right at their doorsteps. Services offered include online advice and referrals for disorders and diseases affecting livestock, details on the costs of animals and livestock products at various marketplaces, and the creation of reports for monitoring needs.

g. Other initiatives for connecting with farmers

Other than the above-mentioned initiatives, various platforms like teleconferencing, videoconferencing, satellite phones and emails are used for connecting to the farmers.

Information Systems

Information systems are the integrated software and hardware systems connected so as to provide information regarding a particular activity or set of activities. Information systems provide need-based information to the farmers and other stakeholders.

a. E-choupal

It was started in 2000 and so far, had covered a target of 38000 villages, 6500 kiosks in 9 states. e-Choupal is an initiative of ITC Limited, a conglomerate in India, to link directly with rural farmers via the Internet for procurement of agricultural and aquaculture products like soybeans, wheat, coffee, and prawns. e-Choupal tackles the challenges posed by Indian agriculture, characterized by fragmented farms, weak infrastructure and the involvement of intermediaries. The programme installs computers with internet access in rural areas of India to offer farmers up-to-date marketing and agricultural information.

b. WMSDP (Web Module for Scientific Dairy Practices)

For dissemination of scientific dairy practices a need-based Web Module for Scientific Dairy Practices (WMSDP) was developed by Sher-E-Kashmir University of Agricultural Sciences & Technology of Jammu. This information system contains information on scientific dairy practices like healthcare management, fodder production and management, general management, nutrition and feeding, and breeding and reproduction. This IT-enabled web module was developed using the latest Microsoft dot(.) net technology. ICT tools like WMSDP can be an excellent medium for dissemination of required information to the farmers.

c. BroiLearn

Web module on Broiler Farming (BroiLearn) was developed by Sher-E-Kashmir University of Agricultural Sciences & Technology of Jammu, and consists of comprehensive information on scientific broiler farming covering important aspects like breeds of chicken, poultry housing, nutrition, brooding, diseases, farm equipments and recent trends in broiler farming like organic broiler farming, contract farming, institutional finances for poultry entrepreneurship development, poultry waste management etc.

Pashu Aadhar – A Scheme to Digitize Animal Health

In August 2019, the Pashu Aadhar system was launched to cover India's 94 million-strong population of cows and buffaloes that are "in milk." Then, it was enlarged to encompass all cattle, including males, calves, elderly cattle, etc. Similar to Aadhaar cards, Pashu Aadhaar would likewise give each animal a 12-digit unique identification number, as well as the owner's information. Information of the pedigree of the cattle as well as details on calving, milk output, and immunization would all be included in Pashu Aadhaar. It will improve the traceability of animals and assist farmers and officials in animal husbandry in coming up with better plans for managing livestock in the nation.

Expert Systems

The expert systems are almost similar to information systems but are developed for a specified purpose like milk fat analysis, disease prediction, etc. The programming in expert systems is

more rigorous as compared to information systems as these are more result oriented. Few examples of expert systems are detailed below.

Name of the System	Start Date	Developed By	Operational Area	Benefits
Automatic Milk Collection Unit Systems (AMCUS)	1996	National Dairy Development Board	Gujarat	<p>Immediate payment for the milk delivered.</p> <p>Accurate information about the fat content, quantity of milk and the payment due to the farmer is displayed</p> <p>Immediate testing of the quality of milk as against testing after 2 to 3 hours of collection.</p> <p>The card reader unit ensures speed of operation and an error-free entry of identification number of the farmer</p>
National Animal Disease Referral Expert System (NADRES)	2011	NIVEDI	For the whole country	ICAR - NIVEDI has identified 13 priority diseases, based on the past incidence patterns and has built a strong database of these diseases. The database, which is backbone of the NADRES, is used for providing monthly livestock disease forewarning, which is compiled as monthly bulletins to alert the animal husbandry departments, both at the National/ state level, to take appropriate control measures.

Web Portals and Websites

In the late 1990s, the Web portal became a Web IT buzzword. A Web portal is a specially designed website that brings information from diverse sources, like emails, online forums and search engines, together in a uniform way. Web portal provides two way communication whereas one way communication is the feature of website. Few examples of portals are Agritech Portal by TNAU, Coimbatore, Vet Extension, Information Network for Animal Productivity and Health (an application that facilitates capturing of real time reliable data on breeding, nutrition and health services delivered at farmer's doorstep), etc.

Various other web-portals are listed below

Name of the Portal	Start Date	Developed By	Operational Area	Benefits
iKisan	1999	Nagarjuna Group of Companies	Andhra Pradesh	iKisan is an agricultural portal, a one-stop information resource for the farmer. iKisan provides online, detailed content on crops, crop management techniques, fertilisers and pesticides and a host of other agriculture related material. It also covers information on soils and fodder. Latest updates on related markets, products and weather forecasts are also available. Information on credit and insurance is also provided.
Electronic Knowledge Network for Innovators "KnowNet-Grin"	2000	SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institutions)	All parts of country, Started in Gujarat	Electronic network of innovators linked with users & peers through village-based kiosks with multimedia/multilingual database, communicating in local language
TARHaat	TARA was formed in 1983	Technology and Action for Rural Advancement (TARA)	Punjab, Uttar Pradesh	Creation of sustainable livelihoods, specifically in the innovation and application of appropriate technologies and their distribution through micro enterprises in rural India. Tarahaat.com is the new innovation of TARHaat which works on livestock development also.
Agropedia	January 2009	Government of India with assistance from World Bank	All the states of country	Agropedia is an online knowledge repository for information related to agriculture in India. It includes universal meta models and localized content for a variety of users with appropriate interfaces built in collaborative mode in multiple languages. It provides information on improved animal husbandry and fish farming practices.

Epashuhaar	2016	Department of Agriculture, Govt.	For the whole country	The portal is easily accessible; no login is required to check information. However, for making any transaction, a prior registration is mandated. Sellers can create an account, upload the details of the animals, including images, edit those, and provide other relevant information along with their complete address so that buyers can easily reach out to them.
mKisan	2013	C-DAC, NIC	For the whole country	This portal was started along with mKisan SMS service in order to register farmers for the same. For subscribing to the SMS service provided by mKisan farmers have to register them in this portal. Further, it also registers farmers for USSD, IVRS, KSeva and KCC. This portal also contains the link to download apps related to agriculture and allied sectors in India.

Education Softwares (Developed By ICAR-IVRI)

Name	Use
Information system for farmers in Hindi on "Pashudhan avum Kukkut Rog Suchna Pranali" (PAKRSP).	This software has been developed for 78 most important diseases of the livestock and poultry prevalent in the country and nine common packages of practices. The system is in Hindi language and would cater to the whole of the country, with voice back up, animations and photo and line diagrams. The CD will be very useful for the farmers rearing the livestock and poultry and would help them provide primary aid for most of the ailments, and would also help in disease identification, its prevention, control.
Software for students and professionals in English on "Livestock and Poultry Disease Information System" (LPDIS)	The system is in English with voice back up, animations and photo and line diagrams. The system will be very useful for the students and veterinary professional dealing with the livestock and poultry disease treatment, for disease identification, its prevention, control and for providing proper and timely treatment.

Goat Health Management Information System (GHMIS)	This is multilingual software in three languages: English, Hindi and Bangla and can be procured from the institute. The goat owners can learn about various diseases of goats, the symptoms of healthy and sick animals, vaccination schedule of goats and their deworming schedule. The system is backed up with the language specific audio, text and good quality visuals to impart the goat health related information in an attention-grabbing manner.
---	---

Educational CDs

CD for farmers in Marathi on “Health Information System” for dairy animals includes detailed information related to important diseases of the dairy animals for which the dairy owners need information. CD for farmers in Hindi based on the frequently asked queries with search engine entitled “Digital Pashuswasthya avum Pashupalan Prashnotri” contain frequently asked question (five hundred) on animal husbandry and veterinary science and is a well-understood solution to address the farmer problem. Other CDs developed by ICAR-IVRI include video CD on Scientific swine management (SSMV) in Hindi and English, video CD on Integrated farming system (MTMIFS) in English and Tamil, audio CDs on Livestock diseases Part-I, Livestock Diseases Part-II and Neonatal Calf Management. Educational CDs on bovine reproduction are developed by GADVASU, Ludhiana.

Nowadays, tutorials, games and simulators are also being used for providing farming related information. Simulators provide real life scenarios with the material to be learned being applied as it would in the real world. Games and simulators based on livestock farming provides a farmer, real life aspects of livestock management.

ICT Based Models

a. NDDB – Next generation AI service delivery model

All activities related to expansion of AI Delivery services will be supported under the National Project on Cattle and Buffalo Breeding (NPCBB), Gol. However, a pilot model for viable doorstep AI delivery services following Standard Operating Procedures through a professional service provider will be supported under NDP I. It is visualised that the Pilot Project will be self-sustainable in five years' time and will continue to provide AI services after five years without any external financial assistance. The Pilot Project envisages inducting of about 3000 trained mobile AI Technicians and carrying out annually some 4 million AIs in a financially self-sustainable manner by the end of NDP I. All the activities were destined to operate through this model digitally.

b. e-velanmai model by Tamil Nadu Agricultural University

It is a fact that less than 20 per cent of the technologies generated by State Agricultural Universities and ICAR institutes were transferred to the farmers' field in India. Scientists and farmers in order to facilitate effective dissemination of location specific technologies in a timely manner, an Information and Communication Technology (ICT) based extension model called

'e-Velanmai' for dissemination of agricultural technologies from the Scientists of Tamil Nadu Agricultural University directly to the needed farmers in the selected command areas of Tamil Nadu state, was developed. This experiment was started during July 2007 and it was carried out with the support of the Government of Tamil Nadu.

Massive Open Online Course (MOOC)

A massive open online course (MOOC) is an online course aimed at unlimited participation and open access via the Web. There are many online courses available for scientific community related to livestock farming but for farmers, there is scarcity of such courses. At present MOOC on Pig Farming in Hindi language is currently being developed by GADVASU, Ludhiana. National Institute of Agricultural Extension Management (MANAGE), Hyderabad provides various MOOCs for veterinarians like PGDAEM, etc. Coursera, Udemy, are the organizations which provides various need-based MOOCs online.

Satellite Broadcasting by Indian Space Research Organization (ISRO)

ISRO is the premier organizations which works for satellite communication in India. ISRO has implemented various projects detailed below for the farming community of the country.

Name of the Project	Start Date	Utility
Training and Development Communication Channel	1995	Three major applications of this network have emerged: distance education, rural development and industrial training. Training Field Extension Workers in Rural Areas were also done under this project
Forecasting Agricultural output using Space, Agrometeorology and Land based observations (FASAL)	2007	Predicts crop acreage using Space, Agrometeorology and Land based observations.
National Agricultural Drought Assessment and Monitoring System (NADAMS)	1986	The drought assessment is done at district level biweekly and bulletins are issued from June to October every year as these months receive highest rainfall. The advisories are given in 13 most vulnerable states of the country. Crop advisories are also issued in Kharif season.
National Agricultural Land Use Mapping	2004-05	Net sown area is important information required for national planning and identification of potential areas to achieve food security. To provide near real time net sown area of the country on an annual basis at 1:250,000 scale, multi-temporal AWIFS datasets are being used since 2004-05 onwards.

Automatic Weather Stations (AWS) and Doppler Weather Radars (DWR)	2010	Weather forecasting. Advisories to fishermen in coastal areas Cyclones are forecasted
Internet based Dairy Geographical Information System (i-DGIS) by NDDB	2014	It contains locational and attribute information of over 5 Lakh villages out of approximately 6 Lakh inhabited villages in the country, (which includes all villages in the major milk producing States of the country) along with all towns & cities, as per Census of India. i-DGIS can be used as a strong visualization tool, for planning of activities in operational area, as human census, livestock census & land use/land cover of the village is integrated and provided in one place on the digital map.

Remote Sensing and GIS Based Mapping

A geographic information system (GIS) is a computer-based tool for mapping and analyzing features and events on earth. GIS technology integrates common database operations, such as query and statistical analysis, with maps. On the other hand, remote sensing is the science of collecting data regarding an object or a phenomenon without any physical contact with the object.

Artificial Intelligence and its Application in Livestock Sector

According to NASSCOM (2017), the present share of AI in case of Agriculture and Allied Sectors in India is only 5 per cent but it is estimated that by 2030, it will be doubled. There are so many ways by which AI can be used for farmers like development of learning simulations for the farmers who want to switch to livestock farming, deriving algorithms for ascertaining the animal production, deriving algorithms to understand the pattern and the number of losses due to animal diseases and mortality, development of AI-Based Livestock Expert Systems, etc. Although, AI has both pros and cons but it is also a true saying that robots cannot replace humans. Humans are blessed with the power of creativity which will always be lacking in robots. This chapter details the artificial intelligence-based ICTs which are being used in livestock sector with special emphasis on the technologies used for livestock products.

Sector wise breakup of Artificial Intelligence in India

Narendra Modi-led government has taken a leap into artificial intelligence and training its gun to counter China's thrust towards artificial intelligence. Though we have made a modest beginning and have allocated \$480 million to promote artificial intelligence, machine learning and IoT this year, but India badly lags behind its neighboring country China. Nearly 14.42 per cent and 85.58 per cent of research is done by the industry and universities respectively on artificial intelligence. As per Scopus Analysis, about 70 per cent of the AI research is at non-

Indian companies headquartered in India. Google and IBM have published almost 62 per cent of all industry research publications, while there is only one Indian company in the top 10 – TCS with 13 per cent of all publications (Sinha, 2018).

In terms of the number of engineers graduating every year, India is among the top countries. But sadly, the engineering talent in India is largely focused on IT and not research and innovation. The Scopus analysis shows that, out of 129 deemed universities, 67 public institutions, 700 degree-granting institutions, 35,539 affiliated colleges, there are only 15 universities that contribute to almost 42 per cent of all research publications. IIT Kharagpur, the research hub of the Indian IT sector contributes to just 2.86 per cent of research publication related to the subject which according to Scopus Analysis, India's research is not matching the world's trend. The country produced less than 600 papers on AI in 2016, which is likely due to the complexity of research and lack of financial support from the government but an exponential growth in Computer Vision research. Additionally, the average citation of a top researcher in the world and Indian researcher in India is almost same (Sinha, 2018).

According to a report by National Software and Services Association (NASSCOM, 2017), the retail sector of the country employs highest number of start-ups related to AI. The agriculture sector on which 48 per cent of our population depends have market share of only 5 per cent. The following pie-chart shows the per cent share of the sectors in India related to AI ventures.

Applications for Livestock Health

- a) Robotics-Controlled Equine Imaging System
- b) Canine Patient Simulators
- c) Thermal Imaging Camera
- d) Pig Respiratory Disease Package
- e) Anti-stress ear tag

Applications for Livestock Production

- a) 3D cameras to assess Beef Cattle
- b) Virtual fences for controlling cattle
- c) AI based hydroponic system
- d) The Dutch cattle expert system
- e) Automatic Feed Manager
- f) Robo-Cams for Poultry

Applications for Animal Reproduction

- a) Face recognition systems
- b) Cow gait analyser
- c) Intelligent dairy assistant
- d) MSUES cattle calculator

- e) Smart pedometers
- f) Smart Collars

Applications for Animal Products

- a) Automatic milking booth
- b) Automated milk cooling systems
- c) Robotic hide puller
- d) Robotic carcass splitter
- e) Smart packaging

Applications for Livestock Statistics

- a) Vetel's diagnostic software
- b) IBM's Vet Computing Tool
- c) Sofie cognitive computing tool
- d) Deep Mind for Record Keeping
- e) Deep Genomics

The Way Forward

The booming increase in the internet users in the country shows the promising role of ICTs in livestock development, provided that this potential should be tapped efficiently and on time. The issues like digital illiteracy is still a challenge for the technological interventions in livestock sector but this can be overcome by implementing need based digital literacy programs for the livestock owners. Improper telecom coverage is also a challenge which can either be overcome by installation of cellular towers in the rural areas or by using satellite phone technology. Further the technology developers require to assess the information needs of the rural community and developing the technologies accordingly. There is a need for the capacity building of stakeholders as well as livestock farmers for development of ICTs and there use respectively. Modern interventions like Remote Sensing and Geographical Information System (GIS) and Artificial Intelligence based ICT tools show a promising future but there is a need to check them for their cost effectiveness and their perceived utility in the Indian rural conditions. Further research should be focused on making the ICT tools more interactive, user friendly and cost effective.

References

1. Abadi M, Agarwal A, Paul B et al (2016) *Tensor Flow: Large-Scale Machine Learning on Heterogeneous Distributed Systems*. DOI:10.1145/2951913.2976746
2. Ahmed I, Lin H, Zou L, et al (2018) An overview of smart packaging technologies for monitoring safety and quality of meat and meat products. *Packag Technol Sci* 31:449– 471.
3. Behera R, Rai S, Sathpathy D et al (2019) Climate smart livestock production. *Innovative Farming* 4(1):15-18.
4. Bell MJ, Wall E, Russell G et al (2011) The effect of improving cow productivity, fertility, and longevity on the global warming potential of dairy systems. *J Dairy Sci* 94:3662–3678.

5. De D, Singh GP (2001) Monensin enriches UMMP supplementation on in vitro methane production in crossbred calves. In: *Proceedings of the Tenth Animal Nutritional Conference (Abstract papers)*, (p. 161). Animal Nutrition Society of India, ICAR-NDRI, Karnal, India.
6. Fletcher DJ, Militello R, Schoeffler GL et al (2012) Development and evaluation of a high-fidelity canine patient simulator for veterinary clinical training. *J Vet Med Educ* 39(1):7-12. doi: 10.3138/jvme.0711.073R. PMID: 22433738.
7. Jalvingh AW, Nielsen M, Dijkhuizen AA et al (1995) A computerized decision support system for contagious animal disease control. *Pig News Info* 16 (1): 9–12.
8. Matindoust S, Baghaei-Nejad M, Abadi MHS et al (2016) Food quality and safety monitoring using gas sensor array in intelligent packaging. *Sens Rev* 36(2): 169-183.
9. Nath M, Elangovan AV, Mandal AB et al (2002) Manual on 'MakeFeed' Software for Feed Formulation. Division of Avian Nutrition and Feed Technology Central Avian Research Institute, Izatnagar, 1–2. 10.
10. Paterson AD, Otte MJ, Slingenbergh J et al (2000) The application of GIS and remote sensing based modeling techniques, for use in the economic and epidemiological assessment of disease control interventions, at a regional or national level. Proceedings of a meeting of Society for Veterinary Epidemiology and Preventive Medicine. pp 172–82. 29–31st March 2000. University of Edinburgh.
11. Ryan TJ, Wilson DA (1991) Future development of the national disease control database. Symposium on Tuberculosis, pp. 245–50. April 1991. Palmerston North Massey University, New Zealand.
12. Sanson RL, Morris RS, Stern MW (1999) EpiMAN-FMD: A decision support system for managing epidemics of vesicular disease. *Revue-Scientifique-et-Technique-Office-International des-Epizooties* 18 (3):593–605.
13. Sasidhar PVK, Sharma VP (2006) Cyber livestock outreach services in India: a model framework. *Livestock Res Rur Dev* 18(1).
14. Sharma VP (2000) Cyber extension in the context of agricultural extension in India- MANAGE. *Extension Res Rev* 1(1):24.
15. Singh, A., Jadoun, Y. S., Brar, P. S., & Kour, G. (2022). Smart Technologies in Livestock Farming. In *Smart and Sustainable Food Technologies* (pp. 25-57). Singapore: Springer Nature Singapore.
16. Singh A, Tiwari R, Dutt T (2021). An ICT driven intervention for transforming waste to wealth: methodic development and assessment of IVRI-Waste Management Guide App. *J Mat Cycles Waste Man* 23:1544–1562.
17. Singh A, Tiwari R, Panda P, Kour G, DuttT (2022). Information source utilization for organic waste management with special reference to digital technologies: A qualitative study on dairy farmers of district Ludhiana, Punjab. *Cogent Edu* 9(1), 2062093.

Harnessing Social Media for Teaching and Learning Purposes

Komal and Sumit Kumar

ICAR-Central Institute of Post-Harvest Engineering and Technology, Ludhiana, Punjab

Corresponding author: atarikomal@gmail.com

Abstract

This chapter explores the potential benefits of harnessing social media for teaching and learning purposes in higher education. The increasing use of social media by students and teachers provides an opportunity to incorporate social media tools into the teaching and learning process. This chapter discusses the ways in which social media can facilitate communication and collaboration among students and teachers, enhance student engagement and motivation, and provide a platform for interactive learning experiences. It also considers the challenges associated with social media use in education, such as issues related to privacy and digital literacy, and provides recommendations for effective integration of social media tools into the classroom. In the end, it concludes that social media has the potential to transform the teaching and learning experience, and that educators should explore ways to harness its power for educational purposes.

Introduction

Social media has revolutionized the way we communicate and interact with each other. With billions of users worldwide, it has become an integral part of our daily lives. However, social media is not just limited to personal communication and entertainment. It can also be a powerful tool for teaching and learning purposes. The benefits of using social media in education are numerous. It provides a platform for students to collaborate and communicate beyond the traditional classroom setting. Social media also promotes interaction and engagement, allowing students to share their ideas and participate in discussions. Moreover, social media can help to promote digital literacy and teach students how to use technology responsibly.

However, there are also challenges associated with using social media in education. These include issues related to privacy, cyberbullying, and distraction. It is crucial for educators to establish clear guidelines for the use of social media in the classroom and educate students about responsible social media use.

After Pandemic

The COVID-19 pandemic has drastically changed the way we learn and teach. When the pandemic hit, higher education institutions around the world were forced to quickly pivot from traditional in-person instruction to Emergency Remote Teaching (ERT) in order to continue educating students safely. Like all disciplines in higher education, the teaching of digital learning was profoundly impacted by this shift. Faculty and students had to adapt to new technologies and teaching methods, and this posed significant challenges for both groups. However, the pandemic also highlighted the importance of digital learning and the role that

social media platforms can play in education. With the advancement of technology and the rise of social media, there are many ways that educators can leverage these platforms to enhance learning experiences and engage students in new and innovative ways.

For example, educators can use social media to create communities where students can collaborate and share their ideas. They can also use social media to share class updates, resources, and reminders with students. Additionally, educators can use social media to provide visual content related to course topics, share educational videos and tutorials, and create podcasts to provide additional learning opportunities.

However, it is essential to note that the COVID-19 pandemic has also highlighted the importance of responsible social media use in education. While social media can enhance learning experiences, it is crucial for educators to establish clear guidelines for its use in the classroom and educate students about responsible social media use.

Here are some potential advancements in learning and teaching using social media after the pandemic:

With the advancement of technology and the rise of social media, there are many ways that educators can leverage these platforms to enhance learning experiences and engage students in new and innovative ways.

1. **Greater emphasis on remote learning:** The pandemic has forced many schools and universities to shift to remote learning, which has led to the increased use of social media platforms for educational purposes. In the future, we may see a continued emphasis on remote learning, with educators using social media to create virtual classrooms and deliver lectures and assignments.
2. **Personalized learning experiences:** Social media platforms can provide educators with insights into individual student's interests, strengths, and weaknesses, enabling them to create more personalized learning experiences. For example, an educator could use data from a student's social media activity to recommend specific reading materials or assignments that align with their interests.
3. **Collaborative learning:** Social media platforms can facilitate collaboration and communication among students and educators, creating a more interactive and engaging learning environment. For example, educators can use social media to create online discussion forums, group chats, and virtual study groups to foster collaboration among students.
4. **Gamification:** Gamification is the use of game design elements in non-gaming contexts, such as education. Social media platforms can be used to create gamified learning experiences, such as educational quizzes, challenges, and competitions, which can help to motivate students and make learning more fun.
5. **Increased engagement:** Social media platforms can be used to increase student engagement by providing a more interactive and visually appealing learning experience. For example, educators can use social media to incorporate multimedia elements such as

videos, images, and interactive graphics into their lessons to make them more engaging and memorable.

Types of Learning

Formal Learning

Formal learning refers to the structured learning that takes place within an educational institution, such as schools, colleges, and universities. It is usually organized and delivered by professional educators or trainers and involves a specific curriculum or syllabus. Formal learning typically leads to the attainment of academic qualifications, such as degrees, diplomas, and certificates.

Informal Learning

Informal learning, on the other hand, is learning that occurs outside of the formal educational setting. It is self-directed and learner-driven and can take many different forms, such as reading books, watching videos, attending workshops or seminars, or participating in online forums or communities. Informal learning is usually not *structured*, and the learner has more control over the pace and content of their learning.

Social Learning

Social learning can occur in a variety of contexts, such as in families, peer groups, schools, workplaces, and communities. It can take place both informally and formally, and it can involve various forms of media, including face-to-face interactions, online communication, and other types of digital media.

Social learning is particularly important for acquiring social skills and values, such as communication, cooperation, empathy, and respect for diversity. It can also be effective in promoting positive attitudes and behaviors, such as health-related behaviors, environmental sustainability, and civic engagement.

A Model of Learning Attributes

Category	Formal Attributes	Informal Attributes	Social Media Attributes
Purpose	Learning as primary purpose (Intentional)	Learning as unintended outcome (Casual learning)	Communication, creating, sharing, connecting, playing, consuming

Purpose of Learning	Teacher-initiated Teacher-led (didactic) Teacher as authority	Incidental, experiential, Individual agency Peer/friend support Feedback	Self-initiated Self-directed Effects Network support
Location/Context	Educational institution Curriculum	Home, community, museum, after school club No curriculum	Online Social recognition
Content	Knowledge Specified rigid outcome	Everyday Practice flexible or serendipitous	User-generated, Re-mixed Unintended network effects

Web History

Web 1.0 refers to the first generation of the World Wide Web, which emerged in the late 1980s and 1990s. During this time, the web was primarily a one-way communication platform, with users consuming information rather than creating or interacting with it.

Some key features of Web 1.0 include:

- i. Static HTML pages: Web 1.0 websites were primarily composed of static HTML pages, which were basic and simple in design.
- ii. Limited interactivity: Interactivity on Web 1.0 was limited to hyperlinks, which allowed users to navigate between pages, but did not allow for much else in terms of user engagement.
- iii. Top-down content creation: Content on Web 1.0 was primarily created by companies, organizations, and individuals with technical expertise and the resources to create and publish content.
- iv. Lack of social media: Social media as we know it did not exist in the Web 1.0 era, meaning that there was little to no user-generated content or social interaction online.
Some popular examples of Web 1.0 websites include early versions of Yahoo!, AOL, and GeoCities.

Web 2.0 refers to the second generation of the World Wide Web, which emerged in the early 2000s and introduced a more interactive and dynamic web experience.

Some key features of Web 2.0 include:

- i. Dynamic web content: Web 2.0 websites feature dynamic and interactive web content, such as multimedia, animations, and real-time updates.

- ii. User-generated content: Web 2.0 platforms allow users to create, publish, and share their own content, such as blog posts, videos, and social media updates.
- iii. Social media: Social media platforms like Facebook, Twitter, and LinkedIn are a major component of Web 2.0, enabling users to connect and interact with one another in real-time.
- iv. Web applications: Web 2.0 introduced a wide range of web applications, such as online productivity tools, e-commerce platforms, and gaming websites.
- v. Personalization: Web 2.0 websites are designed to be more personalized, with algorithms and data analytics used to tailor content and user experiences based on individual preferences and behaviors.

Some popular examples of Web 2.0 websites include Facebook, YouTube, Wikipedia, and Google Maps

Web 3.0 also known as the Semantic Web, is the third generation of the World Wide Web, which is focused on enabling machines to understand and interpret web content in a more sophisticated way.

Some key features of Web 3.0 include:

- i. Semantic web technologies: Web 3.0 relies on semantic web technologies, such as RDF (Resource Description Framework), OWL (Web Ontology Language), and SPARQL (SPARQL Protocol and RDF Query Language), which enable machines to understand and interpret web content in a more meaningful way.
- ii. Artificial intelligence and machine learning: Web 3.0 incorporates artificial intelligence (AI) and machine learning (ML) technologies, which enable machines to learn from and adapt to user behaviors and preferences over time.
- iii. Greater interconnectivity: Web 3.0 aims to create a more interconnected web, in which data and content are more easily shared and accessed across different devices and platforms.
- iv. Personalization and recommendation: Web 3.0 websites and applications are designed to be more personalized, with algorithms and data analytics used to tailor content and user experiences based on individual preferences and behaviors.
- v. Decentralization and blockchain technology: Web 3.0 is also characterized by greater decentralization and the use of blockchain technology, which enable users to have more control over their own data and identities online.

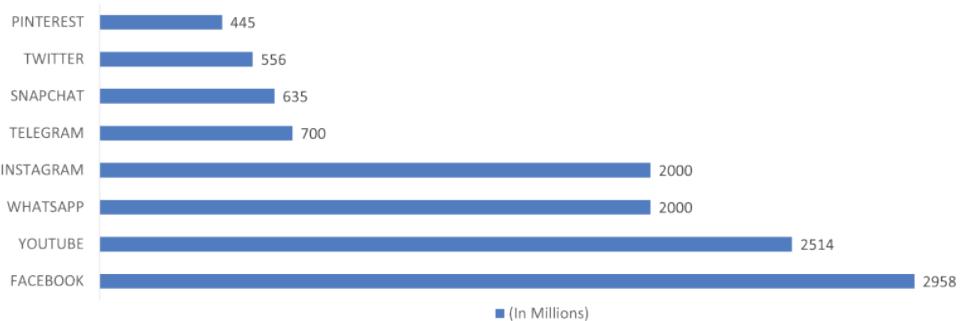
Overview of Social Media Use

Number of Social Media Users	4.76 Billion	Social media users vs Total population	59.4%
Quarter-On-Quarter change in social media users	+23 Million	Social media user age 18+ vs Population age 18+	77.8%

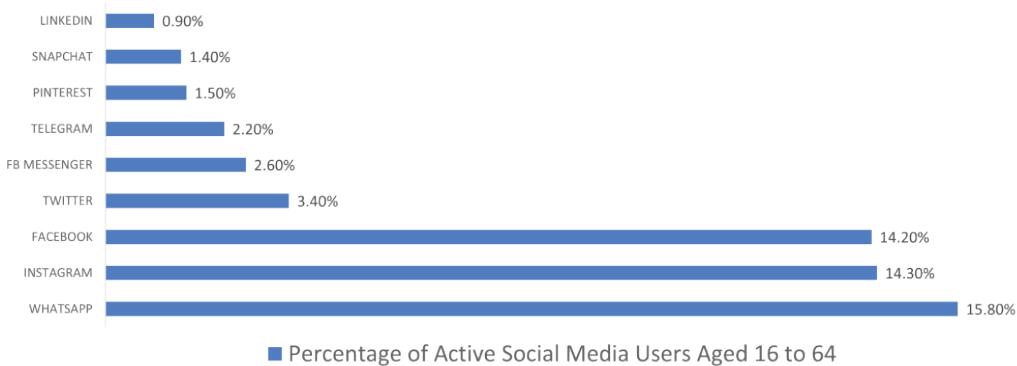
Year-On-Year change in social media users	+137 Million	Social Media users vs Total internet users	92.3%
Average daily time spent using social media	2 Hours 31 Minutes	Female social media users	46.3%
Average number of Social Platforms used each month	7.2	Male Social Media Users	53.7%

Some Social Media Platforms	Some AI Tools
       	          

World's Most Used Social Platforms



Favourite Social Media Platforms



Extension Activities using Google Platforms

Google Blogger

Google Blogger can be a great tool for teaching purposes, particularly for creating and managing class blogs or individual student blogs. Here are some potential benefits:

- i. **Easy to Use:** Blogger is a user-friendly platform that can be easily accessed by teachers and students with a Google account. It provides simple tools for creating and editing blog posts, uploading multimedia content, and managing comments.
- ii. **Promotes Digital Literacy:** Using a blogging platform like Blogger can help students develop digital literacy skills such as online research, writing for online audiences, and ethical online behaviour.
- iii. **Enhances Collaboration:** Blogger allows for collaboration and feedback, allowing students to share their work and ideas with classmates, and receive constructive criticism and feedback from their peers.
- iv. **Personalized Learning:** By creating individual student blogs, students can personalize their learning experiences and demonstrate their understanding of the subject matter in their unique way.
- v. **Engages Students:** Using Blogger to create blogs can help engage students by providing them with a platform to showcase their creativity and ideas. This can motivate them to be more active and enthusiastic learners.

Google Services

Google provides a variety of services that can be used for extension activities. Here are some ways to use Google services for extension activities:

- i. **Google Forms:** Use Google Forms to create surveys, questionnaires, or feedback forms to collect data from your participants. Google Forms are easy to use, customizable, and allow you to view responses in real-time.
- ii. **Google Docs:** Use Google Docs to create and share documents with your participants. You can use Google Docs to collaborate on documents, such as project proposals, reports, or presentations.

- iii. **Google Sheets:** Use Google Sheets to manage and analyze data collected from your extension activities. You can use Google Sheets to create spreadsheets, track data over time, and create graphs and charts to visualize your data.
- iv. **Google Calendar:** Use Google Calendar to schedule and share events with your participants. You can create and share event invitations, set reminders, and keep track of your schedule.
- v. **Google Drive:** Use Google Drive to store and share files related to your extension activities. You can use Google Drive to store documents, photos, videos, and other files in the cloud, and share them with your team members or participants.
- vi. **Google Meet:** Use Google Meet to host virtual meetings or webinars with your participants. Google Meet allows you to host video conferences with up to 100 participants, share your screen, and record your meetings.

Google AdSense

Google AdSense is a program that allows website publishers to monetize their website traffic by displaying targeted ads. Generating traffic to your Blogger blog can be challenging, but there are several strategies you can use to increase your blog's visibility and attract more visitors. Here are some ways to generate traffic on your Blogger blog:

- i. Publish high-quality content: The most important factor in generating traffic to your blog is to publish high-quality, informative, and engaging content that provides value to your readers. Make sure your blog posts are well-written, properly formatted, and optimized for search engines.
- ii. Optimize your blog for search engines: Make sure your blog is optimized for search engines by using relevant keywords, meta descriptions, and tags. This will help your blog rank higher in search results and attract more organic traffic.
- iii. Promote your blog on social media: Share your blog posts on social media platforms like Facebook, Twitter, LinkedIn, and Instagram to reach a wider audience. Use relevant hashtags and engage with your followers to increase visibility and engagement.
- iv. Guest post on other blogs: Look for other blogs in your niche and offer to write guest posts for them. This will help you reach a new audience and generate traffic back to your blog through a link in your author bio.
- v. Participate in online communities: Join online communities and forums related to your niche and participate in discussions. Make sure to add value to the conversation and share your blog posts when relevant.
- vi. Offer freebies and incentives: Offer freebies or incentives to your readers, such as e-books, templates, or exclusive content, to encourage them to subscribe to your blog and share your content with others.

Conclusion

While there are many benefits of using social media in education, there are also some challenges that need to be considered. These include issues related to privacy, cyberbullying,

and distraction. It is important for educators to establish clear guidelines for the use of social media in the classroom and to educate students about responsible social media use. Social media has the potential to transform the way we teach and learn. By harnessing the power of social media, educators can create engaging and collaborative learning experiences for their students. While there are challenges associated with social media use, these can be overcome with careful planning and implementation. By embracing social media in education, we can prepare students for the digital world and equip them with the skills they need to succeed.

References

1. Lu, D., Ruan, B., Lee, M., Yilmaz, Y., & Chan, T. M. (2020). Good practices in harnessing social media for scholarly discourse, knowledge translation, and education. *Media Education*, 10, 23-32
2. Alismail, O. A., Cifuentes-Faura, J., & Al-Rahmi, W. M. (2022). Social media technologies used for education: An empirical study on TAM model during the COVID-19 pandemic. *Frontiers in Education*
3. Johinke, R., Cummings, R., & Di Lauro, F. (2023). Reclaiming the technology of higher education for teaching digital writing in a post-pandemic world. *Journal of University Teaching & Learning Practice*, 20
4. Patel, P. K., & Hebsale Mallappa, V. K. (2022). Predictive factors for farmers' knowledge of social media for sustainable agricultural development. *Indian Journal of Extension Education*, 58, 55-59
5. Al Hashimi, S. (2020). Enhancing the creative learning experience through harnessing the creative potential of digital and social media platforms in art and design educational contexts. *International Journal of Arts and Technology*, 12
6. Greenhow, C., & Lewin, C. (2015). Social media and education: Reconceptualizing the boundaries of formal and informal learning. *Learning, Media and Technology*
7. Sohoni, T. (2019). Harnessing the power of social media in the classroom: Challenging students to create content to share on social media sites to improve learning outcomes. *Journal of Criminal Justice Education*

Communication Skills and Multimedia Usage for Effective Presentation

Girijesh Singh Mahra¹ and R. Roy Burman²

¹*Division of Agricultural Extension, ICAR-IARI New Delhi*

²*Division of Agricultural Extension, KAB-I, New Delhi*

Corresponding author: girijeshmahra22@gmail.com

Abstract

Communication is a process by which two or more people exchange ideas, facts, feelings or impressions in way that each gains a common understanding of meaning, intent and use of message. It is the social interaction where we exchange ideas, facts, feelings or impressions to achieve common understanding. Basic communication skills are essential for continued success, whether personal or professional. At the very base one needs to understand the communication process. Apart from these basic aspects of communications, one needs to keep in mind the non-verbal aspects too, in order to be considered adept in communication skills. The fact is that one needs to constantly work towards developing effective communication skills. And primarily they need to overcome the barriers to effective communication. And this can be done when they are aware of the barriers and shortcomings. This is in fact the first and foremost primary step to being good communicator.

Introduction

The word Communication is originated from latin word '*communis*' meaning 'common'. According to Leagans (1961), Communication is a process by which two or more people exchange ideas, facts, feelings or impressions in way that each gains a common understanding of meaning, intent and use of message. According to Roger and Shoemaker (1971) Communication is the process by which message are transferred from Source to receiver. Thus communication is a process of social interaction where we exchange ideas, facts, feelings or impressions to achieve common understanding. Effective communication occurs when there is common understanding of meaning and intent

Why Effective Communication Skills?

The ability to communicate is the primary factor that distinguishes human beings from animals. And it is the ability to communicate well that distinguishes one individual from another. The fact, is that apart from the basic necessities, one needs to be equipped with habits for good communication skills, as this is what will make them a happy and successful social being. In order to develop these habits, one needs to first acknowledge the fact that they need to improve communication skills from time to time. They need to take stock of the way they interact and the direction in which their work and personal relations are going. The only constant in life is change, and the more one accepts one's strengths and works towards dealing with their shortcomings, especially in the area of communication skills, the better will be their interactions and the more their social popularity.

Every individual needs to be well equipped with the tools to communicate effectively, whether it is on the personal front, or at work. In fact, according to the management gurus, being a good communicator is half the battle won. After all, if one speaks and listens well, then there is little or no scope for misunderstanding. Thus, keeping this fact in mind, the primary reasons for misunderstanding is due to inability to speak well, or listen effectively.

Basic Communication Skills

Communication is essentially the transfer of ideas, messages or information from one person to another. It is effective when it gets the desired action or response. Basic communication skills are essential for continued success, whether personal or professional. At the very base one needs to understand the communication process. Thus, one may ask what are communication skills? To answer that simply - Basically, communicating is like a two-way street, which entails the relation between the sender and the receiver. In this process, a cycle of communicating messages is formed between the sender and the receiver. The sender is required to conceive the message he/she wishes to send, encode this message and then transmit. The receiver then is required to receive the message, decode it and clarify his/her understanding of the message. In order to maintain healthy communication, the two must go through this process, without bringing in other elements of intellectual thoughts and judgments, as they tend to harm the harmonious process of message passing and receiving.

From the sender's perspective one needs to have the following essential skills:

- Skills to compose the message
- Skills to send the message

From the receiver's perspective one needs to have the following essential skills:

The skill of receiving a message

- o Without assumptions
- o Placing biases aside
- o Actively listening

Thus, the elements of effective communication are:

- o Listening
- o Verbal skills
- o Non-verbal skills

Communication is generally classified into a couple of types. The classifications include: i) Verbal and non-verbal, ii) Technological and non-technological, iii) Mediated and non-mediated and iv) Participatory and non-participatory.

However, the commonly known types of communications are:

A. Intra-personal communication skill:

This implies individual reflection, contemplation, and meditation. One example of this is transcendental meditation. According to the experts this type of communication encompasses communicating with the divine and with spirits in the form of prayers and rites and rituals.

B. Interpersonal communication skill:

This is direct, face-to-face communication that occurs between two persons. It is essentially a dialogue or a conversation between two or more people. It is personal, direct, as well as intimate and permits maximum interaction through words and gestures. Interpersonal communications maybe:

1. Focused Interactions:

This primarily results from an actual encounter between two persons. This implies that the two persons involved are completely aware of the communication happening between them.

2. Unfocused interactions:

This occurs when one simply observes or listens to persons with whom one is not conversing. This usually occurs at stations and bus stops, as well as on the street, at restaurants, etc.

3. Non verbal communication skills:

This includes aspects such as body language, gestures, facial expressions, eye contact, etc., which also become a part of the communicating process; as well as the written and typed modes of communications.

C. Mass communication:

This is generally identified with tools of modern mass media, which includes: books, the press, cinema, television, radio, etc. It is a means of conveying messages to an entire populace.

No matter what the different types of communication skills are, communicating is an ever-continuing process that is going on all the time. It is as important to human life as is day-to-day existence.

Effective Communication Skills

More often than never, most people consider themselves to be good and effective communicators simply because they feel they can speak fluently. While speaking fluently is an important aspect of communicating, yet it is not the only requirement. One should be able to listen effectively, speak fluently and clearly, write well and read in the language/s they are familiar with. Apart from these basic aspects of communications, one needs to keep in mind the non-verbal aspects too, in order to be considered adept in communication skills. The fact is that one needs to constantly work towards developing effective communication skills. And primarily they need to overcome the barriers to effective communication. And this can be done when they are aware of the barriers and shortcomings. This is in fact the first and foremost primary step to being good communicator. Given here are some of the barriers that occur in communicating effectively. Understanding these barriers will help one comprehend examples of communicating skills. After all breaking down barriers implies setting good examples...

The verbal barriers which need to be avoided are:

Attacking:

Interrogating, Criticizing, Blaming, Shaming

You messages:

Moralizing, Preaching, Advising, Diagnosing, Endorsing Power, Ordering, Threatening, Commanding, Directing

Shouting

Name-calling, Refusing to talk

The non-verbal barriers are:

Flashing eyes, Rolling eyes, Quick movements, Slow movements, Arms crossed, Legs crossed

Gestures out of exasperation

Slouching, Hunching, Lack of personal hygiene, Doodling, Avoiding eye contact, Staring at people, Over fidgeting

Needed Verbal Communication Skills

Everybody has interesting thoughts floating in their mind, however only a few are able to communicate them effectively, and bring about a resounding impact on their audience. This is because they have probably sharpened their verbal communication skills. Many feel that this skill does not need any training, as every individual is able to communicate. Yes, every individual can communicate, but the problem is that every individual cannot effectively communicate.

Then the common question that arises is: 'how to improve my communication skill'. Though the years, experts in the field of training have found innovative ways and have provided interesting tips and methods to improve your communication skills. **Given here are some interesting tips ways in which one can improve the way in which they communicate:**

- A. **Be aware of the communication process:** One should be aware of every aspect of the present communication - the purpose, objective and needs. One needs to be aware of what is occurring within the self; aware of what the others present feel; aware of all that is occurring between the communicators and aware of all that is happening around the communicators.
- B. **Digging deeper:** One should be able to dig below the surface and derive and understand each communicator's primary needs from the conversation taking place.
- C. **Clarity of thought:** One needs to be clear and focused on the subject at hand and not beat around the bush and be ambiguous.
- D. **Listening empathetically:** One should hone the skills of listening with understanding.

- E. **Assert respectfully:** It is important that one develops speaking up assertive communication skills. This is because when one is assertive, they are proving that they are confident about what they need to convey.
- F. **Conflict resolution:** One should be able to come to win-win solutions in order to solve all problems that may occur from time-to-time.

Based on the communication skills training programs conducted by known experts in the field, here are some tips to good communication skills:

1. **Maintain eye contact with the audience:** This is vital as it keeps all those present involved in the conversation. It keeps them interested and, on the alert, during the course of the conversation.
2. **Body awareness:** One needs to be aware of all that their body is conveying to them, as well as others. For instance, if there is anxiety rising during the course of a conversation then one feels thirsty and there may be a slight body tremor. At that point one needs to pause and let someone else speak. A few deep breaths and some water work as the magic portion at this point.
3. **Gestures and expressions:** One need to be aware of how to effectively use hand gestures and the way they need to posture their body to convey their messages effectively. Sometimes it may happen that they verbally convey something, but their gestures and facial expressions have another story to tell.
4. **Convey one's thoughts:** It is important for one to courageously convey what they think. This is because when things are left unsaid, then what is being spoken is not as convincing as it should be. Then a lack of confidence develops.
5. **Practice effective communication skills:** One should practice speaking and listening skills as often as possible. In order to practice effective speaking skills one can, read passages from a book aloud, in front of a mirror, or simply perform a free speech in front of the mirror. And where listening is concerned, one can try transcribing from the radio or television, etc. this helps in honing sharper listening skills.

The ability to communicate effectively is a trick learnt by many, but practiced perfectly by not too many. This is because for most communicating is simple process. However, it is not so, it a rather simple-complex-networking system that has varied undercurrents flowing between the speaker and listener/s.

Communications Skills for Public Speaking

Public speaking (sometimes termed oratory or oration) is the process or act of performing a presentation (a speech) focused around an individual directly speaking to a live audience in a structured, deliberate manner in order to inform, influence, or entertain them. Public speaking is commonly understood as the formal, face-to-face talking of a single person to a group of listeners. It is closely allied to “presenting”, although the latter is more often associated with commercial activity. Most of the time, public speaking is to persuade the audience. In public speaking, as in any form of communication, there are five basic elements, often expressed as “*who is saying what to whom using what medium with what effects?*” The purpose of public

speaking can range from simply transmitting information, to motivating people to act, to simply telling a story. Good orators should not only be able to engage their audience, but also able to read them. The power of a truly great presenter is the ability to change the emotions of their listeners, not just inform them. Public speaking can also be considered a discourse community. Interpersonal communication and public speaking have several components that embrace such things as motivational speaking, leadership/personal development, business, customer service, large group communication, and mass communication. Public speaking can be a powerful tool to use for purposes such as motivation, influence, persuasion, informing, and translation.

Effective public Speaking

For becoming effective public speaker following points has to be kept in mind

1. Know Your Audience

Before going to prepare your speech/content always investigate about educational background, beliefs, language, norms, and customs of your audience. Prepare the content in that language which is understandable by audience and relevant to their needs and have suitability with norms and mores of society. Knowing as much as you can about their knowledge, their age, the number of people you will be lecturing or speaking to. If you get some idea of what they hope to achieve from the speech, then that will help you to prepare in a more effective way.

2. Know your purpose

Prepare the content according to the occasion. There are different styles of preparation of content for debate, declamation, teaching situation or speech. Be clear about your purpose.

3. Command on Language and Subject Matter

A good speaker has rich and diverse vocabulary of the language in which he communicates. Always choose that language in which you and audience are comfortable.

Command over subject matter on which you are going to speak is the prerequisite of effective communication. Once you have well prepared your content then it will automatically give you inner confidence.

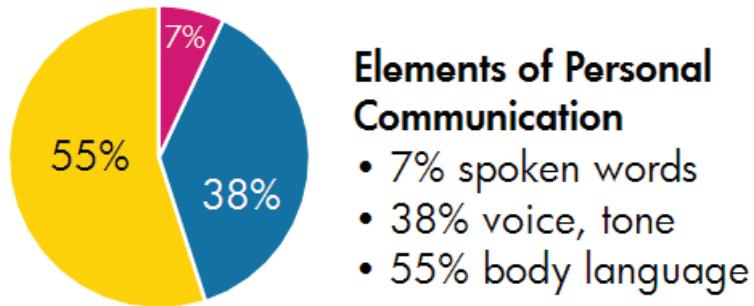
Content should be Simple, understandable, attractive, free of jargons. Make message SMART (simple, measurable, authentic, reliable and timely).

4. Verbal Communication (tone, pitch and modulation)

When your name is announced, from that very moment till you return after finishing your speech, communication goes on. Your starting/opening of speech should be attractive and catchy. *Play with diversity of tone and pitch.* There should be balanced up and down of tone and pitch. Provide effects and punch at suitable places. Verbal Communication varies according to the speaking platform example for debates speaking needs to be argumentative, for declamation speech should contain both pro and cons of the topic.

Adapt your voice according to the occasion. A large group lecture (50+) will be far more formal than a small group. For small groups you can include them in the speech, by asking questions or involving them. Be aware that any holes in your research will be noticed and questioned by someone in the audience, so to prevent any awkward moments make sure there are no holes, sweeping statements or uncertainties. Never assume "no one will notice" or "no one will ask about that". Always assume someone will ask. Try to think of all the questions you could be asked and make sure that you have an answer.

5. Non-Verbal Communication



Maximum communication occurs through non-verbal communication. Always wear cloths suitable to the occasion (formals with soothing colour cloths). Gestures and postures play a crucial role in making your audience understand. Use hand movements in balanced way and in synchronization with your verbal communication. Practice the speech at home, and time it.

6. The 6 I's of credibility for public speaking

Ideation	Be creative in presenting the idea
Information	Bring out new and decision driving facts
Influence	Be charismatic with show of confidence
Integrity	Be authentic and build a trust through the first half of the session
Impact	Identify and present a memorable delivery to root the message
Ignition	Call out to action, if required (E.g. Funding, Social Action etc.)

7. Timing

You will be given a time for your speech, sometimes these are flexible (between 10-15 minutes for example) which is good, as going over time is bad manners. However, if you are told you have 20 minutes make sure you stick to it, as you cannot rush your lecture to finish as this will affect delivery, and you do not want to be stopped before the end. If you have a time slot of 20 minutes, for example, the audience will know this, and will start fidgeting as you go over time, which is distracting for you, and you are certain they are not listening, but rather thinking about their lunch or tea-break.

Always read your notes before you arrive at the venue so it is fresh in your mind which will eliminate a total reliance on notes. Also remember that you are the only one who knows exactly what you intend to speak about, so if you miss something out no one else will know.

8. Listen to Great Orator

Try to develop a habit of listening great orators in History like Martin Luther King, M K Gandhi, Winston Churchill, Swami Vivekananda etc. Learn new words daily and try to use them next time when you speak.

Effective Presentation Skills

Effective presentation skills are the ability to use your voice confidently to communicate in “live” situations—delivering information verbally and “physically,” being able to engage your audience, and thinking on your feet. It also translates to things like videos, which are a more and more common form of communication in professional spheres.

Step 1: Identify and state the purpose of the presentation. Find focus by being able to clearly and simply articulate the goal of the presentation—what are you trying to achieve? This is helpful for you and your audience—you will use it in your introduction and conclusion, and it will help you draft the rest of the presentation content.

Step 2: Outline major sections. Next, break the presentation content into sections. Visualizing sections will also help you assess organization and consider transitions from one idea to the next. Plan for an introduction, main content sections that help you achieve the purpose of the presentation, and a conclusion.

Step 3: Draft content. Once you have an outline, it’s time to fill in the details and plan what you are actually going to say. Include an introduction that gives you a chance to greet the audience, state the purpose of the presentation, and provide a brief overview of the rest of the presentation (e.g. “First, we will describe the results of our study, then we’ll outline our recommendations and take your questions”). Help your audience follow the main content of the presentation by telling them as you move from one section of your outline to the next—use the structure you created to keep yourself and your audience on track.

Step 4: Write presentation notes. For a more effective presentation style, write key ideas, data, and information as lists and notes (not a complete, word-for-word script). This allows you to ensure you are including all the vital information without getting stuck reading a script. Your presentation notes should allow you to look down, quickly reference important information or reminders, and then look back up at your audience.

Step 5: Design supporting visuals. Now it’s time to consider what types of visuals will best help your audience understand the information in your presentation. Typically, presentations include a title slide, an overview or advance organizer, visual support for each major content section, and a conclusion slide. Use the visuals to reinforce the organization of your presentation and help your audience see the information in new ways.

Designing Effective Visuals

Presentation visuals (typically slides, but could be videos, props, handouts, etc.) help presenters reinforce important information by giving the audience a way to see as well as hear the message. As with all other aspects of presentations, the goal of visuals is to aid your audience's understanding, not overwhelm or distract them. One of the most common ways visuals get distracting is by using too much text. Plan and select visuals aids carefully—don't just put your notes on the screen, but use the visuals to reinforce important information and explain difficult concepts.

- **Write concise text.** Minimize the amount of reading you ask your audience to do by using only meaningful keywords, essential data and information, and short phrases. Long blocks of text or full paragraphs are almost never useful.
- **Use meaningful titles.** The title should reveal the purpose of the slide. Its position on the slide is highly visible—use it to make a claim or assertion, identify the specific focus of the slide, or ask a framing question.
- **Use images and graphics.** Wherever possible, replace wordy descriptions with visuals. Well-chosen images and graphics will add another dimension to the message you are trying to communicate. Make sure images are clear and large enough for your audience to see and understand in the context of the presentation.
- **Keep design consistent.** The visual style of the slides should be cohesive. Use the same fonts, colors, borders, backgrounds for similar items (e.g., all titles should be styled the same way, all photos should have the same size and color border). This does not mean every slide needs to look identical, but they should be a recognizable set.
- **Use appropriate contrast.** Pay attention to how easy it is to see elements on the screen. Whatever colors you choose, backgrounds and overlaid text need to be some version of light/dark. Avoid positioning text over a patterned or “busy” background—it is easy for the text to get lost and become unreadable. Know that what looks ok on your computer screen might not be as clear when projected.

Points to remember

- Follow the 6 x 6 rule: Maximum of 6 bullet points per slide and a maximum of 6 words per point.
- Use simple colors: Dark text on a light background or light text on dark background.
- Use font larger than 30pt: Font size should be at least 30pt
- Choose the right images: Supportive, yet not distractive, Inspiring and Engaging
- Use a uniform theme: A uniform theme pulls together the variety in your images and the message

- One story per slide: For a 60 minutes speech, you can have 30-35 slides, depending on the message's story
- 2/4/6 rule: Have a new slide every 2 minutes, not more than four bullets per slide, and not more than six words per bullet.
- PPT should not replace you: People want to listen to you, your thoughts, insights, and interpretations.

References

1. <http://www.wikihow.com/Be-an-Effective-Public-Speaker>
2. <http://www.artofmanliness.com/2008/08/01/the-35-greatest-speeches-in-history/>
3. Swami Vivekananda Chicago Speech on 15th September, 1893 <https://www.youtube.com/watch?v=TlwZNmgFBWM>
4. Mahatma Gandhi Speech London 1931 https://www.youtube.com/watch?v=_SakitCoNYc
5. Martin Luther King, Jr. I Have A Dream Speech <https://www.youtube.com/watch?v=3vDWWy4CMhE>

Communication Skill as an Effective Tool for Information Dissemination

Y.S. Jadoun¹, S.K. Jha² and Rakesh Kumar¹

¹*Sanjay Gandhi Institute of Dairy Technology, Bihar Animal Sciences University, Patna, Bihar*

²*Division of Agricultural Extension, KAB-I, ICAR-HQ, New Delhi*

Corresponding author: ysvet1203@gmail.com

Abstract

Without communication, efficient knowledge dissemination to the clientele would be exceptionally difficult to maintain. Being able to communicate effectively is one of the most important tools of a knowledge managers. The ability to create and sustain the professional and social relationship largely depends on how well we communicate with each other. Communication skills need to be developed and trained continuously so that one can become good communicators. Clear and concise communication is of immense importance in work environment as there are several stakeholders involved. The ability to communicate clearly and share thoughts, ideas and feelings will help us in all our walks of life with other people.

Introduction

In this modern time, we live in, we are receiving, sending, and processing many messages every day. But successful communication is far more than sharing information, it is also an understanding of the feelings behind this information. Developing communication skills can help us avoid conflicts, compromise, and help in better decision making. Strong communication skills can clearly impact our work. Great communicators are the ones who bring solutions, drive change, motivate and inspire peoples. Farmers expect from the extensionists to communicate regularly about their role and goals. Extension personnel who manage to successfully communicate with their stakeholders have good social rapport among the farming community. Therefore, extension personnel need to have a well-set strategy about how to keep their farmers informed and engaged. Similar is the case with teachers and students.

Communication can be defined as process of transmitting information, thoughts, opinions, messages, facts, ideas, or emotions and understanding from one person, place or things to another person, place or thing. Communication skills allow you to understand and be understood by others. These can include but are not limited to effectively communicating ideas to others, actively listening in conversations, giving and receiving critical feedback and public speaking. The desired goal of any communication process is understanding. Communication competence is vital for our health, our relationships, and certainly for all the activities in which we involve as functioning human being (Hannawa & Spitzberg, 2015). Studies have shown a clear and positive relationship between effective interpersonal skills and a range of benefits such as greater happiness in life, resilience to stress and psychosocial problems, and enhanced academic and professional achievements (Müller, Peter, Cieza, et al., 2015; Hargie, 2017). Successful communication helps us better understand people and situations. It helps

us overcome diversities, build trust, and respect, and create conditions for sharing creative ideas and solving problems.

Although disseminating knowledge in general communication seems very simple, often when we try to establish communication with others, there is always a chance for a lack of understanding that can cause conflicts and misunderstanding with other people. By acquiring strong communication skills, we can better connect with our stakeholder including students, professionals, farmer etc.

Communication skills are needed to;

- Inform – for example, communicating the time of a teaching a class.
- Influence – for example, convincing a farmer to adopt a certain scientific practice
- Express the feelings – for example, to say or show that you are enthusiastic about your success or doing the great work.

Importance of Communication Skills

Communication skills are so important because it helps in;

- Quick problem solving
- Strong decision making
- Developing advance professional image of an individual
- Getting better response from all the stakeholders of value-chain
- Better control
- Develop strong business/work relation
- Consistence in the workflow
- Problem-solving
- Breaking down barriers
- Increasing productivity
- Resolving differences
- Building relationships
- Motivating stakeholders
- Bringing about positive changes

Methods of Communication

1. **Verbal (words) communication:** Which includes; speech, sounds, words, and language. Speaking is one of the most effective and commonly used way of communication. It helps

in communicating our emotions in words. By improving our verbal communication skills, you will build good rapport with others, and have a better connection in the social world. Verbal communication includes; interpersonal communication, written communication, small group communication and public communication. Verbal communication is an easy way of communication, in which you can exchange ideas or knowledge by saying what you want and get a quick response. Verbal communication also enables you to keep changing your interaction, ideas and feelings as per the other person's response.

2. **Non-verbal communication:** It is the method of communication in which one can communicate by their expression or exchange of information or messages without using any spoken or written word. In this method of communication, we can send signals and messages to others, through expressions, gestures, postures, body languages, touch, eye contact, space, and para language signals.
3. **Visual communication:** Visual communication proves to be very effective way of communication as it involves interchanging messages only through images or pictures and therefore, you do not need to know any language for understanding the things. It is simple and remains consistent across different places or we can say that exchanging information through images. *For example:* Images showing the strict biosecurity at farm, no pets allowed, no parking zone, you are under CCTV surveillance etc. In our day-to-day or routine communication; 55.00 % communication is done using body movements, facial expressions, arms movements, etc., 38.00% communication is done using voice, tone, pauses, etc and only 7.00% communication is done using words. We can say that around 93.00% of our communication is non-verbal.

Communication process has three important parts

The process of conveying a message is completed successfully only when the person receiving, it has understood the message in its entirely.

1. Transmitting—The sender transmits the message through one medium or another.
2. Listening— The receiver listens or understands the message.
3. Feedback—The receiver conveys their understanding of the message to the sender in the form of feedback to complete the communication cycle.

Key elements of communication process

There are several models to explain the concept of communication. There are six important elements involved in the communication process. The six key elements are: Communicator, Message, Channel, Receiver, Feedback and Effect.

Brief meanings of the key elements are as follows;

- | | |
|--------------|--|
| Communicator | : is the person from whom the message originates. |
| Message | : is the information or the meaning the communicator wants to convey |

Channel	: is the media through which the communicator sends/conveys his message
Audience	: is the receiver of the message or to whom the message is sent
Feedback	: gives the details about audience response to the given communication process
Effect or impact	: is the end-result of the communication. It is the change that has taken place with the receiver due to the communication

Importance of feedback in communication process

Feedback is an important part of the communication cycle. For effective communication, it is important that the sender receives an acknowledgement from the receiver about getting the message across. Feedback can be positive or negative. A good-feedback is always; specific, timely, helpful, kind, offering continuing support, boost-up effective listening, learning and improves performance of the communication cycle and communication skills. To be effective, feedback needs to be skilfully given and the receiver must hear, understand, accept and act upon it. However accurate the feedback, if the individuals reject it, the result will be no improvement in performance. Therefore, always consider the human element during feedback.

H - Hear

U – Understand

M - Motivate

A - Acceptable

N - Negotiate

The giving and receiving of feedback are skills which require very careful handling. They require courage, tact, honesty, understanding and respect – both for yourself and for others. Like all other skills, they are developed only through practice. In providing feedback to others, you will need to be sensitive to the feedback you will receive in response.

Important skills for successful communicator

- *Listening Skill*

Listening is one of the most important aspects of communication. Successful listening is not just and understanding of spoken or written information, but also an understanding of how the speaker feels during communication. If a speaker can see and feel that someone is listening and understanding that can help build a stronger, deeper relationship between speaker and audience. Careful listening can also create an environment in which everyone feels safe to express ideas, opinions and feelings, or plan and solve problems in a creative way.

- **Straight Talking Skill**

Means that the speech which is very honest and direct or it is a style of communication aimed at solving problems--without blaming, defending, bickering, or backbiting. Instead, it uses assertiveness, openness, honesty, and collaboration to get the job done. Conversation is the basis of communication, and one must not neglect its importance. Even a simple, friendly conversation with colleagues can build mutual trust and even detect problems before they become serious. A healthy dose of chatting with an unknown person can lead to a work opportunity. Be accessible and friendly because then you will be able to talk to almost anyone.

- ***Non-verbal Communication Skill***

When we talk about things that matter to us then we send a lot of nonverbal messages. Non-verbal signals are wordless communication, body position, facial expression, hand movements, gestures, eye contact, attitude and tone of your voice, muscle tension and the way you/we breathe. The way you look, listen, create, react, gesture, speaks far more about feelings than words will ever be able to. Why non-verbal communication skills are important? Because, according to Salesforce's research on interpersonal communication, 93.00 percent of communication is non-verbal. Developing the ability to understand others and use nonverbal signals will help you connect with others, express what you think, meet challenging situations, and build better relationships at home and at work.

- ***Stress Management Skill***

In small quantities, stress can be very useful and encouraging for work. However, when the stress becomes constant and completely begins to take effect, it can affect communication, clarity of opinion, and appropriate behavior and action. When we are under stress we may misunderstand other people, send confusing nonverbal signals, and use funny patterns of behavior. When often did we feel stressed during a discussion with our friends or colleagues and then say or did something and regretted later. If you improve stress management skills, not only will you avoid these subsequent regrets, but you will also be able to influence the other person you are entering into a conflict.

- ***Emotion Control Skill***

In communication, feelings play an important role. Making decisions more often affects the way we feel than the way we think. Guided by emotions, our nonverbal behavior affects the understanding of other people and how others understand and perceive us. If we are not aware of our feelings we are guided, we will not be able to express our needs and experiences. This can result in frustration, misunderstanding, and conflict. Control of emotions provides us with tools to understand others, yourself, and the messages we send. Though recognizing feelings makes it simple, many people have a strong feeling like anger, sorrow, or fear of being pushed under the carpet.

SMART Goals for Improving Communication Skills

SMART goals for improving communication skills are essential for success, no matter your profession. Communication proficiency is one of the most crucial skills in a professional setting, and you can improve your skills by using the SMART method.

1. Specific

The first step of setting a SMART goal is to determine exactly what you want to achieve. Be as precise as possible and define your specific goal before acting on it. Instead of aiming for a vague objective or an emotional incentive, determine what you want to change, how you plan to do it, what actions you can take and why you want to change.

2. Measurable

The second step of setting a SMART goal is to determine how you are going to know when you have reached your target. Use quantifiable metrics in your answer to help you track your progress and analyse your outcome. This can help you re-evaluate and adjust your plan as necessary.

3. Attainable

The third step of setting a SMART goal is to determine whether it is possible to accomplish the goal you have set. Assess this realistically to ensure your goal is neither too easy nor too challenging to reach. Two ways to make a goal realistic are either decreasing the scope of the goal or increasing the time frame. An attainable yet challenging goal can keep you motivated and help you understand the limits of your capabilities.

4. Relevant

The fourth step of setting a SMART goal is to determine whether your goal aligns with your long-term plans and values. Be clear about your intentions behind setting a certain communication goal and what difference achieving that goal can make. When goals are relevant to your work, accomplishing them is more meaningful and positively impacts those around you, including your workplace and community.

5. Time-bound

The fifth and last step of setting a SMART goal is to establish a timeframe or deadline by which you intend to achieve your aim. Give yourself a reasonable amount of time to reach your target. While you may want to constantly improve your communication skills, it may be more challenging to track your progress if you do not set a definite timeframe to attain a specific goal. An end date can provide motivation and help you prioritise. If you have not achieved your goal in that timeframe, take time to consider why.

Smart Habits to Improve Communication Skills:

Communication professionals have many advice on how to improve communication skills. As we can see, there is no single way to develop great communication skills or become a great leader/expert. The practice we are going to pick will depend on us, the objectives we want to

achieve and our personality as well. Most productive ways to improve your communication skills speedily and efficiently are;

- ***Listen with empathetically***

Empathy is the ability to *understand the feelings, thoughts, and beliefs* of another person. This is the reason that the organizations have started developing empathy in the workplace or in the employers. Emotional acceptance, closely related to empathy, means that, after empathizing and *understanding how other person feels*, we can accept the reasons why somebody feels or thinks the way they do, regardless of whether we agree with it or not. Try to see things from others' perspectives by accepting what you hear instead of trying to fix things and solve the problem.

- ***Speaks-up***

Communication begins with you. Take responsibility and start communication, do not wait, and expect another person to do so and do not hide behind various forms of online communication. Good communication, especially on important topics, requires far more than what we can express in a written message. We often misunderstand this kind of communication because we do not see the person's face, its non-verbal communication, and in what circumstances communication should starts.

- ***Prepare yourself, you are going to say***

Think carefully before you speak. Most of us work best when we have time to process our own thoughts before we share them. If the conversation or meeting is worth your precious time, take a few minutes to prepare the speech draft. For a very important conversation, try a mock-up conversation with a trusted person so you can get rid of any possible slip-ups.

- ***Be ready for different answers***

As you formulate a speech strategy, *put yourself in the position* of a person who will listen to you. This will ensure balanced approach and you will be prepared to learn and defend potential disagreements and it will be easier for you to defend your position. No one can predict with certainty *how other people will react*. Improve chances of a successful conversation by expecting negative answers and queries.

The 7 C's of communication

Following the seven C's of communication we can make communication more effective and professional. It applies to all types of communication, whether verbal, written, visual or non-verbal. Here are the seven C's of communication:

1. Concise

Brief, well-worded messages will have a more significant impact on the listeners and save time. It is advisable to use the minimum words possible to get your point across. This is particularly important when writing project proposals, memos or research reports. When a message is concise, it is more appealing and understandable to the audience.

2. Complete

Communication is only complete when the receiver is provided with complete information or facts that allow them to respond, react or evaluate properly. Supply your audience with all the specifics they need to make an informed decision.

3. Coherent

For good communication, a message should follow a logical structure. All your ideas should be well connected and relevant to the critical point. This is known as coherence. Organising your message logically from introductory statements to the conclusion will ensure that the message is coherent. When the ideas in your message flow neatly from one end to another in a proper sequence, the overall message becomes easier to follow and recall.

4. Clarity

Clarity in communication means avoiding unnecessary, confusing or elaborate vocabulary and terminology. A clear message should ideally contain short, simple and fluent sentences. It is about caring for the listeners and making sure they understand your communication.

5. Courteous

Delivering a courteous message requires you to think from the audience's point of view. Acknowledge your audience by being always polite and respectful. Refrain from prejudices or biases when communicating with a group of people.

6. Concrete

A message is concrete when facts, figures and real-life examples support it. Concrete communication is not vague or generic but rather factual and relevant. The more direct your speech is, the more effective your delivery. This specificity of language is important for effective and professional communication.

7. Correct

It is essential to ensure that your communication is factually and grammatically correct. Make sure that your communication is accurate by double-checking all facts and figures.

Conclusion

Communication skills are the most important skills that you need to succeed in the workplace. In order to communicate efficiently and effectively, the individuals need to enhance their skills and abilities. The various types of communication skills that have been identified in the present time are; increase vocal clarity, listen carefully, repeat, and reflect, work well as a team, make use of attired words, avoid assumptions, and protocols, promote constructivism, promote effective interactions, illustrate appropriate body language, and use empathy. Communication skills are the crux of effective communication and hence needs to be understood and practiced

in the right perspective to realize the real objectives/goals and makes all the stakeholders better informed at every step of the value chain about the technologies, domestic and international markets, and the emerging trends in the concerned field. Every communication that we make or bring across to the clientele in action. With this empowering tool, one can use it to disseminate information, knowledge, influence people's thought, feeling and action and win them over.

References:

1. Hannawa, A., & Spitzberg, B. (Eds.) (2015). Communication competence. Berlin: Walter de Gruyter
2. Hargie, O. (2017). Skilled interpersonal communication: research, theory and practice. 6th edition. London: Routledge.
3. <https://strategistsworld.com>
4. in.indeed.com/career-advice/career-development/smart-goals-for-improving-communication-skills.
5. Müller, R., Peter, C., Cieza A., et al. (2015). Social skills: A resource for more social support, lower depression levels, higher quality of life and participation in individuals with spinal cord injury? Archives of Physical Medicine and Rehabilitation, 96, 447–455.
6. www.action-strategies.com/smart-skills-for-better-communication
7. www.mygreatlearning.com/blog/how-to-improve-your-communication-skills

Role of IoT in Agriculture and Dairy Sector

¹Prateek Bhaduria and ²Komal

¹RJIT BSF Academy Takenpur, Gwalior, MP

²ICAR-Central Institute of Post-Harvest Engineering and Technology, Ludhiana, Punjab

Corresponding author: bhaduria.prateek@gmail.com

Abstract

The Internet of Things (IoT) is a way of transforming agriculture and dairy farming practiced by providing smart solutions. The integration of Internet of Things (IoT) technology in agriculture has revolutionized the way farming practices are carried out. It can be applicable for precision farming, greenhouse management, livestock monitoring, and other applications. This chapter presents a comprehensive role of IoT in the agriculture and dairy sectors by categorizing and synthesizing existing research in this area. It discusses the IoT network infrastructure, and different platforms employed for agriculture and dairy management. Additionally, the article describes various IoT-based applications for agriculture and dairy farming, including precision irrigation, soil monitoring, milk quality monitoring, and animal health monitoring. Finally, the article presents open research challenges and potential future directions for IoT-based agriculture and dairy management.

Introduction

In general, IoT refers to the interconnection of physical devices, sensors, and software, allowing them to collect and exchange data without human intervention. With the widespread use of smartphones and other mobile devices, IoT has become an integral part of our lives, transforming industries, and revolutionizing the way we work, live, and interact. In agriculture and dairy sectors, IoT has transformed the way of farmers by providing real-time data and insights that enable them to make a valuable decision which optimize resource utilization and improve the overall productivity and performance [1].

One of the primary benefits of IoT in agriculture is precision farming. Farmers can use sensors and drones to collect data about soil moisture, temperature, and nutrient levels. This data is then analysed to determine the optimal time for planting, fertilization, and irrigation [2]. Additionally, IoT enables farmers to monitor crop growth and detect anomalies such as pest infestations, plant diseases, and nutrient deficiencies. With this information, farmers can take corrective measures, such as targeted spraying or fertilizer application, to enhance crop yields and quality. This chapter delves into the key areas where IoT is making a profound impact in agriculture, including precision farming, livestock monitoring, smart irrigation, crop management, and supply chain optimization. It also discusses the benefits, challenges, and future prospects of IoT adoption in agriculture.

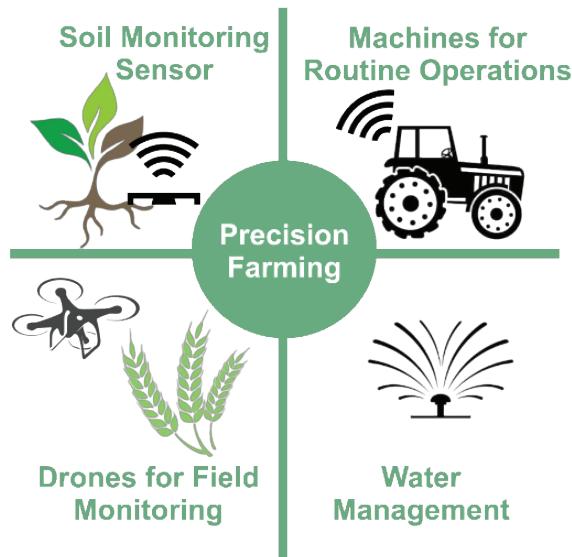
1. Key Areas of Profound Impact: IoT Revolutionizing Agriculture

• Precision Farming:

Precision farming, a key area empowered by IoT technology, revolutionizes the traditional approach to crop management by enabling site-specific and data-driven

practices. This section delves into the intricate details of precision farming, emphasizing the pivotal role played by IoT technologies in achieving remarkable advancements in agricultural productivity, resource efficiency, and pest and disease management.

At the heart of precision farming lies the integration of IoT-enabled sensors, drones, and data analytics platforms. These technologies work in synergy to collect and analyze a vast array of real-time data pertaining to soil conditions, moisture levels, nutrient content, weather patterns, and crop growth. Drones equipped with advanced imaging technologies, such as multispectral and hyperspectral sensors, play a vital role in precision farming. These aerial platforms capture high-resolution images of the fields, providing detailed insights into crop health, growth patterns, and stress indicators.



Data analytics platforms serve as the backbone of precision farming, enabling the interpretation and visualization of vast amounts of data collected from various sources. By employing advanced algorithms and machine learning techniques, these platforms provide actionable insights and predictive models. Farmers can access these insights through intuitive dashboards, facilitating informed decision-making in real-time.

- **Livestock Monitoring:**

The domain of livestock monitoring has witnessed a remarkable transformation with the integration of IoT solutions. This section sheds light on how IoT technologies are being employed to monitor and manage the health, behavior, and welfare of livestock. It explores the diverse applications of wearable devices, smart tags, and automated systems in real-time tracking, disease detection, and improved livestock management practices.

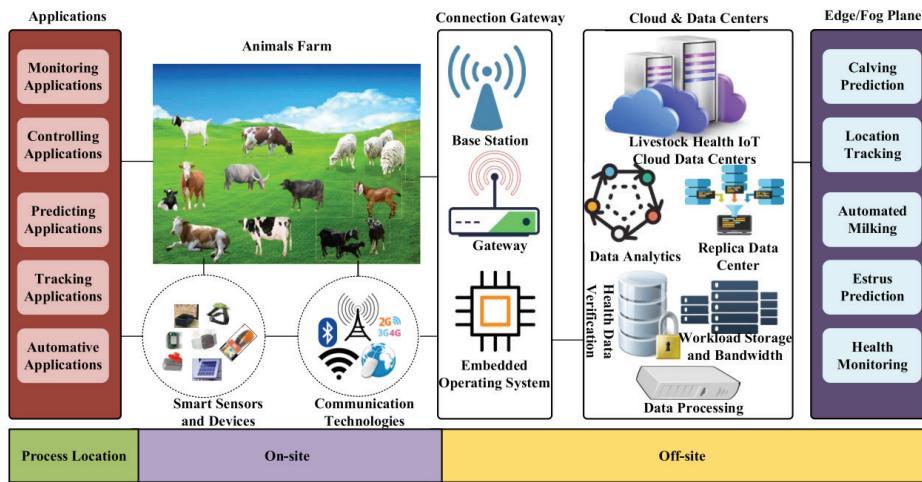
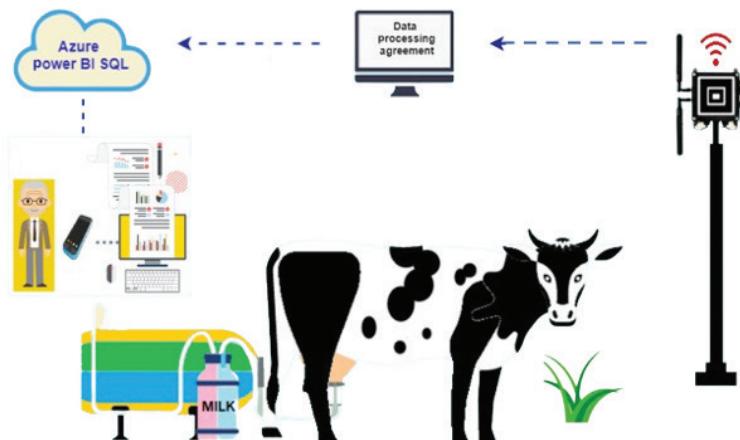


Figure 2- IoT based Livestock Monitoring System [6]

IoT-enabled wearable devices, equipped with sensors and communication capabilities, are revolutionizing livestock monitoring. These devices, such as smart collars or ear tags, collect a wealth of data regarding the animals' vital signs, activity levels, and location. Real-time data transmission from these wearables to centralized data management systems allows farmers and veterinarians to monitor the health status of individual animals or entire herds.

Smart tags, attached to livestock, provide a range of functionalities for enhanced monitoring and management. These tags can monitor parameters such as body temperature, heart rate, rumination patterns, and feeding behavior. Real-time tracking of livestock is a critical aspect of IoT-based livestock management. GPS or RFID technologies, combined with IoT connectivity, enable precise tracking of animals' movements both within designated grazing areas and during transportation.

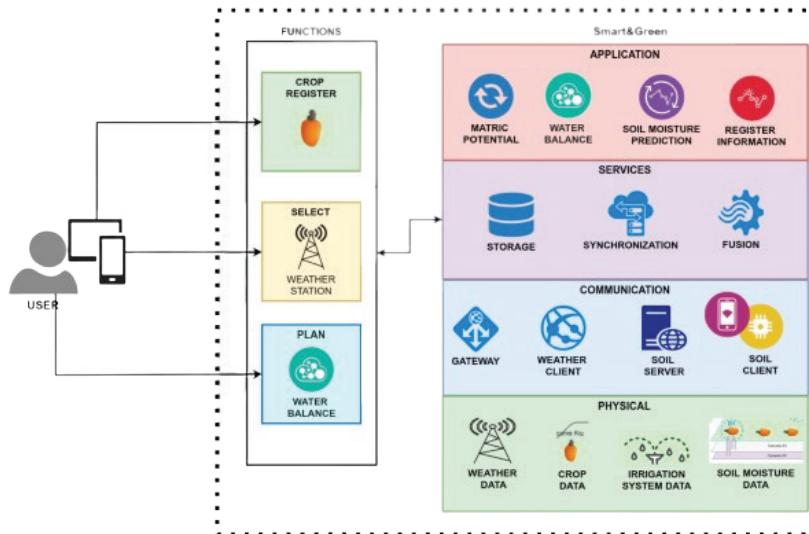


There are various sensors used in the present scenario for the advancement of dairy technology and smart agriculture-based system. Some of the most common examples of sensors are given below.

- Pulse sensor
- Sound sensor
- Temperature sensor
- Rumination sensor
- Motion sensor
- Humidity Sensor

- **Smart Irrigation**

The domain of smart irrigation has witnessed a significant revolution with the integration of IoT technology. This section delves into the profound impact of IoT on irrigation practices, highlighting how it provides real-time data on soil moisture levels, weather conditions, and crop water requirements. It explores the numerous advantages of smart irrigation systems in conserving water, preventing over-irrigation, and optimizing crop productivity.



IoT-enabled smart irrigation systems leverage a network of sensors strategically placed in the fields to monitor soil moisture levels in real time. These sensors collect data on soil moisture content at various depths, enabling farmers to precisely assess the water needs of their crops. By continuously monitoring soil moisture, the system can determine the optimal timing and duration for irrigation, ensuring that crops receive water when and where it is most needed.

Weather conditions play a crucial role in determining irrigation requirements. IoT-based weather stations collect real-time data on temperature, humidity, wind speed, and precipitation. By integrating this weather data with soil moisture readings, smart irrigation systems can dynamically adjust watering schedules based on current and forecasted weather conditions. This enables farmers to optimize irrigation practices, avoiding unnecessary watering during periods of rain or high humidity and ensuring adequate water supply during dry spells.

- **Supply Chain Optimization**

The optimization of agricultural supply chains is undergoing a transformative shift with the integration of IoT technology. This section explores the crucial role of IoT in streamlining agricultural supply chains, emphasizing the benefits of IoT-enabled tracking systems, real-time monitoring of storage conditions, and data analytics in achieving efficient inventory management, reduced post-harvest losses, and improved traceability.

IoT-enabled tracking systems play a pivotal role in optimizing agricultural supply chains by providing real-time visibility and traceability of products throughout the entire journey, from farm to consumer. These tracking systems utilize sensors and connectivity to monitor the location and movement of goods, enabling stakeholders to have accurate information on the whereabouts of products at any given time. This visibility enables proactive decision-making, reduces delays, and enhances operational efficiency.

Real-time monitoring of storage conditions is another critical aspect of IoT's impact on supply chain optimization. IoT sensors deployed in storage facilities, warehouses, and transportation vehicles continuously monitor factors such as temperature, humidity, and environmental conditions. This real-time data allows for precise control and management of storage conditions, ensuring optimal preservation of perishable goods and reducing the risk of spoilage. By maintaining appropriate storage conditions, post-harvest losses can be minimized, leading to improved product quality and reduced waste.

2. Benefits of IoT

The implementation of IoT technology in agriculture brings forth a multitude of benefits while also presenting certain challenges.

- One of the significant benefits of IoT in agriculture is the potential for increased productivity. By leveraging IoT-enabled devices and systems, farmers can collect vast amounts of data regarding various factors such as soil conditions, weather patterns, crop health, and livestock well-being.
- Resource optimization is another key benefit of IoT in agriculture. By using IoT sensors and monitoring systems, farmers can gather real-time information about the soil moisture levels, nutrient content, and weather conditions.
- Cost savings are an inherent advantage of IoT adoption in agriculture. By optimizing

resource usage and improving operational efficiency, farmers can reduce input costs, such as water, fertilizers, and energy.

- Sustainability is a crucial aspect of modern agriculture, and IoT plays a vital role in advancing sustainable practices. By enabling precise resource management, IoT helps reduce the environmental impact of agricultural activities.

3. Challenges of IoT

While IoT brings significant benefits to agriculture, its implementation also comes with certain challenges.

- Data security is a paramount concern in the IoT ecosystem, as the collection and transmission of sensitive agricultural data can be vulnerable to cyber threats.
- Interoperability is another challenge in IoT implementation. With multiple devices, platforms, and protocols in use, ensuring seamless communication and data exchange between different IoT components can be complex.
- Infrastructure requirements pose a challenge, particularly in rural areas where reliable internet connectivity may be limited.
- IoT relies on a robust network infrastructure to facilitate real-time data transmission and remote monitoring.

Conclusion

In conclusion, the implementation of IoT devices and technologies has revolutionized the dairy and agriculture industries, providing farmers with unprecedented access to real-time data and insights into their operations. IoT devices, sensors, and AI techniques have enabled animal health monitoring and improved livestock management, while cloud and fog computing have provided farmers with new ways to manage data and enhance operational efficiency. The potential for IoT in the dairy and agriculture industries is immense, and as technology continues to advance, we can expect to see even more innovative solutions that will further transform these industries and help to meet the growing demand for food while minimizing the impact on the environment.

References

1. Farooq MS, Riaz S, Abid A, Abid K, Naeem MA. A Survey on the Role of IoT in Agriculture for the Implementation of Smart Farming. *Ieee Access*. 2019 Oct 25;7:156237-71.
2. M. O. Akbar, M. S. S. Khan, M. J. Ali, A. Hussain, G. Qaiser, M. Pasha, U. Pasha, M. S. Missen, and N. Akhtar, "IoT for development of smart dairy farming," *J. Food Qual.*, vol. 2020, pp. 1–8, Mar. 2020
3. Ö. Köksal and B. Tekinerdogan, "Architecture design approach for IoTbased farm management information systems," *Precis. Agricult.*, vol. 20, no. 5, pp. 926–958, 2018.
4. S. Lee, M. Bae, and H. Kim, "Future of IoT networks: A survey," *Appl. Sci.*, vol. 7, no. 10, p. 1072, Oct. 2017.
5. S. Vyas, V. Shukla, and N. Doshi, "FMD and mastitis disease detection in cows using Internet of Things (IoT)," *Proc. Comput. Sci.*, vol. 160, pp. 728–733, Jan. 2019.
6. www.kitrum.com

Methods of Data Collection, Interpretation and Report Writing

Puspendra Kumar Singh¹ and Dr. Y. S. Jadon²

¹*Bihar veterinary College, BASU, Patna*

²*Sanjay Gandhi Institute of Dairy Technology, BASU, Patna*

Corresponding author: puspendra2001@gmail.com

Introduction

The process of gathering raw facts or evidence about a subject of interest in a systematic way, that enables one to answer stated research questions and evaluate outcomes. It can also be defined as gathering of information (figures, words or responses) that describes some situation from which conclusions can be drawn. Data-collection methods allow us to systematically collect information about our objects of study (people, objects) and about the settings in which they occur. Data collection tools are instruments that are used hand in hand with the data collection methods to collect/retrieve data. To avoid confusion in the use of terms, the following table points out the distinction between techniques and tools applied in data collection.

Table 1. Data collection techniques and tools

Techniques	Tools
Administering written questionnaires.	Questionnaire.
Interviewing	Interview guide, checklist, tape recorder.
Observation	Eyes and other senses, pen/paper, microscope.
Using available information	Check lists, data compilation forms.

Data is a collection of discrete values that convey information, describing quantity, quality, fact, statistics, other basic units of meaning, or simply sequences of symbols that may be further interpreted. Data is a collection of facts, figures, objects, symbols, and events gathered from different sources. Data collection is the methodological process of gathering information about a specific subject from all the relevant sources to find a solution to the research problem. It's crucial to ensure your data is complete during the collection phase and that it's collected legally and ethically. If not, your analysis won't be accurate and could have far-reaching consequences.

Before collecting data, there are several factors you need to define:

- The question you aim to answer
- The data subject(s) you need to collect data from
- The collection timeframe
- The data collection method(s) best suited to your needs

Types of Data Collection Methods

- **Primary Data Collection Methods:**

Primary data is collected from first-hand experience and is not used in the past.

- **Secondary Data Collection Methods:**

Secondary data is the data that has been used in the past. The researcher can obtain data from the data sources, both internal and external, to the organization.

Table 2. Difference between primary data and secondary data

Primary Data	Secondary Data
<ul style="list-style-type: none"> • Real Time • Sure about the sources • Can answer research question • Cost and time • Can avoid bias • More flexible 	<ul style="list-style-type: none"> • Past data • Sure about the sources • Refining the research problems • Cheap and no time • Bias can't be ruled out • Less flexible

Sources of secondary data collection

Internal sources of secondary data:

1. Organization annual report, Mission and vision statements
2. Financial Statements
3. Magazines
4. Executive summaries etc

External sources of secondary data:

1. Government reports
2. Press releases
3. Academic journals
4. Libraries
5. Internet etc

Primary Data Collection Methods

Survey Method:

A 'survey' is a technique of gathering information by questioning those individuals who are the object of the research belong to a representative sample, through standardized or questioning

procedure, with the aim of studying the relationship among the variables and/or collecting information that probably describe the whole population.

Observation Method

Observation method is a method under which data from the field is collected with the help of observation by the observer or by personally going to the field.

Types of Observation Methods

- **Structured Observation:** When the observation is characterized by a careful definition of the units to be observed (predefined).
- **Unstructured Observation:** When it takes place without the above characteristics. (Not predefined)
- **Participant Observation:** When the observer is member of the group which he is observing then it is Participant Observation.
- **Non-Participant Observation:** When the observer is not the member of the group which he is observing then it is Non-Participant Observation.
- **Uncontrolled Observation:** When the observation takes place in natural condition i.e., uncontrolled observation. It is done to get spontaneous picture of life and persons.
- **Controlled Observation:** When observation takes place according to pre-arranged plans, with experimental procedure then it is controlled observation generally done in laboratory under controlled condition.
- **Interview Method:** The Interview Method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral- verbal responses. Where the questions are asked personally directly to the respondent. Interviewer asks questions to respondent.

Types of Interview Methods

1. **Structured Interviews:** In this case, a set of pre decided questions are there.
2. **Unstructured Interviews:** In this case, we don't follow a system of pre-determined questions. It is done in a group of 6 to 8 individuals is interviewed.
3. **Focused Group Interview:**
 - Unstructured and Free flowing
 - Focus Group has one Moderator
 - Moderator maintains control and focuses discussion
 - It involves 6 to 10 people
 - Group interview start with broad topic and focus in on specific issues
 - Relatively homogeneous

- Similar lifestyles and experiences
- Generate discussion and interaction
- Listens to what people have to say
- Everyone gets a chance to speak

Questionnaires

The term “questionnaire” refers to an instrument for the collection of data, usually in written form, consisting of open/closed questions and other enquiries requiring a response from subjects. A Questionnaire is sent (by post or by mail) to the persons concerned with a request to answer the questions and return the Questionnaire. A Questionnaire consists of a number of questions printed in a definite order on a form.

Types of Questionnaire Methods:

1. Open-ended questions: This gives the respondents the ability to respond in their own words.
2. Close-ended or fixed alternative questions: This allows the respondents to choose one of the given alternatives.

Types:- Dichotomous questions and Multiple Questions.

Essentials of Good Questionnaire:

- Should be short and simple
- Follow a sequence of questions from easy to difficult one
- Technical terms should be avoided
- Should provide adequate space for answers in questionnaire
- Directions regarding filling of questionnaire should be given Physical Appearance – Quality of paper, Color
- Sequence must be clear

Schedules

Very similar to Questionnaire method. The main difference is that a schedule is filled by the enumerator who is specially appointed for the purpose. Enumerator goes to the respondents, asks them the questions from the Questionnaire in the order listed, and records the responses in the space provided. Enumerator must be trained in administering the schedule.

3. Interpretation

After the data is collected and analyzed using several data analysis methods, the next task is to draw Inferences from these data. In other words, Interpretation of data needs to be done, so as to derive certain conclusions, which is the whole purpose of the research study. *“Interpretation refers to the process of making sense of numerical data that has been collected, analyzed and presented”.*

Need of Interpretation:

- Maintaining Continuity of Research
- Pointers for further Research
- Communicate Significance of Research
- Transition of Exploratory Research to Experimental Research

Techniques of Interpretation:

- Explanations of the relations which the researcher has found during the research study
- Interpretation of the lines of relationship in terms of the underlying processes
- Finding thread of uniformity that lies beneath the diversified research findings and thereby, forming generalizations and theories.
- Extraneous information, collected during the study, must also be considered while interpreting the final results of research study, as it may result in better understanding of the problem in hand.
- Consulting an expert having an insight of the research study who points out omissions and errors in logical argumentation will result in correct interpretation and, add to usefulness of the research results.
- All relevant factors affecting the problem must be considered before forming Interpretations or Generalizations. Otherwise, it may lead to incorrect conclusions.

4. **Research Report Writing**

Dr. Shlesinger and M. Stephenson in the encyclopaedia of Social Sciences define Research as the manipulation of things, concepts or symbols for the purpose of generalizing to extend correct or verify knowledge aids in construction of theory or in the practice of an art. Writing the Research Report is the last step of Research Process. Research Report is defined as “*Systematic, articulate and orderly presentation of research work in a written form.*”

Research Report is a Research Document that contains basic and important aspects of a Research project.

Contents of Research Report:

1. Description of events
2. Facts discovered during investigation
3. Description of procedures/ analysis tools
4. References carefully documented
5. Conclusion
6. Results objectively recorded
7. Recommendations/ Suggestions

Principles of Report Preparation:

- **Easy to follow-**The report should be written in an easy form. Short sentences should be used as far as possible. No technical terms or business phraseology should be used which are not likely to be understood by the person (s) for whom the report is intended. The presentation of the report should be such that every subject is given with headings and sub-headings.
- **Conciseness-** The report should be as brief as possible in keeping with the purpose for which it is needed. But clearness should not be sacrificed for the sake of conciseness.
- **Clarity in writing-** The language should be simple, clear and unambiguous. The report should not be vague which leads to faulty conclusions. Uniform style and format also increases the clarity of the report.
- **Objectivity-** Objectivity means presenting material free from personal feelings or prejudice. This can be achieved by reporting all pertinent information by giving both positive and negative aspects and following the impersonal style of writing a report.
- **Stress on practical report-**The report should be based on practical findings with a realistic point of view. The report should also have the evidence supporting the findings.
- **Accurate information & data-** Since the information in a report is used to make decisions reports should have the correct facts taken through reliable sources.
- **Completeness-** A report will be considered complete when it includes all information which is required for the purpose of research. The interest and abilities of the researcher determine the completeness of the report.

Characteristics of an Ideal Research Report:

1. Proper title
2. Relevant subheadings and paragraph divisions
3. The Research report should be factual
4. The Research report should relate to certain period
5. The Research report should be clear, brief and concise
6. The reporting must be prompt
7. Distinguish between controllable and non-controllable factors
8. Appropriate remarks
9. Periodically reviewed
10. Permissible degree of inaccuracy
11. Highlight important deviations from standards
12. Visual reporting
13. Comparison between comparable matters

Significance of Report Writing:

- Major component
- Findings are brought into light
- Medium to communicate research work with relevant people.
- Contributes to the body of knowledge
- Effective way of conveying the research work
- Reference material
- Aid for decision making

Steps in Report Writing:

- Analysis of the Subject-matter
- Making of the Final Outline
- Making Rough Draft
- Polishing the Rough Draft
- Making of Bibliography
- Writing the Final Draft

Format of Research Report:

- A. Preliminary Pages**
- B. Main Text**
 - 1. Introduction
 - 2. Statement of Findings and Recommendation
 - 3. The Results
 - 4. The Implications Drawn from the Results
 - 5. The Summary
- C. End Matter**

Contents of the Research Report:

1. **Title Page:** The title page is the first page of a long report. It contains the title and author's name, the report's reference number and date.
2. **Acknowledgements:** On this page, the writer expresses his gratitude to those who have contributed and helped him during the course of the work in one way or the other.
3. **Summary:** This sets out main points of the report from the beginning, middle and end. The end product of the summary is a concise overview of the report.
4. **Table of Contents:** This shows the sections and subsections of the report with the pages of the report where each may be found.
5. **Terms of Reference:** This section states the goals and scope of the report.

6. **Procedure:** Under procedure, the report writer states the methodology used in tracking down the problems/getting the data. The procedure may be in the form of interview, questionnaire and other forms of gathering factual information.
7. **Findings:** Under this section of the report, the writer gives authentic discoveries made during the course of the investigation. All the materials collected are interpreted and analyzed.
8. **Conclusion:** This section gives an unbiased judgment of the findings made. Personal opinions are avoided and objective statements are made to prove the authenticity of claims and allegations as the case may be.
9. **Recommendations:** Recommendations demonstrate the writer's sense of judgments'. They are actually meant to precede whatever the discoveries are in the findings.
10. **References:** The books and materials consulted in the course of the work are arranged correctly. Usually this adopts alphabetical arrangements.
11. **Appendices:** The raw data used for the reports are also presented in an appendix. Some other materials such as blank questionnaires, copies of written tests, maps, and charts are included in an appendix. These are basically meant to show the original forms in which certain pieces of information occur.

Precautions in Writing Research Report:

- Communicate research finding
- Length of research report
- Curiosity within reader
- Objective style of writing
- Use of charts, graphs and tables
- Appropriate layout
- Avoid grammatical mistakes
- Logical analysis
- Appendices
- Bibliography of necessary sources
- Appearance
- Policy implications
- Originality
- Objectives of study

Referencing Styles:

There are some well specified reference styles which are accepted by different scientific communities and societies. These are as:

A. APA (American Psychological Association) Referencing Style

1. For a Research paper/Article

Authors surname followed by his (their) initials (Year of publication) Article title. Name of Journal, Volume, Page no.

Example

Singh, P. & Singh, S. (2010). IFRS in United States: Challenges and opportunities, Review of Business,30,59-71

2. For a Book

Author's surname, Initials (Year of publication) Book title. Place: Publisher

Example

Kumar, R (2014). Research Methodology: A Step-by-Step Guide for Beginners (4th ed). Thousand Oaks, California: Sage Publications

B. Harvard Referencing Style

The broad style to reference is

Author Surname, Initials. (Publication Year) 'Article title, Newspaper/Magazine Name, Day Month Published, Page(s). Available at: URL or DOI (Accessed date)

Ethics in Report/Research Paper Writing:

- Avoid Plagiarism
- Honesty
- Objectivity
- Integrity
- Alertness
- Openness
- Confidentiality
- Publication
- Social Responsibility

References:

- Banks, M. (2007). Using Visual Data in Qualitative Research. SAGE Publications Ltd, London.
- Barnett, V. (2002). Sample Survey: Principles and Methods. Arnold Publication, London.
- Kabir, S.M.S. (2016). Basic Guidelines for Research: An Introductory Approach for All Disciplines. Book Zone Publication, ISBN: 978-984-33-9565-8, Chittagong-4203, Bangladesh.
- Olson, W. (2012). Data Collection: Key Debates and Methods in Social Research. SAGE Publications Ltd, ISBN:9781847872562, New Delhi, India.
- Rajesh J. B. (2014). Technical Writing and Communication Skills for Professional Students. LAP Lambert Academic Publishing, ISBN-13: 978-3659521850, India.
- Sharma, S. D. (2006). A textbook of professional communication Skills and ESP. Saroop & Sons publication, New Delhi.

Statistical Methods for Biological and Social Sciences Data

Amit Kumar Jha, S. S. Tomar, N.M. Gupta and R. K. Vandre

College of Veterinary Science & A. H., Rewa (M.P.), NDVSU Jabalpur

Corresponding author: jha.amit002@gmail.com

Abstract

Statistical methods are widely used in both biological and social sciences to analyze and interpret data. These statistical methods assist researchers in analyzing data, testing hypotheses, and drawing meaningful conclusions in both biological and social sciences. Statistics are described as classified facts indicating the situations of a people in a state - specifically the information that can be stated in numbers or any other tabular or classed arrangement. This chapter entails a brief outline of statistical methods generally used in biological and social sciences data. The specific method(s) selected will depend on the research question, study design, and characteristics of the data. The chapter describes some of the commonly employed statistical methods required for describing a data set and descriptive statistics, hypothesis testing, statistical tests by using statistical software package SPSS has also been taken up.

Introduction

The study and manipulation of data is the simplest definition of statistics. Statistics are described as “classified facts indicating the situations of a people in a state - specifically the information that can be stated in numbers or any other tabular or classed arrangement,” according to the Merriam-Webster dictionary. The definition of statistics by another statistician, Sir Arthur Lyon Bowley, is “Numerical descriptions of facts in any domain of investigation set in connection to each other.”

Basically, there are two types of statistics

- Descriptive Statistics
- Inferential Statistics

In the case of descriptive statistics, the data or collection of data is described in summary. But in the case of inferential stats, it is used to explain the descriptive one. Both these types have been used on large scale.

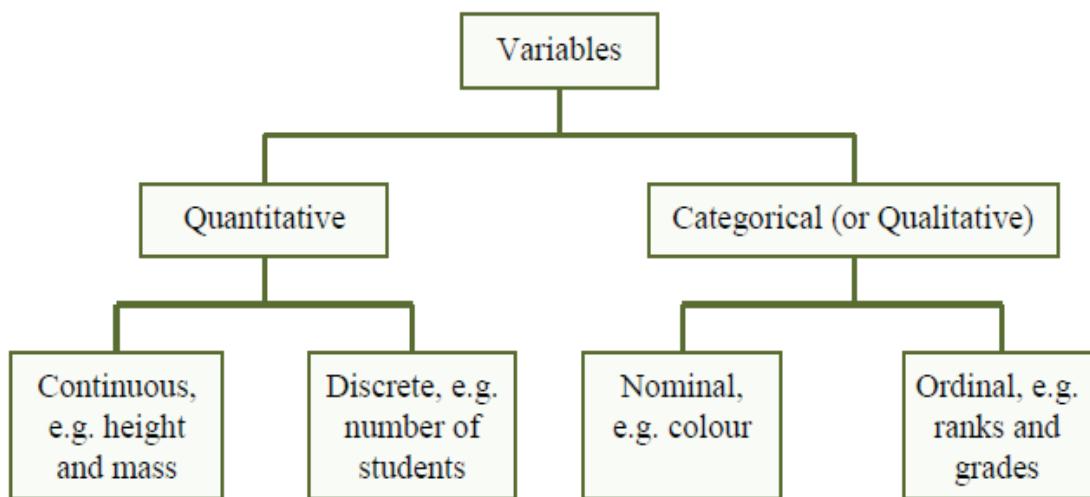
Descriptive Statistics

Descriptive statistics are used to summarize and interpret the data. The summary is created using a population sample and numerous variables, including mean and standard deviation. A set of data can be organised, represented, and explained using descriptive statistics by employing graphs, charts, and summary measures. To summarize data and present it in tables or graphs, common methods include histograms, pie charts, bars, and scatter plots.

Inferential Statistics

Using inferential statistics, we try to explain what descriptive statistics mean. After the data has been gathered, assessed, and summarized, we use inferential statistics to explain what the data indicate. Inferential statistics uses the probability principle to examine if patterns observed in a study sample can be extrapolated to the larger population from which the sample was taken. Inferential statistics can be used to forecast population sizes in addition to testing hypotheses and examining connections between variables. To draw conclusions and inferences from samples, or to make precise generalisations, inferential statistics are used.

A character or attribute which varies from individual to individual or group to group is called a variable. For example, body weight, body height, milk yield, litter size, hematological counts, biochemical parameters, hormonal level, coat colour etc. The variable is of two main types viz., qualitative and quantitative variables.



Measures of Central Tendency

In frequency distributions it may be observed that the variable values cluster or concentrate towards the center of distribution. This tendency of the data (variable values) to cluster towards the middle of the distribution is called the central tendency. The statistical constants used to measure or express this tendency of data are called measures of location or measures of central value or averages. An average is a value which is typical or representative of entire distribution of a given set of data. This value enables us to comprehend the significance of entire distribution. The most common measures of central tendency are (i) Arithmetic mean or simply mean (ii) Median (iii) Mode (iv) Geometric mean and (v) Harmonic mean.

i. Arithmetic Mean

This is the most popular and commonly used measure of Central Tendency. Its values are obtained by adding together all the items and dividing this total by number of items.

If $x_1, x_2, x_3, \dots, x_n$ are n observations, their arithmetic mean (\bar{x}) is given by:

$$\bar{x} = \frac{x^1 + x^2 + \dots + x^n}{n} = \frac{1}{n} \sum_{i=1}^n x_i$$

In case of frequency distribution, where values $x_1, x_2, x_3, \dots, x_n$ occur as f_1, f_2, \dots, f_n the formula for calculating arithmetic mean is:

$$\bar{x} = \frac{x^1 f^1 + x^2 f^2 + \dots + x^n f^n}{f^1 + f^2 + \dots + f^n} = \frac{\sum_{i=1}^n f_i x_i}{\sum_{i=1}^n f_i}$$

$$\frac{1}{N} \sum_{i=1}^n f_i x_i, \text{ where } N = \sum_{i=1}^n f_i$$

When the given frequency distribution is grouped or continuous type, the x_i s in the above formula are taken to be the mid values of the corresponding classes.

ii. Median:

Another frequently used measure of central tendency is the ‘median’. It is the value of variable which divides the distribution into two equal parts. That means it is the value such that number of observations below it are equal to the number of observations above it. Thus, median is a positional average. In the case of ungrouped data, median of given ‘ n ’ observations is determined by arranging the data in ascending or descending order (array) of their magnitude.

If n is odd the median is middle most value i.e. $\left(\frac{n+1}{2}\right)^{\text{th}}$ observation of the array. When n is

even, there are two middle values i.e. $\left(\frac{n}{2}\right)^{\text{th}}$ and $\left(\frac{n}{2}+1\right)^{\text{th}}$ observations of the array and the

median is obtained by taking the arithmetic mean of these two values:

iii. Mode:

Mode is a well-known but infrequently used measure of central tendency. It is the most commonly occurring observation in a set of values. Thus, it is defined as the value which occurs most frequently in a set of observations and around which the other items of the set cluster densely. Which the other items of the set cluster densely. That means it is the value of variable which is pre-dominant in the series.

iv. Geometric Mean

The geometric mean of a set of ‘ n ’ observations is n^{th} root of their product. If there are two numbers, we take square root, if there are three items, we take cube root and so on. If given ‘ n ’ numbers are , then the geometric mean is

v. Harmonic Mean:

The harmonic mean (H) of a set of numbers is the reciprocal of the arithmetic mean of the reciprocals of the numbers.

$$H = \left(\frac{1}{\frac{1}{2} \sum_{i=1}^n \frac{1}{x_i}} \right) = \frac{n}{\sum_{i=1}^n \frac{1}{x_i}}$$

Measures of Dispersion

The different measures used to estimate the degree of dispersion or variation exhibited by a set of observations are (i) Range, (ii) Quartile deviations or Semi-interquartile range, (iii) Mean deviation and (iv) Variance and Standard Deviation. These are the absolute measures of dispersion. The relative measures of dispersion are called the coefficients of dispersion. The coefficients of dispersion is the most important measure of dispersion.

i. Range

The range is the difference between the largest and the smallest observation of the series.

$$R = L - S$$

ii. Mean Deviation

Mean deviation is defined as the arithmetic mean of the absolute deviations of all the observations from their average (mean, median and mode).

For ungrouped data, it is given by

$$\text{Mean Deviation} = \frac{1}{n} \sum_{i=1}^n |x_i - \bar{A}|$$

and for grouped data, it is given by

$$\text{Mean Deviation} = \frac{1}{n} \sum_{i=1}^n f_i |x_i - \bar{A}|$$

where, $|x_i - \bar{A}|$ represents modulus or absolute value of the deviation ($x_i - A$) ignoring negative sign and ' A ' is the average (i.e. mean or median or mode). In case of continuous frequency distribution x_i 's are taken to be the mid-points of various classes.

iii. Variance and Standard Deviation:

The variance is defined as the mean of the squared deviations of all the observations from their arithmetic mean. The population variance is denoted by Greek letter σ^2 and sample variance is denoted by s^2 . The positive square root of variance is known as standard deviation. So standard deviation is defined as the positive square root of the arithmetic mean of the squares of deviations of the given values from their arithmetic mean. The population and

sample standard deviations are denoted by σ and s , respectively. The standard deviation is more commonly used than variance. For ungrouped data, the variances is given by

$$\sigma^2 = \frac{1}{n} \sum_{i=1}^n (xi - \bar{x})^2$$

and for a frequency distribution it is given by

$$\sigma^2 = \frac{1}{N} \sum_{i=1}^n fi(xi - \bar{x})^2$$

Where, $N = \sum_{i=1}^n fi$

CORRELATION:

Correlation is a measure of linear relationship between two variables. If change in one variable is accompanied by a change in the other variable, the two variables are said to be correlated and this relationship is known as correlation.

Karl Pearson Coefficient of Correlation: This is a measure of degree or intensity of linear relationship between two variables. It was given by Professor Karl Pearson (1867-1936), a British biometrician and hence the name. Correlation coefficient between two random variables X and Y usually denoted by r_{xy} is a numerical measure of linear relationship between them and is defined as the ratio of covariance of the two variables to the geometric mean of their variances.

$$r_{xy} = \frac{\text{Cov}_{xy}}{\sigma_x \sigma_y} = \frac{\frac{1}{n} [\sum X_i Y_i - \frac{(\sum X_i)(\sum Y_i)}{n}]}{\sqrt{\left[\frac{1}{n} \left[\sum X_i^2 - \left(\frac{\sum X_i^2}{n} \right) \right] \cdot \frac{1}{n} \left[\sum Y_i^2 - \left(\frac{\sum Y_i^2}{n} \right) \right]}}$$

$$= \frac{\sum X_i Y_i - \frac{(\sum X_i)(\sum Y_i)}{n}}{\sqrt{\left[\sum X_i^2 - \left(\frac{\sum X_i^2}{n} \right) \right] \left[\sum Y_i^2 - \left(\frac{\sum Y_i^2}{n} \right) \right]}}$$

REGRESSION

The term regression was first used by Sir Francis Galton (1822-1911) in 1877 while studying relationship between heights of parents and offspring. Regression is widely used in economics, business, commerce, science and need not necessarily have reference to biometry. Regression analysis provides a mathematical measure of the average relationship between two or more variables in terms of original units of the data. This technique is used to establish the functional relationship between two or more variables by developing mathematical equation which relates the variables. This equation is used to predict the value of one variable (dependent variable) from the value of other variable (s)(independent variable). Thus, in regression analysis there are two types of variables (i) The variable whose value is influenced or is to be predicted

is called dependent variable and (ii) The variable which influences the value or is used for prediction are called independent variables. Dependent variable is also known as regressed or explained or response or outcome variable and independent variable is also known as regressor or predictor or explanatory variable.

Fitting the lines of regression (Developing prediction equations):

The line of regression is the line of best fit because it gives the best estimate of the value of one variable (dependent) for any specific value of other variable (independent variable). The regression line (line of best fit) is obtained by the principle of least squares. There are two lines of regression (i.e. regression equations), the line of regression of Y on X and the line of regression of X on Y. The regression equation of Y on X is used to predict the value of Y for any specific or given value of X. The regression equation of X on Y is used to predict the value of X for a particular value of Y. Suppose that in a bivariate distribution (X_i, Y_i) ; $i=1, 2, \dots, n$; Y is dependent variable.

Let the line of regression of Y on X be

$$Y = a + bX$$

Where,

'Y' is the predicted value of dependent variable.

'a' is the constant term which represents the intercept of the line; it is the value of Y when the value of X is zero.

'b' is the slope or gradient of the line; it is the coefficient of regression of Y on X (b_{YX}).

'X' is a known value of independent variable.

Here 'b' or to be more precise the slope of line of regression of Y on X is called Co-efficient of regression of Y on X. It represents the expected change in the value of dependent variable 'Y' corresponding to a unit change in the value of independent variable 'X'. This equals the covariance of X and Y (CoV X, Y) divide by the variance of X (Var_X) and is computed as:

$$b_{YX} = \frac{\sum XY - (\sum X)(\sum Y)}{\sum X^2 - \frac{(\sum X)^2}{n}}$$

TEST OF HYPOTHESIS (TEST OF SIGNIFICANCE)

Hypothesis testing or significance testing is a method for testing a claim or hypothesis about a parameter in a population, using data measured in a sample. In this method, we test some hypothesis by determining the likelihood that a sample statistic could have been selected, if the hypothesis regarding the population parameter were true. The goal of hypothesis testing is to determine the likelihood that a population parameter, such as the mean, is likely to be true.

Null Hypothesis: For applying any test of significance first we set up a hypothesis- a definite statement about the population parameter. Such a hypothesis, which is usually a hypothesis of no difference is called null hypothesis and is denoted by H_0 .

Alternative Hypothesis: Any hypothesis which is complementary to the null hypothesis is called an alternative hypothesis, usually denoted by H_1 .

Errors in hypothesis testing (Errors in sampling): The main objective in sampling theory is to draw valid inferences about the population parameters on the basis of results obtained by studying the sample. We decide to accept or reject the null hypothesis (H_0) after examining a sample.

True Situation → Decision Made ↓	H_0 is True	H_0 is False
Reject H_0	Type I error	Correct decision
Accept H_0	Correct decision	Type II error

Critical region and level of significance:

It is the region or area under sampling distribution such that if value of sample statistic falls in that region, H_0 is rejected. Probability that a random value of statistic falls in critical region is called the level of significance. In other words the level of significance is the size or probability of Type I error. When the level of significance is 5% (95% confidence level) the critical region of 5% is divided into 2.5% at both the tail ends of the distribution if the test applied is two-tailed test. In case of single-tailed test this 5% critical region lies at one end (right or left) of the distribution depending on whether the test is right tailed or left tailed.

DIFFERENT TYPES OF TESTS OF SIGNIFICANCE

1. Normal Deviate test (Z-test)

(i) Z-test of significance for single mean (to test $\bar{x} = \mu$)

$$Z = (\bar{x} - \mu) / (\sigma / \sqrt{n})$$

(ii) Z-test of significance for two means (to test $\bar{x}_1 = \bar{x}_2$)

$$Z = | \bar{x}_1 - \bar{x}_2 | / \sqrt{s^2 (1/n_1 + 1/n_2)}$$

2. F-test

F test is used to test equality or otherwise of two sample variances. Suppose we are given two samples of sizes n_1 & n_2 , respectively. The means of two samples are \bar{x}_1 and \bar{x}_2 and their variances are s_1^2 and s_2^2 , respectively. We have to test whether s_1^2 and s_2^2 are equal or there exists significant difference between them.

$$F = \text{Greater variance} / \text{smaller variance} = s_1^2 / s_2^2 \quad (\text{suppose } s_1^2 > s_2^2)$$

3. t-test

The entire large sample theory (Z-test) was based on the application of normal test. But, if sample size is small, the distribution of various statistics is far from normality and as such normal test cannot be applied. In such cases exact sample tests, pioneered by W.S. Gosset (1908) who wrote under the pen name of student and later on developed by Professor R.A. Fisher are used. In all the exact sample tests, the basic assumption is

that "the population(s) from which sample(s) is (are) drawn is (are) normal i.e., the parent population(s) is (are) normally distributed. Let x_i ($i = 1, 2, \dots, n$) be a random sample of size n from a normal population with mean μ and variance σ^2 , then the student's 't' is defined by the statistic

$$t = (\bar{x} - \mu) / (s/\sqrt{n}),$$

where, \bar{x} is the mean and s^2 is the variance of the sample.

(i) Test for single mean (Single mean t-test) i.e. to test $\bar{x} = \mu$.

$$t = (\bar{x} - \mu) / (s/\sqrt{n}), \quad s^2 \text{ is the sample variance.}$$

(ii) Two means t-test (to test $\bar{x}_1 = \bar{x}_2$):

$$t = |\bar{x}_1 - \bar{x}_2| / \sqrt{s^2(1/n_1 + 1/n_2)}$$

Where, s^2 is the pooled variance of the two samples and calculated as

$$s^2 = [(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2] / (n_1 + n_2 - 2)$$

(iii) Paired t-test: This test is designed to test the significance of average difference between two treatment effects. Here the sample sizes are equal and the two samples are not independent but the sample observations are paired together i.e. the pair of observations corresponds to the same sample unit.

$$t = \bar{d} / (s_d / \sqrt{n})$$

$$\text{where, } \bar{d} = 1/n (\sum d_i); \quad s_d^2 = [1/(n-1)] [\sum d_i^2 - (\sum d_i)^2 / n]$$

4. Chi-square test

The Z, t and F tests discussed earlier are called parametric tests because they require assumption about the type of population or parameters. Chi-square test is a non-parametric test, because no assumption about the parameters of the population or populations from which sample or samples are drawn is made in conducting this test. This is also known as distribution-free test. This was pioneered by Karl Pearson in the year 1900. The quantity describes the magnitude of the discrepancy between theory and observation. It is defined as:

$$\text{Chi square} = \sum [(O_i - E_i)^2 / E_i]$$

Where ' O_i ' refers to the observed frequencies and ' E_i ' refers to the expected frequencies, in i^{th} class. If expected frequency in any of the cell is less than 5, the nearby cells are clubbed together before calculating the chi-square value.

ANALYSIS OF VARIANCE (ANOVA)

Analysis of variance is an extremely powerful method where total variation present in a set of data may be partitioned or subdivided into number of different components associated with nature of classification of data. The systematic procedure for achieving this is called analysis of variance. This involves estimation of variance due to each of the independent factors (different assignable causes) and the experimental error which arises due to uncontrolled and extraneous factors. Then the variances due to different factors (sources) are compared with the variation due to chance factor (experimental error) i.e. error variance employing F test. ANOVA is applicable when the aim is to infer differences in group values when there is one

dependent variable and more than two groups, such as one independent variable with three or more levels, or when there are two or more independent variables. Since an independent variable is called a “factor”, ANOVAs are described in terms of the number of factors; if there are two independent variables, it is a two-factor ANOVA. In the simpler case of a one-factor ANOVA, the Null hypothesis asserts that the population means for each level (group) of the independent variable are equal.

Planning Execution and Analysis of Agricultural Experiments

Arpan Bhowmik

ICAR-Indian Agricultural Research Institute, Gogamukh, Assam-787035

Corresponding author: arpan.bhowmik@icar.gov.in

Abstract

An experiment is usually associated with a scientific method for testing certain phenomena. An experiment facilitates the study of such phenomena under controlled conditions and thus creating controlled condition is an essential component. Scientists in the biological fields who are involved in research constantly face problems associated with planning, designing and conducting experiments. Basic familiarity and understanding of statistical methods that deal with issues of concern would be helpful in many ways. Researchers who collect data and then look for a statistical technique that would provide valid results will find that there may not be solutions to the problem and that the problem could have been avoided first by a properly designed experiment. Obviously, it is important to keep in mind that we cannot draw valid conclusions from poorly planned experiments. Second, the time and cost involved in many experiments are enormous and a poorly designed experiment increases such costs in time and resources. For example, an agronomist who carries out fertilizer experiment knows the time limitation of the experiment. He knows that when seeds are to be planted and harvested. The experimenter plot must include all components of a complete design. Otherwise, what is omitted from the experiment will have to be carried out in subsequent trials in the next cropping season or next year. The additional time and expenditure could be minimized by a properly planned experiment that will produce valid results as efficiently as possible. Good experimental designs are products of the technical knowledge of one's field, an understanding of statistical techniques and skill in designing experiments.

Introduction

Any research endeavor may entail the phases of Conception, Design, Data collection, Analysis and Dissemination. Statistical methodologies can be used to conduct better scientific experiments if they are incorporated into entire scientific process, i.e., From inception of the problem to experimental design, data analysis and interpretation. When planning experiments, we must keep in mind that large uncontrolled variations are common occurrences. Experiments are generally undertaken by researchers to compare effects of several conditions on some phenomena or in discovering an unknown effect of particular process. An experiment facilitates the study of such phenomena under controlled conditions. Therefore, the creation of controlled condition is the most essential characteristic of experimentation. How we formulate our questions and hypotheses are critical to the experimental procedure that will follow. For example, a crop scientist who plants the same variety of a crop in a field may find variations in yield that are due to periodic variations across a field or to some other factors that the experimenter has no control over. The methodologies used in designing experiments will

separate with confidence and accuracy a varietal difference of crops from the uncontrolled variations.

The different concepts in planning of experiment can be well explained through *chapati tasting experiment*.

Consider an experiment to detect the taste difference in chapati made of wheat flour of c306 and pv 18 varieties. The null hypothesis we can assume here is that there is no taste difference in chapatis made of c306 or pv18 wheat flours. After the null hypothesis is set, we have to fix the level of significance at which we can operate. The pv18 is a much higher yielding variety than c306. Hence a false rejection may not help the country to grow more pv18 and the wheat production may decrease while a false acceptance may give more production of pv18 wheat and the consumption may be less or practically nil. Thus, the false acceptance or false rejection are of practically equal consequence and we agree to choose the level of significance at $\alpha = 0.05$. Now to execute the experiment, a subject is to be found with extrasensory powers who can detect the taste differences. The colors of c306 and pv18 are different and anyone, even without tasting the chapatis, can distinguish the chapatis of either kind by a mere glance. Thus, the taster of the chapatis has to be blindfolded before the chapatis are given for tasting. Afterwards, the method is to be decided in which the experiment will be conducted. The experiment can be conducted in many ways and of them three methods are discussed here:

- Give the taster equal number of chapatis of either kind informing the taster about it.
- Give the taster pairs of chapatis of each kind informing the taster about it.
- Give the taster chapatis of either kind without providing him with any information. Let us use 6 chapatis in each of these methods.

Under first method of experimentation, if the null hypothesis is true, then the experimenter cannot distinguish the two kinds of chapatis and he will randomly select 3 chapatis out of 6 chapatis given to him, as made of pvl8 wheat. In that case, all correct guesses are made if selection exactly coincides with the exactly used wheat variety and the probability for such an occurrence is:

$$\frac{1}{\binom{6}{3}} = \frac{1}{20} = 0.05$$

Under second method, the pv18 wheat variety chapaties are selected from each pair given if the null hypothesis is true. Furthermore, independent choices are made of pv18 variety chapaties from each pair. Thus, the probability of making all correct guesses is

$$1/(2)^3 = 1/8 = 0.125.$$

In third method the experimenter has to make the choice for each chapati and the situation is analogous at calling heads or tails in a coin tossing experiment. The probability of making all correct guesses would then be:

$$1/2^6 = 1/64 = .016.$$

If the experimenter makes all correct guesses in third method as its probability is smaller than the selected $\alpha = 0.05$, we can reject the null hypothesis and conclude that the two wheat

varieties give different tastes at chapatis. In other methods the probability of making all correct guesses does not exceed $\alpha = 0.05$ and hence with either method, we cannot reject the null hypothesis even if all correct guesses are made.

However, if 8 chapatis are used by first method and if the taster guesses all of them, we can reject the null hypothesis, at 0.05 level of significance, as the probability of making all correct guesses would then be $\frac{1}{\binom{8}{3}} = \frac{1}{56}$ which is smaller than 0.05. 8 chapatis will not enable us to reject the null hypothesis even if all correct guesses are made by second method as the probability of making all correct guesses is $\left(\frac{1}{4}\right)^4 = \frac{1}{16} = 0.06$ it is easy to see that if 10 chapatis are given by second method and if all correct guesses are made, then we can reject the null hypothesis at 0.05 level of significance. Not to unduly influence the taster in making guesses, we should also present the chapatis in a random order rather than systematically presenting them for tasting.

The above discussed chapati tasting experiment brings home the following salient features of experimentation:

- All the extraneous variations in the data should be eliminated or controlled excepting the variations due to the treatments under study. One should not artificially provide circumstances for one treatment to show better results than others.
- For a given size of the experiment, though the experiment can be done in many ways, even the best results may not turn out to be significant with some designs, while some other design can detect the treatment differences. Thus, there is an imperative need to choose the right type of design, before the commencement of the experiment, lest the results may be useless.
- If for some specific reasons related to the nature of the experiment, a particular method has to be used in experimentation, then adequate number of replications of each treatment have to be provided in order to get valid inferences.
- The treatments have to be randomly allocated to the experimental units.

The terminologies often used in planning and designing of experiments are listed below.

Treatment: Treatment refers to controllable quantitative or qualitative factors imposed at a certain level by the experimenter. For an agronomist several fertilizer concentrations applied to a particular crop or a variety of crop is a treatment. Similarly, an animal scientist looks upon several concentrations of a drug given to animal species as a treatment. In agribusiness we may look upon impact of advertising strategy on sales a treatment. To an agricultural engineer, different levels of irrigation may constitute a treatment.

Experimental Unit: An experimental unit is an entity that receives a treatment e.g., for an agronomist or horticulturist it may be a plot of a land or batch of seed, for an animal scientist it may be a group of pigs or sheep, for a scientist engaged in forestry research it may be different tree species occurring in an area, and for an agricultural engineer it may be manufactured

item. Thus, an experimental unit maybe looked upon as a small subdivision of the experimental material, which receives the treatment.

Experimental Error: Differences in yields arising out of experimental units treated alike are called Experimental Error.

Controllable conditions in an experiment or experimental variable are terms as a factor. For example, a fertilizer, a new feed ration, and a fungicide are all considered as factors. Factors may be qualitative or quantitative and may take a finite number of values or type. Quantitative factors are those described by numerical values on some scale. The rates of application of fertilizer, the quantity of seed sown are examples of quantitative factors. Qualitative factors are those factors that can be distinguished from each other, but not on numerical scale e.g., type of protein in a diet, sex of an animal, genetic make up of plant etc. While choosing factors for any experiment researcher should ask the following questions, like What treatments in the experiment should be related directly to the objectives of the study? Does the experimental technique adopted require the use of additional factors? Can the experimental unit be divided naturally into groups such that the main treatment effects are different for the different groups? What additional factors should one include in the experiment to interact with the main factors and shed light on the factors of direct interest? How desirable is it to deliberately choose experimental units of different types?

1. Basic Principles of Design of Experiments

Given a set of treatments which can provide information regarding the objective of an experiment, a design for the experiment, defines the size and number of experimental units, the manner in which the treatments are allotted to the units and also appropriate type and grouping of the experimental units. These requirements of a design ensure validity, interpretability and accuracy of the results obtainable from an analysis of the observations.

These purposes are served by the principles of:

- Randomization
- Replication
- Local (Error) control

Randomization: After the treatments and the experimental units are decided the treatments are allotted to the experimental units at random to avoid any type of personal or subjective bias, which may be conscious or unconscious. This ensures validity of the results. It helps to have an objective comparison among the treatments. It also ensures independence of the observations, which is necessary for drawing valid inference from the observations by applying appropriate statistical techniques.

Depending on the nature of the experiment and the experimental units, there are various experimental designs and each design has its own way of randomization. Various speakers while discussing specific designs in the lectures to follow shall discuss the procedure of random allocation separately.

Replication: If a treatment is allotted to r experimental units in an experiment, it is said to be replicated r times. If in a design each of the treatments is replicated r times, the design is said to have r replications. Replication is necessary to

- Provide an estimate of the error variance which is a function of the differences among observations from experimental units under identical treatments.
- Increase the accuracy of estimates of the treatment effects.

Though, more the number of replications the better it is, so far as precision of estimates is concerned, it cannot be increased infinitely as it increases the cost of experimentation. Moreover, due to limited availability of experimental resources too many replications cannot be taken.

The number of replications is, therefore, decided keeping in view the permissible expenditure and the required degree of precision. Sensitivity of statistical methods for drawing inference also depends on the number of replications. Sometimes this criterion is used to decide the number of replications in specific experiments.

Error variance provides a measure of precision of an experiment, the less the error variance the more precision. Once a measure of error variance is available for a set of experimental units, the number of replications needed for a desired level of sensitivity can be obtained as below.

Given a set of treatments an experimenter may not be interested to know if two treatments differ in their effects by less than a certain quantity, say, d . In other words, he wants an experiment that should be able to differentiate two treatments when they differ by d or more.

The significance of the difference between two treatments is tested by t-test were

$$t = \frac{\bar{y}_i - \bar{y}_j}{\sqrt{2s^2 / r}},$$

Here, \bar{y}_i , and \bar{y}_j are the arithmetic means of two treatment effects each based on r replications, s^2 is measure of error variation.

Given a difference d , between two treatment effects such that any difference greater than d should be brought out as significant by using a design with r replications, the following equation provides a solution of r .

$$\begin{aligned} t &= \frac{|d|}{\sqrt{2s^2 / r}}, \\ r &= \frac{t_0^2}{d^2} \times 2s^2 \end{aligned} \quad \dots(1)$$

where t_0 is the critical value of the t-distribution at the desired level of significance, that is, the value of t at 5 or 1 per cent level of significance read from the t-table. If s^2 is known or based on a very large number of observations, made available from some pilot pre-experiment investigation, then t is taken as the normal variate. If s^2 is estimated with n degree of freedom (d.f.) then t_0 corresponds to n d.f.

When the number of replications is r or more as obtained above, then all differences greater than d are expected to be brought out as significant by an experiment when it is conducted on a set of experimental units which has variability of the order of s^2 . For example, in an experiment on wheat crop conducted in a seed farm in Bhopal, to study the effect of application of nitrogen and phosphorous on yield a randomized block design with three replications was adopted. There were 11 treatments two of which were (i) 60 Kg/ha of nitrogen (ii) 120 Kg/ha of nitrogen. The average yield figures for these two applications of the fertilizer were 1438 and 1592 Kg/ha respectively and it is required that differences of the order of 150 Kg/ha should be brought out significant. The error mean square (s^2) was 12134.88. Assuming that the experimental error will be of the same order in future experiments and t_0 is of the order of 2.00, which is likely as the error d.f. is likely to be more than 30 as there are 11 treatments; Substituting in (1), we get:

$$r = \frac{2t_0^2 s^2}{d^2} = \frac{2 \times 2^2 \times 2134.88}{150^2} = 4 \text{ (approx)}$$

Thus, an experiment with 4 replications is likely to bring out differences of the order of 150 Kg/ha as significant.

Another criterion for determining r is to take a number of replications which ensures at least 10 d.f. for the estimate of error variance in the analysis of variance of the design concerned since the sensitivity of the experiment will be very much low as the F test (which is used to draw inference in such experiments) is very much unstable below 10 d.f.

Local Control: The consideration in regard to the choice of number of replications ensure reduction of standard error of the estimates of the treatment effect because the standard error of the estimate of a treatment effect is $\sqrt{s^2/r}$, but it cannot reduce the error variance itself. It is, however, possible to devise methods for reducing the error variance. Such measures are called *error control* or local control. One such measure is to make the experimental units homogenous. Another method is to form the units into several homogenous groups, usually called blocks, allowing variation between the groups.

A considerable amount of research work has been done to divide the treatments into suitable groups of experimental units so that the treatment effect can be estimated more precisely. Extensive use of combinatorial mathematics has been made for formation of such group treatments. This grouping of experiment units into different groups has led to the development of various designs useful to the experimenter. We now briefly describe the various term used in designing of an experiment

Blocking: It refers to methodologies that form the units into homogeneous or pre-experimental subject-similarity groups. It is a method to reduce the effect of variation in the experimental material on the Error of Treatment of Comparisons. For example, animal scientist may decide to group animals on age, sex, breed or some other factors that he may believe has an influence on characteristic being measured. Effective blocking removes considerable measure of variation from the experimental error. The selection of source of variability to be used as basis of blocking, block size, block shape and orientation are crucial for blocking. The blocking factor is introduced in the experiment to increase the power of design to detect treatment effects.

The importance of good designing is inseparable from good research (results). The following examples point out the necessity for a good design that will yield good research. First, a nutrition specialist in developing country is interested in determining whether mother's milk is better than powdered milk for children under age one. The nutritionist has compared the growth of children in village A, who are all on mother's milk against the children in village B, who use powdered milk. Obviously, such a comparison ignores the health of the mothers, the sanitary-conditions of the villages, and other factors that may have contributed to the differences observed without any connection to the advantages of mother's milk or the powdered milk on the children. A proper design would require that both mother's milk and the powdered milk be alternatively used in both villages, or some other methodology to make certain that the differences observed are attributable to the type of milk consumed and not to some uncontrollable factor. Second, a crop scientist who is comparing 2 varieties of maize, for instance, would not assign one variety to a location where such factors as sun, shade, unidirectional fertility gradient, and uneven distribution of water would either favor or handicap it over the other. If such a design were to be adopted, the researcher would have difficulty in determining whether the apparent difference in yield was due to variety differences or resulted from such factors as sun, shade, soil fertility of the field, or the distribution of water. These two examples illustrate the type of poorly designed experiments that are to be avoided.

2. Analysis of Variance

Analysis of Variance (ANOVA) is a technique of partitioning the overall variation in the responses into different assignable sources of variation, some of which are specifiable and others unknown. Total variance in the sample data is partitioned and is expressed as the sum of its non-negative components is a measure of the variation due to some specific independent source or factor or cause. ANOVA consists in estimation of the amount of variation due to each of the independent factors (causes) separately and then comparing these estimates due to ascribable factors (causes) with the estimate due to chance factor the latter being known as experimental error or simply the error.

Total variation present in a set of observable quantities may, under certain circumstances, be partitioned into a number of components associated with the nature of classification of the data. The systematic procedure for achieving this is called *Analysis of Variance*. The initial techniques of the analysis of variance were developed by the statistician and geneticist R. A. Fisher in the 1920s and 1930s, and is sometimes known as Fisher's analysis of variance, due to the use of Fisher's F-distribution as part of the test of statistical significance.

Thus, ANOVA is a statistical technique that can be used to evaluate whether there are differences between the average value, or mean, across several population groups. With this model, the response variable is continuous in nature, whereas the predictor variables are categorical. For example, in a clinical trial of hypertensive patients, ANOVA methods could be used to compare the effectiveness of three different drugs in lowering blood pressure. Alternatively, ANOVA could be used to determine whether infant birth weight is significantly different among mothers who smoked during pregnancy relative to those who did not. In a particular case, where two population means are being compared, ANOVA is equivalent to the independent two-sample t-test.

The fixed-effects model of ANOVA applies to situations in which the experimenter applies several treatments to the subjects of the experiment to see if the response variable values change. This allows the experimenter to estimate the ranges of response variable values that the treatment would generate in the population as a whole. If factors are fixed and are attributable to a finite set of levels of factor eg. Sex, year, variety, fertilizer etc.

Consider for example a clinical trial where three drugs are administered on a group of men and women some of whom are married and some are unmarried. The three classifications of sex, drug and marital status that identify the source of each datum are known as factors. The individual classification of each factor is known as levels of the factors. Thus, in this example there are 3 levels of factor drug, 2 levels of factor sex and 2 levels of marital status. Here all the effects are fixed. Random effects models are used when the treatments are not fixed. This occurs when the various treatments (also known as factor levels) are sampled from a larger population. When factors are random, these are generally attributable to infinite set of levels of a factor of which a random sample are deemed to occur eg. research stations, clinics in Delhi, sires, etc. Suppose new inject-able insulin is to be tested using 15 different clinics of Delhi state. It is reasonable to assume that these clinics are random sample from a population of clinics from Delhi. It describes the situations where both fixed and random effects are present.

In any ANOVA model, general mean is always taken as fixed effect and error is always taken as random effect. Thus, class of model can be classified on the basis of factors, other than these two factors. ANOVA can be viewed as a generalization of t-tests: a comparison of differences of means across more than two groups.

The ANOVA is valid under certain assumptions. These assumptions are:

- Samples have been drawn from the populations that are normally distributed.
- Observations are independent and are distributed normally with mean zero and variance σ^2 .
- Effects are additive in nature.

The ANOVA is performed as one-way, two-way, three-way, etc. ANOVA when the number of factors is one, two or three respectively. In general, if the number of factors is more, it is termed as multi-way ANOVA.

3. Basic Experimental Designs

In this section, three basic designs viz., Completely randomized design (CRD), Randomized Complete Block Design (RCBD) and Latin Square Design (LSD) are explained in detail.

3.1. Completely Randomized Design

Designs are usually characterized by the nature of grouping of experimental units and the procedure of random allocation of treatments to the experimental units. In a completely randomized design, the units are taken in a single group. As far as possible the units forming the group are homogeneous. This is a design in which only randomization and replication are used. There is no use of local control here.

Let there be v treatments in an experiment and n homogeneous experimental units. Let the i^{th} treatment be replicated r_i times ($i = 1, 2, \dots, v$) such that $\sum_{i=1}^v r_i = n$. The treatments are allotted at random to the units.

Normally the number of replications for different treatments should be equal as it ensures equal precision of estimates of the treatment effects. The actual number of replications is, however, determined by the availability of experimental resources and the requirement of precision and sensitivity of comparisons. If the experimental material for some treatments is available in limited quantities, the numbers of their replication are reduced. If the estimates of certain treatment effects are required with more precision, the numbers of their replication are increased.

Randomization in CRD

There are several methods of random allocation of treatments to the experimental units. The v treatments are first numbered in any order from 1 to v . The n experimental units are also numbered suitably. One of the methods uses the random number tables. Any page of a random number table is taken. If v is a one-digit number, then the table is consulted digit by digit. If v is a two-digit number, then two-digit random numbers are consulted. All numbers greater than v including zero are ignored.

Let the first number chosen be n_1 ; then the treatment numbered n_1 is allotted to the first unit. If the second number is n_2 which may or may not be equal to n_1 , then the treatment numbered n_2 is allotted to the second unit. This procedure is continued. When the i^{th} treatment number has occurred r_i times, ($i = 1, 2, \dots, v$) this treatment is ignored subsequently. This process terminates when all the units are exhausted.

One drawback of the above procedure is that sometimes a very large number of random numbers may have to be ignored because they are greater than v . It may even happen that the random number table is exhausted before the allocation is complete. To avoid this difficulty the following procedure is adopted. We have described the procedure by taking v to be a two-digit number.

Let P be the highest two-digit number divisible by v . Then all numbers greater than P and zero are ignored. If a selected random number is less than v , then it is used as such. If it is greater than or equal to v , then it is divided by v and the remainder is taken to be the random number. When a number is completely divisible by v , then the random number is v . If v is an n -digit number, then P is taken to be the highest n -digit number divisible by v . The rest of the procedure is the same as above.

Analysis

This design provides a one-way classified data according to levels of a single factor. For its analysis the following model is taken:

$$y_{ij} = \mu + t_i + e_{ij}, \quad i = 1, \dots, v; j = 1, \dots, r_i,$$

where y_{ij} is the random variable corresponding to the observation y_{ij} obtained from the j^{th} replicate of the i^{th} treatment, μ is the general mean, t_i is the fixed effect of the i^{th} treatment and e_{ij}

is the error component which is a random variable assumed to be normally and independently distributed with zero means and a constant variance σ^2 .

Let $\sum_j y_{ij} = T_i$ ($i = 1, 2, \dots, v$) be the total of observations from i^{th} treatment. Let further $\sum_i T_i = G$. Correction factor (C.F.) = G^2/n .

$$\text{Sum of squares due to treatments} = \sum_{i=1}^v \frac{T_i^2}{r_i} - C.F.$$

$$\text{Total sum of squares} = \sum_{i=1}^v \sum_{j=1}^{r_i} y_{ij}^2 - C.F.$$

ANALYSIS OF VARIANCE

Sources of variation	Degrees of freedom (D.F.)	Sum of squares (S.S.)	Mean squares (M.S.)	F
Treatments	$v - 1$	$S \sum_{i=1}^v \frac{T_i^2}{r_i} - C.F.$	$MST = SST / (v - 1)$	MST/MSE
Error	$n - v$	$SSE = by subtraction$	$MSE = SSE / (n - v)$	
Total	$n - 1$	$\sum_j y_{ij}^2 - C.F.$		

The hypothesis that the treatments have equal effects is tested by F-test where F is the ratio MST / MSE with $(v - 1)$ and $(n - v)$ degrees of freedom.

3.2. Randomized Complete Block Design

It has been seen that when the experimental units are homogeneous then a CRD should be adopted. In any experiment, however, besides treatments the experimental material is a major source of variability in the data. When experiments require a large number of experimental units, the experimental units may not be homogeneous, and in such situations CRD cannot be recommended. When the experimental units are heterogeneous, a part of the variability can be accounted for by grouping the experimental units in such a way that experimental units within each group are as homogeneous as possible. The treatments are then allotted randomly to the experimental units within each group (or blocks). The principle of first forming homogeneous groups of the experimental units and then allotting at random each treatment once in each group is known as local control. This results in an increase in precision of estimates of the treatment contrasts, due to the fact that error variance that is a function of comparisons within blocks, is smaller because of homogeneous blocks. This type of allocation makes it possible to eliminate from error variance a portion of variation attributable to block

differences. If, however, variation between the blocks is not significantly large, this type of grouping of the units does not lead to any advantage; rather some degrees of freedom of the error variance is lost without any consequent decrease in the error variance. In such situations it is not desirable to adopt randomized complete block designs in preference to completely randomized designs.

If the number of experimental units within each group is same as the number of treatments and if every treatment appears precisely once in each group, then such an arrangement is called a *randomized complete block design*.

Suppose the experimenter wants to study v treatments. Each of the treatments is replicated r times (the number of blocks) in the design. The total number of experimental units is, therefore, vr . These units are arranged into r groups of size v each. The error control measure in this design consists of making the units in each of these groups homogeneous.

The number of blocks in the design is the same as the number of replications. The v treatments are allotted at random to the v plots in each block. This type of homogeneous grouping of the experimental units and the random allocation of the treatments separately in each block are the two main characteristic features of randomized block designs. The availability of resources and considerations of cost and precision determine actual number of replications in the design.

Analysis

The data collected from experiments with randomized block designs form a two-way classification, that is, classified according to the levels of two factors, *viz.*, blocks and treatments. There are vr cells in the two-way table with one observation in each cell. The data are orthogonal and therefore the design is called an *orthogonal design*. We take the following model:

$$y_{ij} = \mu + t_i + b_j + e_{ij}, \quad \begin{cases} i=1,2,\dots,v; \\ j=1,2,\dots,r \end{cases}$$

where y_{ij} denotes the observation from i^{th} treatment in j^{th} block. The fixed effects μ, t_i, b_j denote respectively the general mean, effect of the i^{th} treatment and effect of the j^{th} block. The random variable e_{ij} is the error component associated with y_{ij} . These are assumed to be normally and independently distributed with zero means and a constant variance σ^2 .

Following the method of analysis of variance for finding sums of squares due to blocks, treatments and error for the two-way classification, the different sums of squares are obtained

as follows: Let $\sum_j y_{ij} = T_i$ ($i = 1, 2, \dots, v$) = total of observations from i^{th} treatment and $\sum_j y_{ij} = B_j$ ($j = 1, \dots, r$) = total of observations from j^{th} block. These are the marginal totals

of the two-way data table. Let further, $\sum_i T_i = \sum_j B_j = G$.

Correction factor (C.F.) = G^2/rv , Sum of squares due to treatments = $\sum_i \frac{T_i^2}{r} - C.F.$,

Sum of squares due to blocks = $\sum_j \frac{B_j^2}{v} - C.F.$, Total sum of squares = $\sum_j y_j^2 - C.F.$

ANALYSIS OF VARIANCE

Sources of variation	Degrees of freedom (D.F.)	Sum of squares (S.S.)	Mean squares (M.S.)	F
Blocks	$r - 1$	$SSB = \sum_j \frac{B_j^2}{v} - C.F.$	$MSB = SSB / (r - 1)$	MSB/MSE
Treatments	$v - 1$	$SST = \sum_i \frac{T_i^2}{r} - C.F.$	$MST = SST / (v - 1)$	MST/MSE
Error	$(r - 1)(v - 1)$	$SSE = \text{by subtraction}$	$MSE = SSE / (v - 1)(r - 1)$	
Total	$vr - 1$	$\sum_j y_j^2 - C.F.$		

The hypothesis that the treatments have equal effects is tested by F-test, where F is the ratio MST / MSE with $(v - 1)$ and $(v - 1)(r - 1)$ degrees of freedom. We may then be interested to either compare the treatments in pairs or evaluate special contrasts depending upon the objectives of the experiment. This is done as follows:

The critical difference for testing the significance of the difference of two treatment effects, say $t_i - t_j$ is $C.D. = t_{(v-1)(r-1)\alpha/2} \sqrt{2MSE/r}$, where $t_{(v-1)(r-1)\alpha/2}$ is the value of Student's t at the level of significance α and degree of freedom $(v - 1)(r - 1)$. If the difference of any two-treatment means is greater than the C.D. value, the corresponding treatment effects are significantly different.

3.3. Latin Square Design

Latin square designs are normally used in experiments where it is required to remove the heterogeneity of experimental material in two directions. These designs require that the number of replications equal the number of *treatments* or *varieties*.

Definition 1: A Latin square arrangement is an arrangement of v symbols in v^2 cells arranged in v rows and v columns, such that every symbol occurs precisely once in each row and precisely once in each column. The term v is known as the order of the Latin square.

If the symbols are taken as A, B, C, D , a Latin square arrangement of order 4 is as follows:

A	B	C	D
B	C	D	A
C	D	A	B
D	A	B	C

A Latin square is said to be in the standard form if the symbols in the first row and first column are in natural order, and it is said to be in the semi-standard form if the symbols of the first row are in natural order. Some authors denote both of these concepts by the term standard form. However, there is a need to distinguish between these two concepts. The standard form is used for randomizing the Latin-square designs, and the semi-standard form is needed for studying the properties of the orthogonal Latin squares.

Definition 2: If in two Latin squares of the same order, when superimposed on one another, every ordered pair of symbols occurs exactly once, the two Latin squares are said to be orthogonal. If the symbols of one Latin square are denoted by Latin letters and the symbols of the other are denoted by Greek letters, the pair of orthogonal Latin squares is also called a graeco-latin square.

The following is an example of graeco latin square:

A	B	C	D	α	γ	δ	β	$A\alpha$	$B\gamma$	$C\delta$	$D\beta$
B	A	D	C	β	δ	γ	α	$B\beta$	$A\delta$	$D\gamma$	$C\alpha$
C	D	A	B	γ	α	β	δ	$C\gamma$	$D\alpha$	$A\beta$	$B\delta$
D	C	B	A	δ	β	α	γ	$D\delta$	$C\beta$	$B\alpha$	$A\gamma$

We can verify that in the above arrangement every pair of ordered Latin and Greek symbols occurs exactly once, and hence the two latin squares under consideration constitute a graecolatin square.

It is well known that the maximum number of MOLS possible of order v is $v - 1$. A set of $v - 1$ MOLS is known as a complete set of MOLS. Complete sets of MOLS of order v exist when v is a prime or prime power.

Randomization in LSD

According to the definition of a Latin square design, treatments can be allocated to the v^2 experimental units (may be animal or plots) in a number of ways. There are, therefore, a number of Latin squares of a given order. The purpose of randomization is to select one of these squares at random. The following is one of the methods of random selection of Latin squares.

Let a $v \times v$ Latin square arrangement be first written by denoting treatments by Latin letters $A, B, C, \text{etc.}$ or by numbers $1, 2, 3, \text{etc.}$ Such arrangements are readily available in the *Tables for Statisticians and Biometricians* (Fisher and Yates, 1974). One of these squares of any order can be written systematically as shown below for a 5×5 Latin square:

A	B	C	D	E
B	C	D	E	A
C	D	E	A	B
D	E	A	B	C
E	A	B	C	D

For the purpose of randomization rows and columns of the Latin square are rearranged randomly. There is no randomization possible within the rows and/or columns. For example, the following is a row randomized square of the above 5×5 Latin square;

A	B	C	D	E
B	C	D	E	A
E	A	B	C	D
D	E	A	B	C
C	D	E	A	B

Next, the columns of the above row randomized square have been rearranged randomly to give the following random square:

E	B	C	A	D
A	C	D	B	E
D	A	B	E	C
C	E	A	D	B
B	D	E	C	A

As a result of row and column randomization, but not the randomization of the individual units, the whole arrangement remains a Latin square.

Analysis of Latin Square Designs

In Latin square designs there are three factors. These are the factors P , Q , and treatments. The data collected from this design are, therefore, analyzed as a three-way classified data. Actually, there should have been v^3 observations as there are three factors each at v levels. But because of the particular allocation of treatments to the cells, there is only one observation per cell instead of v in the usual three way classified orthogonal data. As a result we can obtain only the sums of squares due to each of the three factors and error sum of squares. None of the interaction sums of squares of the factors can be obtained. Accordingly, we take the model.

$$Y_{ijs} = \mu + r_i + c_j + t_s + e_{ijs}$$

where y_{ijs} denotes the observation in the i^{th} row, j^{th} column and under the s^{th} treatment; $\mu, r_i, c_j, t_s (i, j, s = 1, 2, \dots, v)$ are fixed effects denoting in order the general mean, the row, the column and the treatment effects. The e_{ijs} is the error component, assumed to be independently and normally distributed with zero mean and a constant variance, σ^2 .

The analysis is conducted by following a similar procedure as described for the analysis of two-way classified data. The different sums of squares are obtained as below: Let the data be arranged first in a $row \times column$ table such that y_{ij} denotes the observation of $(i, j)^{th}$ cell of table.

$$\text{Let } R_i = \sum_j y_{ij} = i^{\text{th}} \text{ row total } (i=1,2,\dots,v), C_j = \sum_i y_{ij} = j^{\text{th}} \text{ column total } (j=1,2,\dots,v),$$

T_s = sum of those observations which come from s^{th} treatment ($s=1,2,\dots,v$),

$$G = \sum R_i = \text{grand total. Correction factor, } C.F. = \frac{G^2}{v^2}. \text{ Treatment sum of squares} = \sum_s \frac{T_s^2}{v} - C.F., \text{ Row sum of squares} = \sum_i \frac{R_i^2}{v} - C.F., \text{ Column sum of squares} = \sum_j \frac{C_j^2}{v} - C.F.$$

Analysis of Variance of $v \times v$ Latin Square Design

Sources of Variation	D.F.	S.S.	M.S.	F
Rows	$v - 1$	$\sum_i \frac{R_i^2}{v} - C.F.$		
Columns	$v - 1$	$\sum_j \frac{C_j^2}{v} - C.F.$		
Treatments	$v - 1$	$\sum_s \frac{T_s^2}{v} - C.F.$	s_t^2	s_t^2 / s_e^2
Error	$(v - 1)(v - 2)$	By subtraction	s_e^2	
Total	$v^2 - 1$	$\sum_j y_{ij}^2 - C.F.$		

The hypothesis of equal treatment effects is tested by F -test, where F is the ratio of treatment mean squares to error mean squares. If F is not significant, treatment effects do not differ significantly among themselves. If F is significant, further studies to test the significance of any treatment contrast can be made.

References

- Kempthorne, O. (1977). Why randomize? *Journal of Statistical Planning and Inference*, 1, 1-25.
- Dean, A. and Voss, D. (1999). *Design and Analysis of Experiments*. Springer Text in Statistics, New York.
- Fisher, R.A. and Yates, F. (1963). *Statistical Tables for Biological, Agricultural and Medical Research*. Longman Group Ltd., England.
- Parsad, Rajender and Gupta, V.K. Basic Experimental Designs. E book chapter available @http://www.iasri.res.in/ebook/EB_SMAR/ebook_pdf%20files/Manual%20III/2-Basic%20Experiments.pdf

Extension Tools for Dissemination of Research Information & Technologies to Farmers

Suniti Kumar Jha

ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata

Corresponding author: sunitikumarjha@gmail.com

Abstract

Extension is an educational process for bringing about the maximum number of desirable changes among the people and the purpose behind the approach is to stir the people to motivate them to act towards some specified goal. The extension teaching methods are also called the Extension tools and techniques used to increase the effectiveness of extension work and create situations to draw clientele's attention, arouse their interest and help them to have a successful experience of the new practice. Extension methods may be according to use (written form, spoken form, visual form) and nature of Contact (individual approach, group approach, mass approach). An extension worker, must first know "what methods are available to him", secondly, he should know, "when to use a given method, and thirdly, "he should become efficient in using each method." Therefore, the extension methods are to be selected tactfully based on the end users' socio-economic status, their resource level, groups, organizations, and communities. Dissemination needs to recognize both aspects. The extension tools should be product-centered as well as user-centered. In using teaching aids, we have to be selective otherwise failure to select tools appropriate to the objectives of a communicator will interrupt the interpretation of the message, in the manner in which it is desired, by the intended audience.

What is Extension?

The word 'Extension' is derived from the Latin roots, 'ex' meaning 'out' and 'tensio' meaning 'stretching'. Literally it means 'stretching out'. That is stretching out beyond the boundaries of university and research stations to reach the rural people to educate them on various issues. In India, the terms community development and extension became more popular with the launching of Community Development Projects in 1952 and with the establishment of the National Extension Service in 1953. Since then, Community development has been regarded as a programme for an all-round development of the rural people, and extension as the means to achieve this objective.

Definition of Extension

Cumberlage (1956) defined that Extension is education of the rural adults and children outside the school, in matters of their own choice and interest; education for freedom which seeks to help persons to use the liberty of action with which a democratic society is constructed. Kelsey and Hearne (1963) explained that extension work is an out-of-school systems of education in which adults and young people learn by doing.

Leagans (1961) defines Extension Education is an applied science consisting of content derived from research, accumulated field experiences and relevant principles drawn from the behavioural sciences synthesized with useful technology into a body of philosophy, principles, contents and methods focused on the problems of out-of-school education for adults and youth.

The National Commission on Agriculture (1976) explains extension education as an out-of school education and services for the members of the farm family and others directly or indirectly engaged in farm production, to enable them to adopt improved practices on production, management, conservation and marketing. OP Dahama (1973) defines extension education as an educational process to provide knowledge to the rural people about the improved practices in a convincing manner and help them to take decision within their specific local conditions.

It may be summed up from above definitions that education is the integral part of extension and the type of education imparted to the out of school children and adult is non-formal in nature. However, these definitions do not cover the entire scope of Extension Education which has now attained the stature of a distinct discipline with its own research, methodology, teaching and field (practice) of activities. We may say that the extension education is a science which deals with the creation, transmission and application of knowledge designed to bring about planned changes in the behaviour (knowledge, skill and attitude) of people, with a view to help them live better by learning the ways of improving their vocations, enterprise and institutions. By definition, extension and extension education are synonymous. They are used interchangeable in the extension literatures.

- Extension is an educational process for bringing about the maximum number of desirable changes among the people,
- Involves both learning, teaching and extension teaching methods.
- Extension helps in Transfer of technology (TOT) which is an essential process for agricultural development.
- Research creates knowledge, extension transfers it to farmers and farmers utilize it.

Since extension is education and education is the process of bringing about or producing maximum desirable change in human behaviour, there must be some tool to do so. *These tools are called Extension Teaching Methods and are popularly called "Extension Methods".* They are basic and proven methods of extension teaching for approaching, working with, encouraging and influencing village people to accept and adopt improved practices of all aspects of community development, whether agriculture, health or Industry of the village. Thus, they are the methods of contacting and extending "know-how" to the people who live in the villages, by attracting their attention, arousing their interest and help them to have a successful experience of the new practice.

The extension teaching methods are the tools and techniques used to increase the effectiveness of extension work and create situations which - a) draw their attention, b) arouse their interest and c) help them to have a successful experience of the new practice.

Extension may be said to be extension approach or technique for reaching the people. The purpose behind the approach is to stir the people to motivate them to act towards some specified goal. This may be to fire up their imagination for a higher standard of living through higher yields in crops, better animals, better home managements, etc. The approaches may be grouped as given below:

Classification of Extension Methods used by the Extension Personnel

- i) According to use and nature of Contact ii) According to form

Extension methods according to use and nature of Contact

Individual Approach Through	Group Approach Through	Mass Approach Through
Personal visit – Farm visit, Home visit	Method Demonstrations Result Demonstrations	Printed materials
Individual Approach Through	Training the leaders	Film and slides
	Group discussion, panel discussion, focused group discussion, workshop, symposium	Flash cards, posters, flannel graph, bulletin boards, photographs
	Farmers' Day/ Farmers Awareness Camp	Models and exhibits, Charts, diagrams, Exhibitions, Krishi mela
	Field days	Radio, Television, Campaigns
	Farmers field school	Recorded talks
	Exposure visits, Tours	Newspaper stories

Extension methods according to form

Written form	Spoken form	Objective or Visual
Bulletins	General / special meetings	Method Demonstrations
Leaflets / folders	Farm visit / Home visit	Result demonstrations
News articles	Office calls	Posters /Charts/ Flannel graph etc.
Personal letters	Personal telephone calls	Movies
SMS	Radio	Models / Exhibits

Individual approach: For this approach, the extension worker should know about the motivating factors involved in making the life of the individual. For this kind of approach, the extension worker is required to find out the villagers' interests, (b) to discover to whom the villagers tend to look for leadership and for other purposes. (c) to find out the villagers' problems and their interest in solving them. (d) to create learning attitudes among the villagers and himself. The advantages are:

(1) It provides first-hand information about village problems and activities. (2) It establishes confidence in the worker. (3) It develops goodwill. (4) It helps the extension worker in the selection of good leaders and establishing of good relations. (5) It stimulates interest. (6) It provides a high ratio of expectation and efforts.

Group approach: This is an approach to two or more people. For it, the extension worker is required to know: (1) type of group he is approaching, (2) leadership patterns, and (3) particular interest of the group. This approach may help in motivating other villagers to adopt the same, (3) organising discussion meetings so that the farmers are able to discuss their problems and find solutions. In such meetings, the specialists can discuss the various methods and practices.

Mass approach: In this method, the masses can be approached through films, slides, film-strips, radio talks, exhibitions, use of flash-cards, social media etc. It has been estimated that in some communities this method has amounted to 30 per cent of the total approach against 18 per cent in case of individual approach and 25 per cent in group approach. The visual and audio-visual aids help the extension worker to approach and contact the masses in quick time. Now, in case of social media (*youtube, facebook, whatsapp etc.*) provision of feedback (likes, review, comments, rating, subscribing etc.) has been done to get the clienteles' review.

Extension Tools for Technology Dissemination Process in a nutshell

- **Farm and home visit:** Such visits provide an opportunity for a two-way communication.
- **Exhibitions / Melas:** It is one of the best media for reaching a large number of people especially illiterate and semi-illiterate people.
- **Exposure visits / Study tours:** opportunity of seeing the results of new technologies, demonstrations of new implements.
- **Campaigns:** focus the attention of the people on a particular topic, as it involves more no. of people, so it builds up the community confidence.
- **Visual aids:** Good action photographs catch the feelings and emotion of the people.
- **Printed matter (literature):** used to communicate general/ specific type of information on a programme of technology or specific practice.
- **Result demonstration:** Used to prove the advantages of recommended practices and to demonstrate their applicability to the local condition.
- **Method demonstration:** Used to show the techniques of doing things or carrying out new practices
- **Field days:** farmer, whose field is involved in the technology demonstration, explains the advantage of the technology
- **Extension Activities such as Farmers' Day / Seed Day / Awareness Camp:** The principle of "seeing is believing" works in all the above activities as farmers see it through their eyes and get firsthand information which ultimately paves the way for greater and faster adoption of the technologies.

- **Training:** improving knowledge and understanding, stimulating attitude and imparting skills
- **Radio:** radio talks or group discussions, dramas, folk songs, skits
- **Television:** Very useful in demonstration of a new method to large no. of clientele across the country. Television "is society's mass entertainer, mass informer, mass persuader, and mass educator".
- **Text SMS / Whatsapp Chat:** fastest technology to reach with relevant and timely information as the most effective delivery method in the extension system.
- **New Things coming up**

Now, a greater number of farmers have access to net banking, teleshopping, news & weather services, distance educational courses, agricultural, farm management, and lifestyle databases. Various agricultural Apps are also available which provide direct access to information and reduces the need for extension agents to visit farmers to demonstrate the latest innovations. Interactive videos, Youtube videos also provide a way to be with knowledge as well as provides knowledge itself. It encourages individual autonomy and shows respect for individual pacing of knowledge acquisition. This instructional mode of information giving further individualizes information access and use. Cyber extension, market led extension and farmer led extension should be major means to transfer of technology.

How to Select Extension Tools

An extension worker, must first know "*what methods are available to him*"; *secondly, he should know, "when to use a given method, and thirdly, "he should become efficient in using each method.*" The studies have shown that the combination of several methods is more effective than one method, we are not concerned with choosing the best, but rather we should know: (1) what all the methods are, (2) what each has to contribute, and (3) what is the best combination of personal, group and mass media for a specific plan of work or educational campaign.

It is very important to use right methods and tools in the right proportion at the right time. In addition to the above knowledge of extension teaching methods and skills, the extension worker must have a clear understanding of how people can be influenced to change?

Functions of Extension Worker / Agent: A proper understanding of these methods is essential in successfully carrying out an extension programme by the extension agent. They should perform the following functions:

- a) Raise general awareness of beneficiaries
- b) Provide mass advisories
- c) Provide technical information, demonstrate or train
- d) Diagnose problems & recommend solutions
- e) Respond to follow up questions raised by client
- f) Facilitate access to credit and inputs

- g) Assist with business planning
- h) Linking farmers to markets
- i) Knowledge management
- j) Conduct surveys, enumerations or monitoring

Whereas, lack of understanding may result in casual deployment of methods, leading to the following consequences:

- The benefits of the extension programme do not reach as many people as quickly as they should.
- Many new practices might not be accepted by the people since they are not properly presented.
- The extension worker might develop frustration because of the indifferent responses and people might lose confidence in the extension programmes.
- An ineffective extension programme would mean not only enormous wastage of resources but also serious repercussions which would render further welfare work more difficult.

Transfer of Technology (TOT) Process

Effectiveness of Dissemination Strategy

The strategy that works well for transmitting general information to the masses may be inappropriate for communicating specific research findings to policy makers. The strategy that works well for diffusing technological innovations among organizations may not be compatible with dissemination strategies linked to the development of third world countries. Strategies designed for reaching one minority group may not fit well with another minority group. Hence, it can be said that effectiveness of the dissemination strategies may depend on factors such as:

- Characteristics of the innovation,
- Target audience/clientele
- Information channel

Getting the proper fit among the innovation, information channel, purpose, and target audience is important. Understanding channels for communication and how these are changing is essential for effective utilization of information. It is assumed that transmission of new ideas through face-to-face communication and through mass media can prepare a climate that is propitious for the acceleration of change in the desired direction.

An extension worker, must first know

Communication media and extension methods are the tools of approach as they increase the effectiveness of extension work. An extension worker, must

- first know “*what methods are available to him*”,

- secondly, he should know, “*when to use a given method*, and,
- thirdly, “he should become efficient in using each method”.

Way to Proceed for Extension Workers/ Agents: For an effective use of extension tools of disseminating information, it is not enough to know these methods and their techniques. The important aspect is the appropriate selection of a method or combination of methods. In fact, when a farmer is exposed to a new idea several times by different methods or a combination of methods, he is likely to accept it more quickly. Farmers learn about new practices through several stages. These stages are known as :

- Awareness – Interest – Evaluation – Trial – Adoption
- For awareness and interest stages help of mass media tools should be taken;
- For evaluation and trial stages help of personal localite tools should be taken
- For final adoption stage help of personal localite tools plus help of extension agencies should be sought after.
- Various stages of adoption process

People may hear of an innovation via mass media but pursue it themselves only after a friend or acquaintance has introduced them to it in a comfortable setting. Each contributes to the other over time through the various stages of adoption proposed by Rogers (1983):

- **Knowledge (K), Persuasion (P), Decision (D), Implementation(I), and Confirmation(C).**

Systematic approach to mass media : For a shorter-term approach to information dissemination through the mass media, consider some of these: use multiple media, combine media and interpersonal/community strategies, segment the intended audience, use celebrities to get attention and entertainment programs to sustain attention, provide simple, clear and repeated messages, emphasize positive behavior more than negative consequences of current behavior, emphasize current rewards, not distant negative consequences, involve key power figures and organizations, take advantage of timing, use formative evaluation etc.

Therefore, extension methods are to be selected tactfully based on the end users' socio-economic status, their resource level, groups, organizations, and communities. Dissemination needs to recognize both aspects. The extension tools should be product-centered as well as user-centered. For example, if we want to teach the farmers the use and advantages of balanced application of chemical fertilizers, we should do this by

- conducting demonstrations in their fields,
- showing them the method and compare the advantage of it over imbalanced application of fertilizers.
- After seeing the beneficial effect of the technology, the farmer is convinced and motivated to action and starts using balanced application of fertilizers regularly, which is the desired change.

Conclusion

All extension tools are not equally useful in attaining a specific objective. Failure to select tools appropriate to the objectives of a communicator will interrupt the interpretation of the message, in the manner in which it is desired, by the intended audience. The more extension tools a communicator uses in parallel, or at about the same time, the more chances he has of the message getting through and being properly received. While interpersonal channels are those which are used for face-to-face communication between two or more people, mass media are mechanical devices through which an individual or a group can reach a relatively larger population in a shorter time. So, we have to decide which aid will help in teaching our audience in a better way. The decision is also on whether to use a single aid or in a combination. (d) Resources: While planning for the use of aids we have to see our resources of finance, or equipment and facilities for making and using them. We may have a film projector and films but may not have electricity or a generator for a film show in a village. Even though we may not have an artist we can use visuals prepared from cut-out pictures from journals, magazines, etc.

Planning Monitoring and Evaluation of Capacity Development Programmes

Keshava

Division of Agricultural Extension, KAB-I, ICAR-HQ, New Delhi - 110 012

Corresponding author: keshava.69@gov.in

Abstract

In the era of fast changing technology capacity building programmes has become an important area of investment for accelerating transfer of information and technology to different stakeholders. There is always need to improve competency in terms of skills, knowledge and attitude of the employees through appropriate training and development programmes from time to time. However, the training programmes are, most often, being organized very casually leading to its no visible impact in the work place. A systematic approach to training is needed to make it effective. The chapter deals in detail with different steps of the training cycle as well as those aspects of training. Which are generally ignored while organizing it.

Introduction

Human resource in an organization is the most crucial, vital and dynamic resource. Over the period, the Human Resource Management functions have undergone significant changes. Organizations are attaching tremendous importance to the management and development of their personnel. A systematic approach to develop and continuously and individual competencies and capabilities is necessary for achieving organisational goals and objectives effectively. Capacity building of professionals is an emerging area of investment for accelerating organizational growth. Capacity building is defined as the “process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in the fast-changing world.” Training and development initiatives are educational activities within an organization that are designed to improve the work performance of an individual or group. These programs typically involve advancing a worker’s knowledge and skill sets and instilling greater motivation to enhance their performance. A focused, comprehensive approach to training and development is a key component of supporting professional through a change, providing a deeper learning experience which can be important in mitigating against risks.

Concept of Training

A training is an educational process for a group of selected groups of individuals facilitated by competent trainers to change their attitudes, to make them understand the required knowledge and learn the required knowledge and learn the required skills for adoption of new technologies at a place where appropriate facilities exist and at a time suitable to the farmers. It includes many steps in a sequence which includes:

Training need assessment

- Selection of trainees
- Formulation of objectives
- Developing course curriculum
- Deciding training methods and teaching aids
- Conducting training
- Evaluation of training
- Follow-up

Training Need Assessment

Training programme in general and its objectives as well as curriculum in particular depend upon the training needs. But trainers generally skip this step assuming that they themselves know the farmer's needs better. Any agricultural technology has a capacity of production achievable through certain resources. Farmers differ in resources as well as knowledge, skills and attitudes to utilize the resources for getting the production capacity of technology. Thus, training is needed in terms of knowledge, skills and attitudes required by a farmer to minimize the gap between expected and present levels of production considering his resources.

Trainers must move out of their training institutions to identify the training needs and see farmer's practice in their fields, their interaction pattern, their ways of operating tools and equipment's, etc. They should also try to know the resources needed and the problems being faced by the farmers. To make it more fruitful, it is also important to know the farmer's preference about time, venue and duration of training. Thus, training need assessment should include the following aspects:

- Who needs training in certain kind of knowledge, skills and attitudes?
- What will be the content and duration of training?
- Where and when will the training be organized?
- Are resource persons of requisite can be available?
- Are the requisite training facilities available?
- What are the likely outcomes of training?

There are number of methods for analysing the training needs of farmers like interviewing individual farmers focused group discussion, participant observation, non-participant observation, participatory rural appraisal (PRA), etc. Use of a particular method depends upon availability of time, money and manpower as well as extent of content. Training courses based on actual observation farmers expectations and diagnosis would be more fruitful.

Selection of Trainees

Farmers differ in farm size, literacy level economic condition, knowledge, resources, etc. Accordingly, they need different kinds of training. Even in case of same training to different class of farmers, the course organization, training methods and teaching aids will vary according to the characteristics of farmers. It is therefore, essential to categorize farmers according to their status and make the training group as much homogeneous as possible (Kumar and Keshava 1994).

Formulation of Objectives

Next step in the training process is formulation of training objectives. A training objective is a statement of changed ability of trainees after training. It describes what types of changes in behavior (Knowledge, aspects in attitudes, skills and other attributes) of trainees are intended through training. Well-defined objectives facilitate the trainers in deciding contents of training course; identifying reading and reference materials; and selecting teaching methods and aids. It also provides criteria for evaluating the effectiveness of training. One should keep the following aspects in mind while formulating the training objectives (Misra, 1995).

- **The trainees:** background, educational and economic status, needs, interest.
- **The behavioural change:** change in knowledge, attitudes, skills and other attributes like interests and value systems to be brought about in the trainees.
- **The context:** When and under what condition, the changes will occur.

The training objectives must be trainee group specific and stated in terms of changes in behaviour expected. It should be specific (precise and to the point without any ambiguity), Measurable (should describe the changes that may be observed), Attainable (capable of being achieved), Realistic (should take into account other factors that will have a bearing on changes in behaviour of trainees) and time bound (should state the time frame within which it will be fulfilled).

Example: Objective for a two-day training programme on Integrated Plant Nutrient Management (IPNM) for grass root level functionaries can be stated in two different ways.

- After training, the trainees will be able to understand and use the concept of IPNM.
- After training, the trainees will be able to (a) recall different macro and micro-nutrients essential for plant growth; (b) enlist chemical and bio fertilizers that contain essential macro and micro-nutrients; (c) state the steps of crop residue management and (d) collect soil samples and calculate recommended doses of different fertilizers.

The objective put down in format (A) gives clue neither for contents of the training nor for evaluating it, whereas objective written in format (B) can be useful both in deciding training contents and its evaluation.

Developing Course Curriculum

Since training needs of farmers change with change in agro-climatic and technological situations, there cannot be a ready-made curriculum. Even for the same training course, the curriculum will vary according to the socio-economic and personal characteristics of the trainees. Thus, a tailor-made course curriculum is essential for the success of any training programme. It, largely, depends upon needs of the trainees, their characteristics and objectives of training.

The course outline and content should be designed in keeping with the specific objectives of training after which relevant course material is collected. Next step in developing curriculum is to organise the content into logical sequence that is from general to specific to make the learning easier and meaningful. The contents must reflect the real work situation and be based on earlier experiences of trainees.

Deciding Training Methods and Teaching Aids

Training methods and teaching aids are the means through which training messages reach the trainees and trainers receive concurrent feedback on the training. Farmer's training must be designed around sound principles of adult learning. Adults learn new skills best through practice and experience.

There are plenty of training methods, which can be classified, into three major categories i.e., mass contact methods, group contact methods and individual contact methods. Comparisons of training methods on their suitability for different characteristics have been shown in Table 1. Each method has its own advantages and disadvantages. The methods differ in terms of objectives and purposes these can serve, simplicity/complexity in their use, etc. It is important for the trainers to choose the right type of methods for the right type of clients to teach the right type of subject matter. Thus, training managers must consider the following while selecting training methods and teaching aids for farmer's training:

- **Teaching objectives:** Whether the particular topic is to inform, to impart skill or to change the attitude.
- **Characteristics of trainees:** Age, education, intelligence, knowledge level, comprehension level, past experiences, socio-cultural settings, their attitudes towards the methods of training, number of trainees, etc.
- **Characteristics of trainers:** Familiarity with methods, competencies in use attitudes of trainers towards training methods, availability of trainers, etc.
- **Nature of subject matter:** Whether the subject matter is simple or complex.
- **Time and material availability:** Time needed for preparation of methods and aids; length of training course and its sessions; facilities available to use different methods and aids; etc.

Table 1: Comparison of different categories of training methods on suitability for different characteristics

Characteristics	Individual Methods	Group Methods	Mass Methods
Activating learning process	Medium	High	Low
Creating awareness about others	Low	Medium	High
Creating awareness about self	High	Medium	Low
Change in knowledge	Low	Medium	High
Change in attitude	High	Medium	Low
Change in skill	High	High	Low
Interaction with fellows	Low	High	Low
Interaction with trainer	High	High	Low
Providing feedback	High	High	Low
Per unit cost	High	Medium	Low
Suitability to local situation	High	Medium	Low

A mix of training methods is likely to be more successful than a single training method. It is, therefore, recommended to use a number of methods in right combination and in proper sequence for a better impact of training. A combination of methods should be used, which make use of variety of senses like hearing, seeing, doing, etc. The methods should be compatible to each other, should involve trainees in variety of ways; and should be able to provide different kinds of feedback.

Conducting Training

Conducting a training programme, consisting of two phases, namely, a) Preparation, and b) Implementation, requires considerable effort and coordination. Even a well-designed training programme can be fruitless if not conducted properly and professionally.

Preparation phase includes selection of trainers; preparation of time table, duty chart of supporting staff, and a checklist of required training facilities; pre-training contact with trainees; checking boarding and lodging facilities for trainees; sanction of finance and budgeting; arrangement for leisure time management of trainees; arrangements of classrooms; contingency plan for the likely mishaps. The implementation phase includes reception of trainees, adherence to timetable, and promoting professional training environment (Misra, 1990). These aspects seem trivial but play important roles in making the programme effective.

Selection of Trainers

Utmost care is required in the selection of trainers. Farmers in our country are, generally, illiterate or neo-literate who cannot understand highly technical matter. Message for them needs to be developed in their own language considering the actual field problems. Therefore, instead of stalwarts in their subject area, the trainers should be those who understand farmer's socio-economic environment, know the actual field constraints and speak their language.

Preparation of Timetable, Duty Chart and Checklists: The contents should be divided into small topics each of which is to be covered in a small session of not more than forty-five minutes. A schedule of training programme should invariably be developed giving 10 minutes break between two sessions. Services of supporting staff are required for efficient management of the training programme. The staff should include personal like audio-visual technicians, typists, drivers and caretakers. A duty chart for them indicating the dates and time should be prepared and communicated to the concerned persons in advance.

The facilities like classrooms, audio-visual aids, communication and information technology, lighting arrangements, transport arrangements, etc. are required for conducting any training programme. A checklist of all these facilities should be prepared well in advance and their availability should be ensured in time.

Pre-Training Contact with Trainees: The potential trainees should be informed at least 15 days in advance about the training including its major objectives and how to reach the training venue so that they will be mentally prepared to attend it with well-defined expectations.

Sanction of Finance and Budgeting: Money is the main aspect for successfully carrying out the training activity. The course Director should approach the sponsoring agencies to get timely sanction of the budget for the preparation and implementation of the training programme. Budgeting of expenditure is essential to keep it within the limits and to avoid unnecessary cost over-run.

Arrangement for Leisure Time Management of Trainees: best utilization of time of trainees, including the leisure time, is the responsibility of Course Director in any residential training programme. Some arrangements for the entertainment of participants must be made at their place of stay so that they should not get bored and spend their free time joyfully. It will be more fruitful to utilize their leisure time in the events, which are both entertaining and educative.

Arrangements of Classrooms: Seating arrangement in classroom should be such that it is not too crowded and should give the participants a homely feeling. There should be proper light and aeration. Unwanted noise should not be there at the training place.

Contingency Plan for the Likely Mishaps: Mishaps during training programmes do occur causing embarrassment and resulting in poor performance. Some of the common mishaps are breakdown of power supply, internet connection, problem in any machine to be used, unforeseen difficulty in field trips, non-arrival of resource persons, etc. There must be alternative arrangements to deal with such problems.

Reception of Trainees: There may be two types of arrangements for trainee farmers to reach the training place. They will arrive either through the conveyance arranged by organisers or through their own means. Whatever may be the case, they must be informed about it at the time of pre-training contact. In the latter case, they must be told about exact location of training place along with route chart to reach the venue. One person must be deputed to receive the trainees at the expected arrival time and venue. An introductory session must be organized before start of technical training sessions. Trainees should be introduced to trainers, each other and the whole training programme in brief in this session. They should be handed over the training materials including timetable and asked for their expectations from the programme.

Promoting Professional Training Environment: It is very essential to make the training environment conducive for better learning. The appropriate training environment requires not only the physical facilities mentioned earlier but also the atmosphere to exchange the ideas and experiences freely as well as the harmonious relationships between trainers and trainees.

Evaluation of Training

Evaluation of training is a systematic collection of information about different training activities for assessing the effectiveness and impact of that on the trainees. It helps in taking decisions on various facets like, re-defining the training objectives, getting rid of unnecessary contents of training, making training methods meet the requirements of trainees, and reducing training costs. Evaluation of training are of two types- a) Formative and b) Summative. Formative evaluation deals with implementation of training and helps in day-to-day decision -making. Feedback is obtained from trainees and others involved in training and key elements of training are monitored in a systematic manner to identify potential problems before they become serious. Summative evaluation is concerned with final assessment of impact of the training. It tells about the degree to which the intended objectives and goals have been met. Besides, it gives feedback on behaviour, ability and proficiency of training staff; quality of training; appropriateness of training methods, contents and training materials; facilities provided during training; etc. to evolve future training strategies. Purposively developed questionnaires, rating scales, checklists and knowledge tests are used in evaluation of training.

Follow-up

Many training courses end up without result because of lack of adequate follow-up and support to the trainees in their field. The trainees require repeated persuasion, guidance and advice to help them adopt the acquired knowledge, skill and attitude. Follow-up support may be ensured through association/club/discussion group of trainees and newsletters/magazines in simple local language.

Many of the Krishi Vigyan Kendras extends follow-up support to the trainees through farm science clubs or ex-trainees sammelan in their villages. They discuss the problems in farming and disseminate the knowledge through club's activities. Trainers' co-ordinate with bank and other government agencies to help the trainees receive critical inputs. In Punjab Agricultural University, trained farmers are encouraged to organise discussion groups in their villages and solve the problems of fellow farmers with needed technical support from university scientists (Kumar and Keshava, 1994).

Frequently Ignored Dimensions

Besides the process, several other aspects are generally ignored in farmer's training, which appear minor but have serious impact on its success. Such dimensions, discussed below, need utmost care for better effectiveness and impact of farmer's training (Tyagi and Keshava, 1999).

Appropriate Technology

Farmers adopt those technologies, which are culturally acceptable, superior to the existing ones, suit their resource base and fulfil their personal as well as social needs. Majority of the

farmers in our country are small or marginal. They need low technological inputs. Besides, many of the new technologies are not environment friendly which deteriorate the environment and natural resources. Trainers must pay attention to the suitability of agricultural technologies in diverse socio-economic, cultural and agro-ecological situations for sustainable and balanced agricultural development.

Traditional Wisdom and Experiences

In case of farmer's training programmes, where the farmers have long affiliation with farming and possess valuable experiences about natural resources, and techniques of farming suitable to agro-ecological conditions of the area. Adults get involved better and learn more if the learning inputs provided are related to their day-to-day experiences. Thus, the training has to be such that the trainers learn traditional wisdoms from the farmers. This wisdom will serve as a foundation for formulation of learning experiences.

Mutual Participation of Trainers and Trainees

Lack of people's participation is identified as one of the reasons for failure of different development programmes. People's participation gives an ownership feeling to the beneficiaries and leads to success. Here people's participation means active involvement of people right from beginning of the programme. The beneficiaries must be involved in decision-making roles at its various stages and they must have some control over its resources and benefits.

In the case of farmer's training, involvement of farmers in selection of contents and methods as well as decision about time, venue and duration of training will be fruitful. Participation of farmers in training sessions can be ensured by encouraging their active involvement in sharing knowledge, experiences and trying out new ideas.

Thus, a systematic approach is needed to organize fruitful and effective training programme. Detailed assessment training needs including time, venue and duration of training programme; selection of needy and interested farmers as trainers; formulation of specific, measurable, achievable and time bound objectives; tailor-made course curriculum; and use of appropriate training methods and teaching aids are the key aspects for success of any training programme. Selection of suitable trainers; preparation of timetable, duty chart of supporting staff, and a checklist of required facilities; pre-training contact with trainees; classroom arrangements; adherence to timetable; contingency plan for likely mishaps; and conductive training environment also play equally important roles for desirable impacts. Besides, active involvement of trainees must be ensured giving due importance to their indigenous technical knowledge and experiences.

References

1. Kumar, B. and Keshava. 1994. Vocational training for small farmers. Agricultural Extension Review, 6(2) 11-13
2. Misra, D.C. 1990. Implementing extension training programme. New Directions in Extension Training. Pp 135-142. Directorate of extension, West Block 8, R.K. Puram, New Delhi-110066
3. Misra, M 1995. Formulation of training objectives Reading Materials for course on Training Management (January 11-18, 1995). Division of Agricultural Extension, IARI, New Delhi. Pp 107-114
4. Tyagi, Lalit Kumar and Keshava 1999. Farmers training for sustainable rural development. IASSI Quarterly 18(1): 65-71

Importance of Evaluating Extension Programmes at Field Level

Sarjeet Kaur¹, Y.S. Jadoun², Akshith Sai Pabba³, Pinky Preeti⁴

^{1,2}*Sanjay Gandhi Institute of Dairy Technology, Bihar Animal Sciences University, Patna*

³*National Dairy Research Institute, Karnal, Haryana.*

⁴*TVO, Mora Veterinary Hospital, Bhagwanpur, Siwan, Bihar-841507*

Corresponding author: sarjeetkaur0511@gmail.com

Abstract

Each year, people spend trillions of dollars on programs designed to improve knowledge, skills, performance, and attitudes. We invest in these formal and informal programs in the hope that we and our communities will change for the better. Extension programme is a statement of situation, objectives, problems, and solutions which is arrived at co-operatively by the local people and the extension personnels and accomplished by extension teaching activities. Such programmes are mostly funded with public money and are planned and implemented by an organization which generally comprises of various departments under the government. With so much time, money, and other resources directed to educational and social programs, how can we be sure that our programs are efficient and effective? How can we improve them and hold them accountable for the results? So, to justify the appropriate use of valuable funds and to get continuing support from the people, it is important that every aspect of the programme including management, input, process, and failures is evaluated time to time. To evaluate management, achievements and failures of these programmes has been a challenge to extension workers right from the time when planned extension programmes were introduced. However, it was when Tyler's (1950) philosophy of educational evaluation became a part of the extension education and the pattern of extension educational evaluation took a more usable, understandable form' (Sabrosky, 1966).

Extension Programme

The word 'programme' has several distinct meanings in the dictionary. It means a proclamation, a prospectus, a list of events, a plan of procedure, a course of action prepared or announced beforehand, a logical sequence of operations to be performed in solving a problem. When used by an organization, it means a prospectus or a statement issued to promote understanding and interest in an enterprise.

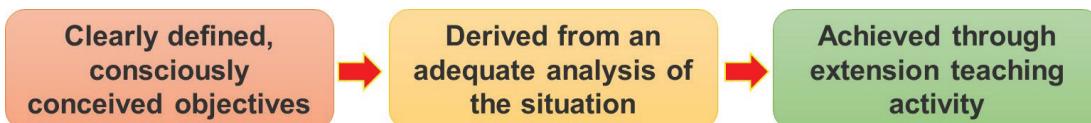
According to Kelsey and Hearne (1949), an "extension programme" is a statement of situation, objectives, problems, and solutions. According to the USDA (1956), an "extension programme" is arrived at co-operatively by the local people and the extension staff and includes a statement of:

- The situation in which the people are located;
- The problems that are a part of the local situation;

- The objectives and goals of the local people in relation to these problems; and
- The recommendations or solutions to reach these objectives on a long-time basis (may be several years) or on a short-time basis (may be one year or less).

Leagans (1961) says that an “extension programme” is a set of clearly defined, consciously conceived objectives or ends, derived from an adequate analysis of the situation, which are to be achieved through extension teaching activity’.

Lawrence (1962) says that an “extension programme” is the sum total of all the activities and undertakings of a county extension services. It includes: (i) programme planning process; (ii) written programme statement; (iii) plan of work; (iv) programme execution; (v) results; and (vi) evaluation.



Extension Programme Planning

Planning is a process which involves studying the past and present in order to forecast the future and in the light of that forecast determining the goals to be achieved and what must be done to reach them. Programme planning is a decision-making process involving critical analysis of the existing situation and the problems, evaluation of the various alternatives to solve these problems and the selection of the relevant ones, giving necessary priorities based upon local needs and resources by the cooperative efforts of the people both official and non-official with a view to facilitate the individual and community growth and development.

Extension Programme Planning is the process of determining, developing, and executing programmes. It is a continuous process, whereby farm people, with the guidance and leadership of extension personnel, attempt to determine, analyse, and solve local problems. In this, there are three characteristics:

- What needs to be done;
- When it should be done; and
- How it should be done

(Musgraw, 1962).

This is the process whereby the people in the country, through their leaders, plan their extension programme. Country and state professional extension staff members assist in this process. The end-result of this process is a written programme statement (Lawrence, 1962). An organised and purposeful process, initiated and guided by the agent, to involve a particular group of people in the process of studying their interests, needs and problems, deciding upon and planning education and other actions to change their situation in desired ways and making commitments regarding the role and responsibilities of the participants (Olson, 1962). An analysis of these and other definitions of extension programme planning implies that it

- Is a decision-making, social process;
- Involves advance thinking;

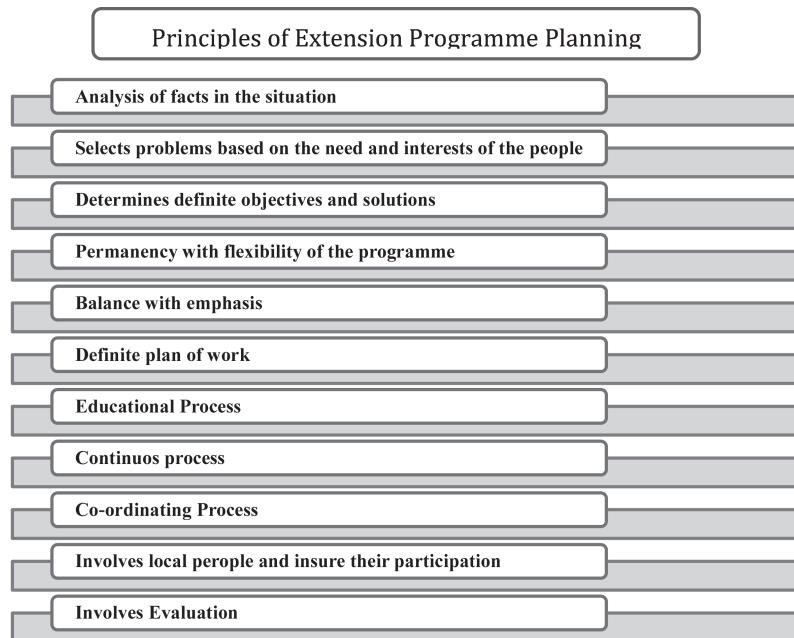
- Is a progressive step-by-step process;
- Involves people in defining the goals to be achieved
- Uses educational means in defining the goals and situations;
- Is built around improved technology, people, their needs interests, resources, values, attitudes and skills; and -The end-product is a written statement of situation, problems, objectives and solutions

Thus, extension programme planning may be defined as: A decision-making, social-action process in which extension educationists involve people's representatives, to determine their needs, problems, resources, and priorities, in order to decide on an extension programme consisting of situation analysis, problems, objectives, and solutions which will form the basis of extension teaching plans for a given period.

Features of Extension Programme Planning

1. **Extension programme planning is a process:** It shows continuous change in time or continuous operation or treatment. It is dynamic, ongoing, everchanging continuous process which has no beginning, an end or fixed sequence of events. It involves a series of actions which culminate in the accomplishment of goals. In extension programme planning, the immediate goal would be the development of a programme document.
2. **Extension programme planning is a decision-making process:** Planning is basically a decision-making process and so is extension programme planning. In extension programme planning, scientific facts are put to value judgements of the people through the implementation of a rational planning model in order to decide a programme which will be carried out through the extension teaching activities
3. **Extension programme planning requires advance thinking:** If we are clear about our long term and short-term objectives and can visualise the process before it has happened, we can better decide the best method of executing the process and this forms the basis of planning. Effective rural development results from our choices not by chance. It must be designed in the desired way. Good extension programme planning is an intellectual activity since it usually involves a study and use of facts and principles. It requires knowledge, imagination, and reasoning ability. It is a complex exercise as it involves people, their needs, their interests, useful technology, educational process, analysing a situation, and making decisions about what should be done, determining useful actions, projecting the desired shape of things in future and several other components, which are rarely simple.
4. **Extension programme planning requires skill and ability on the part of planners:** planning and executing extension programmes require high-level professional skills like understanding the role of extension education organization, knowledge and understanding of the technology being imparted, ability to frame smart objectives and making it understand to the executing agency without distortion, data collection skills and rapport building ability.
5. **Extension programme planning is built around content:** A programme regarding any extension activity can only be built based on content. Extension programme planning is

- built around available improved technology, the people, their resources, problems, needs and interests.
6. **Programme planning is a social action process:** Extension programme planning involves interaction and the decisions which would affect others. Interaction involves communication between two or more people in the planning process. The programme content which is designed for extension teaching is included in the social planning for it is decided by the involvement of extension personnel and the representatives of beneficiary people so the appropriate methods can be used to reach the goals. The results of the programme will further have consequences which would affect different sections of the society in various ways like actions, awareness, education, persuasion and adoption and practice of technologies introduced to them.
 7. **Extension programme planning is a collaborative effort:** Extension programme planning is a collaborative effort involving identification, assessment, evaluation of needs, problems, resources, priorities and solutions.
 8. **Extension programme planning is a system:** Extension programme planning is a system as its procedures and processes are interrelated, ordered and linked progressively to form a collective whole. It includes several subprocesses, such as planning, designing, implementing, evaluation etc.
 9. **The end-product of extension programme planning is an extension programme:** According to Vandeberg (1965), the primary purpose of any planning, first and foremost, is that of developing a sound, defensible and progressive course of action or plan. In the process followed many other benefits might occur, such as the education of participants, but the result should be in the form of the plan which can be used to educate people or serve the identified needs of the farm families.



Steps in Extension Programme Planning

1. **Collection of facts:** Data relevant to the objectives of the programme should be collected, either from secondary sources or by surveying the area. Significant information regarding the people should be collected like facilities available, factors guiding production, cropping patterns etc. Good planning shall depend on the availability of adequate and reliable data and scientific elaboration and interpretation of the same.
2. **Analysis of situation and Identification of problems:** Situation analysis involves collection, analysis and interpretation of the existing facts. Extension agents should have adequate knowledge about the situation of the farmers and how it can be improved. It is of great importance that all the extension workers possess the factual and basic farm and family information for creating sound family, village and block. Local facts are needed to define correct and projected need, interests and problems of the area are assembled. These facts are analysed and interpreted and the needs and problems which are within the scope of extension educational responsibility are identified.
3. **Determination of objectives and goals:** The objectives should be determined based on the situation analysis. According to Thompson (1943), three levels of education al objectives may be recognised.
 - **Fundamental:** These are all-inclusive objectives of a society. For example: democracy, better citizenship etc.
 - **General:** These are general but more definite social objectives. For example: helping rural people to have better home for living, helping farmers to raise their farm production.
 - **Working objectives:** These are specific objectives. They may be stated in two ways. One is from the point of view of the extension worker and the other is from the point of view of the people.

In deciding upon objectives, it is necessary to decide on the overall objectives first and then to fix the smaller ones. Each small or working objectives, when attained, contributes to the larger objective of change in behaviour.
4. **Developing plan of work and calendar of operations:** Plan or Plan of work is an outline of activities so arranged as to enable efficient execution of the entire programme. It answers the questions of what, why, how, when, where and by whom the work is to be done. Calendar of work is a plan of work arranged chronologically, according to the time when step of work is to be done. It is a time schedule of work. The plan of work should be in written form. The plan should have all the essential details and no important point should be left out.
5. **Follow through plan of work and calendar of operations:** Training of participants, communication of information, conducting method demonstrations, making regular visits and monitoring are some of the important mechanisms to follow through he plan of work.

6. **Evaluation of progress:** All programmes must have an in-built system of evaluation to know how well the work is done. It should be a continuous process not only to measure the end result but also to ensure that all the steps are correctly.
7. **Reconsideration and revision of the programme:** Based on the results of evaluation, the programme should be reconsidered, and revised if needed. This reconsideration should be done not only with the participants; but also with the scientists, administrators in extension organization and local bodies like panchayats, etc. Reconsideration shall help in making necessary corrections and modifications in the programme. In reconsideration, emphasis should be on the removal of technical defects if any, and how to obtain more cooperation and involvement of the participants and various organizations.

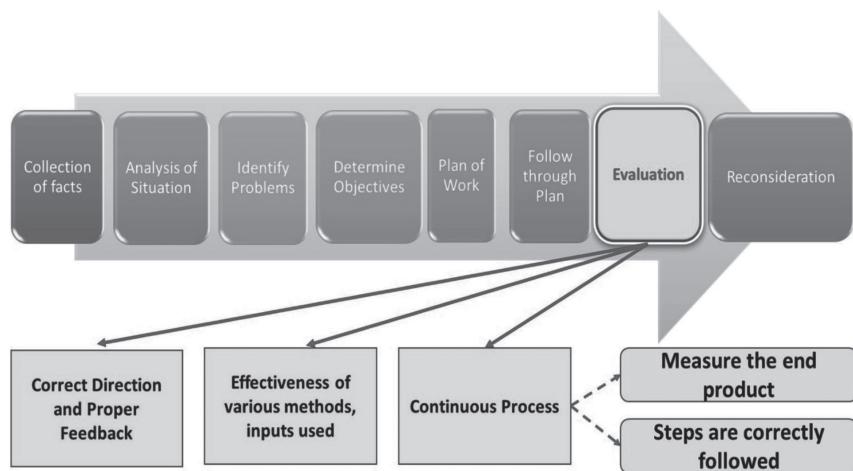


Fig 1: Flow Diagram showing Steps in Extension Programme Planning

(Kaur et al., 2023)

Evaluation

- The word ‘evaluation’ has its origin in the Latin word “valere” meaning to be strong or valiant. Its dictionary meanings are the determination of the value, the strength or worth of something, an appraisal, an estimate of the force of or making a judgement of something.
- Evaluation is a co-ordinated process carried on by the total system and its individual subsystem. It consists of making judgements about a planned programme based on established criteria and known, observable evidence (Boone, 1985).
- Programme evaluation is the determination of the extent to which the desired objectives have been attained or the amount of movement that has been made in the desired direction (Boyle and Johns, 1970).
- Evaluation is the process of delineating, obtaining, and providing useful information for judging decision alternative (Stufflebeam, 1971).

- Evaluation is a process by which the values of an enterprise are ascertained or analysed by which one can understand and appreciate the relative merits or deficiencies of persons, groups, programmes, situations, method, and processes (Kelsey and Hearne, 1949).
- The process of evaluation is essentially...determining to what extent the objectives are actually realised (Tyler, 1950).
- Evaluation as applied to the field of extension education, may be defined as "a process of systematic appraisal by which we determine the value, worth or meaning of an activity or an enterprise". It is a method for determining how far an activity has progressed and how much further it should be carried to accomplish objectives. Thus, to an extension worker evaluation means determining the results of his extension programmes in order to know the extent to which objectives have been achieved and why and what changes would be needed in case the programme is planned again, or in its implementation.

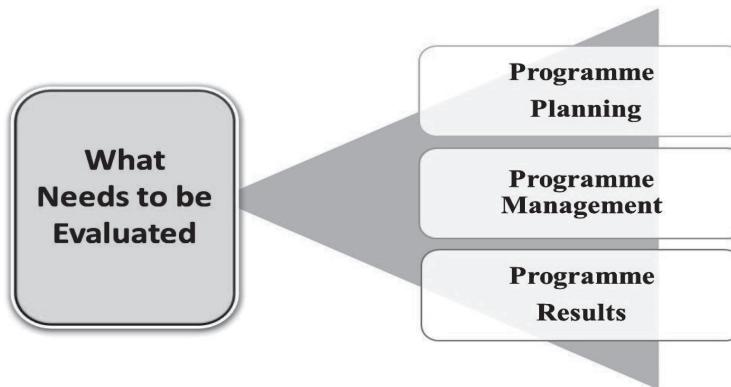


Fig 2: Areas of Evaluation

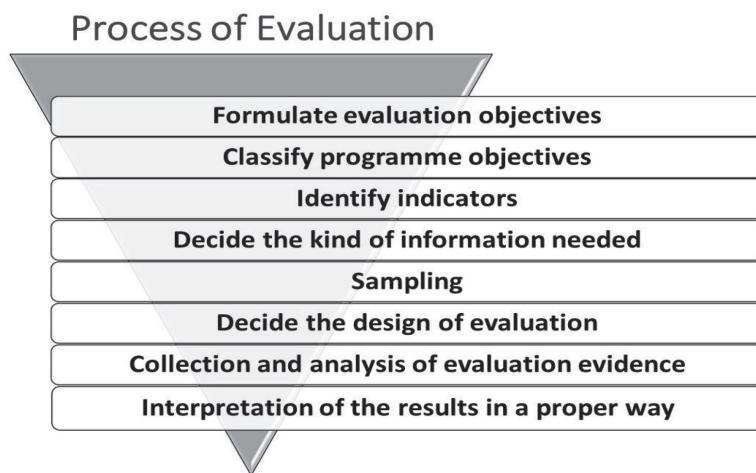


Fig 3: Process of Evaluation

Typologies of Evaluation

Evaluation can be classified into two major types: formative and summative, based on object under evaluation and its purpose. Formative evaluations are conducted during programme development and implementation. These are useful when directions are sought on how to achieve goals or improvement in programme. Formative evaluations thus strengthen and improve the object being evaluated. They help form it by examining the delivery of the programme, project, and technology. Summative evaluations examine the effects or outcomes of some object. They summarize it by explaining the consequences of the programme or technology delivery. They are meant to assess the causal effect of an object to lead to the outcome. Summative evaluation further aids in determining the overall impact of the causal factor beyond only the immediate target outcomes; and estimating the relative costs associated with the object.

Formative evaluation includes the following:

- Need assessment to determine who needs the programme, how important the need is, and what would be the means to satisfy need. Evaluability assessment to determine feasibility of an evaluation and how stakeholders can help shape its usefulness.
- Structured conceptualization to help stakeholders define a programme, target population, and the possible outcomes.
- Implementation evaluation to monitor the fidelity of the programme, project, and technology delivery.
- Process evaluation to measure effort and the direct outputs of programmes, i.e., what, and how much could be accomplished in terms of exposure, reach, knowledge, attitude, etc.; to investigate the process of delivering the programme or technology, including alternative delivery mechanisms.
- Summative evaluation includes the following:
 - Outcome evaluation - to investigate into the demonstrable effects of the programme or technology on specifically defined target outcomes.
 - Impact evaluation-to assess the overall intended or unintended net effects of the project, programme or technology as a whole.
 - Cost-effectiveness and cost-benefit analysis to address questions of efficiency by standardizing outcomes in terms of costs and values.
 - Secondary analysis - to re-examine the existing data for addressing new questions or use new methods previously not employed.

Meta-analysis-to integrate the outcome estimates from multiple studies to arrive at an overall or summary judgment on an evaluation question

Programme Stage	Before Programme begins	New Programme	Established Programme	Mature Programme
		FORMATIVE	SUMMATIVE	
Evaluation type	Need Assessment	Process/Implementation Evaluation	Outcome Evaluation	Impact evaluation
Questions asked	To what extent is the need being met? What can be done to address the need	Is the programme operating as planned	Is the programme achieving the objectives	What predicted and unpredicted impact has the programme had.

Fig 4: Typologies of Evaluation and programme stages

Summative and Formative Evaluation of Training Programmes for Farmers

Formative Evaluation	Summative Evaluation
<ul style="list-style-type: none"> Reviewing the training materials with one or a group of trainees Using the material in a situation similar to that of an actual training program Holding group discussions with the trainees to gain feedback Assessing the material with managers and supervisors who oversee trainees 	<ul style="list-style-type: none"> Testing trainees on how well they grasped the information provided Asking trainees for their opinion about the training program after it has been delivered Measuring changes in production and quality of work that has been accomplished post-training Conducting surveys or interviews with each trainee.

Important Models of Evaluation

1. CIPP evaluation model of Stufflebeam

The CIPP evaluation model is a comprehensive framework for guiding evaluation of programmes, projects, personnel, products, institutions, and evaluation systems. The model was originally developed in the 1960s for improving the United States (US) school programmes. The model's core concepts are context, input, process and product evaluation (CIPP). Context assesses

needs, problems and opportunities within a defined environment. Input evaluation assesses competing strategies, work plans and budgets of approaches chosen for implementation. Process evaluation monitors, documents and assesses activities, and also helps in carrying out improvement efforts to maintain accountability records of their execution of action plans. Product evaluation identifies and assesses short-term, long-term, intended, and unintended outcomes. The CIPP model is oriented to administration, development, effective service, accountability, dissemination, and research. Figure 5 summarizes the CIPP model's basic elements in three concentric circles and portrays the central importance of defined values. The inner circle denotes core values to be identified and used in evaluation. The circle around the core values is divided into four compartments denoting four evaluation foci associated with a programme. The outer circle identifies the type of evaluation that serves each of the four evaluative foci. The two directional arrows indicate to the reciprocal relationships between an evaluative focus and the type of evaluation.

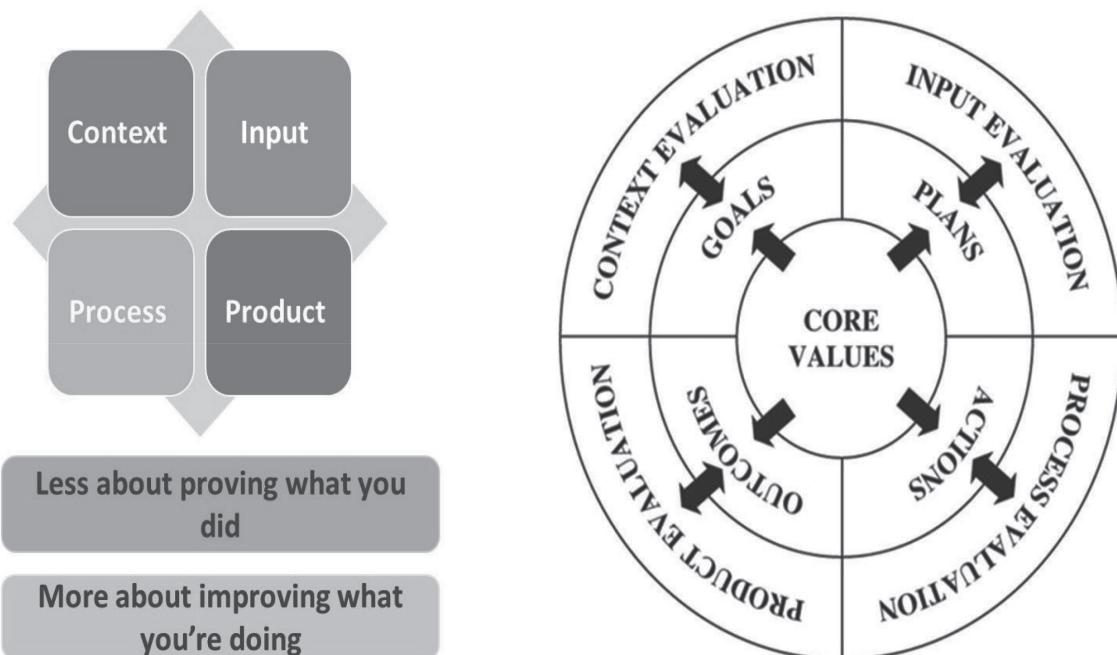


Fig 5: CIPP Model of Evaluation

2. Kirkpatrick /Phillips model for Evaluation

This popular model is used in analysing and evaluating the results of training and educational programmes. The model can be implemented before, throughout, and following training to show the value of training programmes. The four levels proposed in the model are as follows:

- 1) **Level 1:** Reaction-At this level, trainees' reaction to the training programme is measured. It is important to measure reaction of trainees because it helps in understanding how well the training was received by the participants.

- 2) **Level 2:** Learning-At this level, the extent of increase in trainees' knowledge as a result of the training is measured.
- 3) **Level 3:** Behaviour-At this level, change in trainees' behaviour as a result of the training programme is measured. Specifically, it looks at how trainees apply the acquired knowledge.
- 4) **Level 4:** Results- At this level, final results of the training programme are analysed. It includes outcomes that the organization determines to be good for its objectives, and employees.

Kirkpatrick Evaluation Model

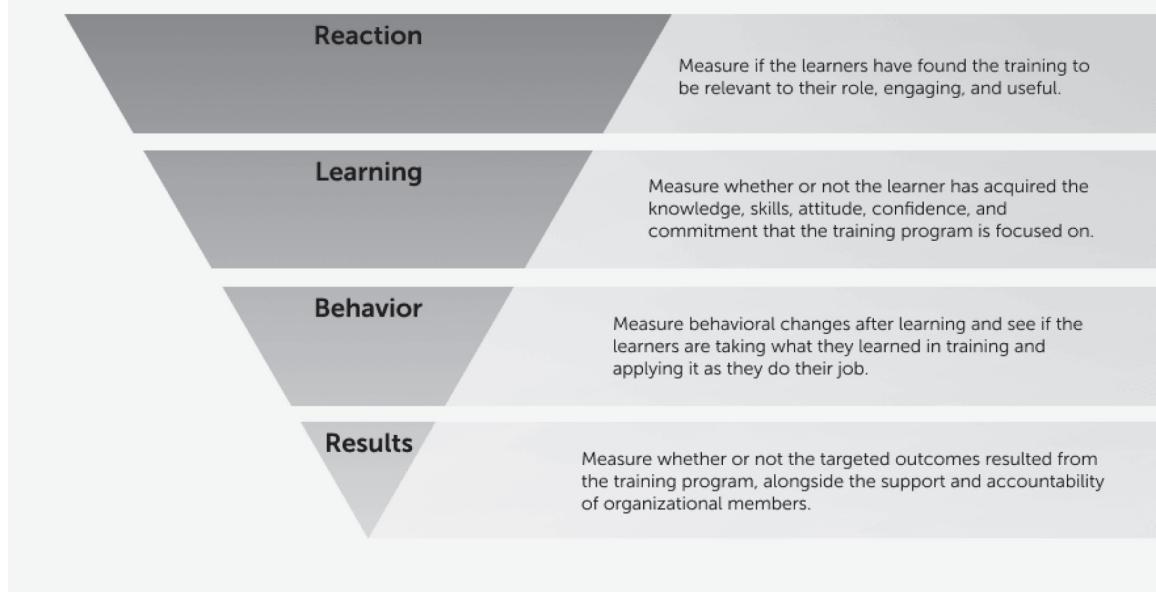


Fig 6: Krickpatrick's Evaluation Model

3. The Phillip's ROI Model

Jack Phillip's decision to add a fifth level to the Kirkpatrick Model is by far the most commonly quoted aspects of the Phillips ROI Model. The Phillips model has five levels that broadly follow the scope and sequence of the Kirkpatrick model. The five levels of the Phillips ROI Methodology are as follows:

- **Level 1: Reaction-** In common with the Kirkpatrick taxonomy, the Phillips ROI Models begins by evaluating the participants' reaction to the training they received. The most common approach is to use short questionaries or surveys to collect data about what people thought about their training.
- **Level 2: Learning-** The second level of the Philips ROI Model evaluates whether learning took place. This is the same as the Kirkpatrick Model and usually entails

giving the participants multiple-choice tests or quizzes before and/or after the training.

- **Level 3: Application and Implementation:** Level 3 of the Kirkpatrick Model looks at workplace behavior and assesses whether participants are using what they learned on-the-job. One of the main criticisms of the Kirkpatrick Model has always been that it doesn't gather enough data to help improve training; it simply tells you whether the training was put into practice or not. Jack Phillips felt that this level could be improved, so he expanded it to cover both application and implementation.
- **Level 4: Impact-**The Phillips ROI Model makes it far easier to see why training does or doesn't translate into workplace changes. If there is a problem, the Phillips ROI Model helps you determine whether the issue lay with the application of the learning or with its implementation? While the fourth level of the Kirkpatrick taxonomy focuses purely on results, the Phillips ROI model is much broader and looks at the impact of the training on the organization. This helps identify whether factors other than training were responsible for delivering the outcomes.
- **Level 5: Return on investment (ROI)-**Unlike the Kirkpatrick taxonomy that simply measures training results against stakeholder expectations (ROE), the Phillips ROI model contains a fifth level. This is designed to measure ROI – Return on Investment. This level uses cost-benefit analysis to determine the value of training programs. It helps companies measure whether the money they invested in the training has produced measurable returns, and if so, what they are. Return on investment (ROI): ROI is the ultimate level of evaluation. It compares the monetary benefits from the programme with the programme costs. Although the ROI can be expressed in several ways, it is usually presented as a percentage or cost/benefit ratio. The formula for ROI is:

$$ROI = \frac{(Total\ Programme\ Benefit - Total\ Programme\ Costs)}{Total\ Programme\ Costs} \times 100\%$$

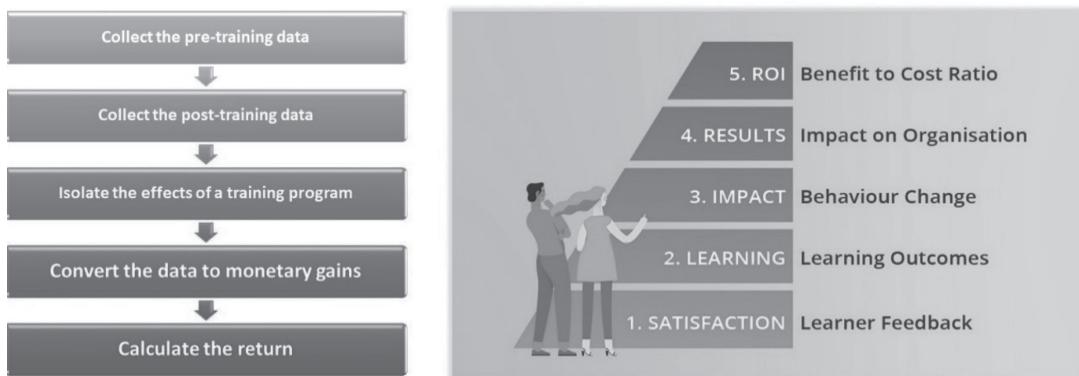


Fig 7: Phillip's ROI Model

4. Anderson's Model of Learning Evaluation

The Anderson model of learning evaluation is a unique three-stage learning evaluation cycle that is designed to be applied at an organizational level. While other training evaluation models focus on specific learning interventions, Anderson's model is more concerned with aligning the training goals with the organization's strategic goals. The Anderson model was first published by the Chartered Institute of Personnel and Development in 2006 as the 'Anderson's Value of Learning Model'. Thus, it aligns the learning function with the organization's strategic priorities. The two main challenges all organization faces are – the evaluation challenge and the value challenge. The organization says they struggle to the evaluations well. Also, the main struggle is to find the evidence that their training works. The Anderson's Model for Learning Evaluation has three stage cycles to address the value challenge and evaluation.

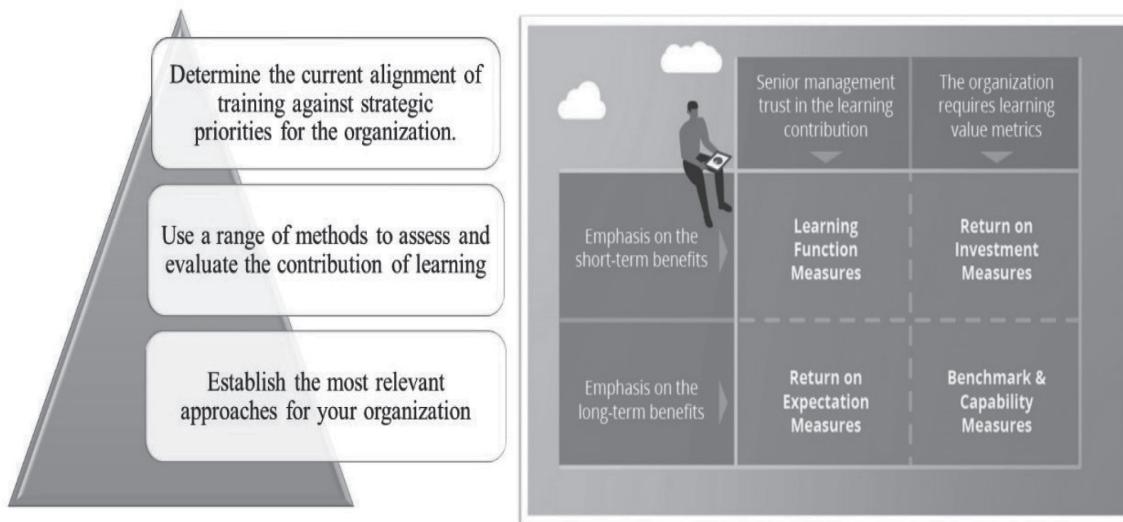


Fig 8: Three Stage Cycle of Anderson's Model of Evaluation

Evaluation of Standards

By the late 1960s, program developers, sponsors, and evaluators recognized the need for rigorous standards to guide program evaluation. In 1974, representatives from three national professional organizations came together to form the Joint Committee on Standards for Educational Evaluation (JCSEE). By 1981, the JCSEE was a corporation supported by 12 North American professional organizations and had published its first set of evaluation standards, the Standards for Evaluations of Educational Programs, Projects and Materials.

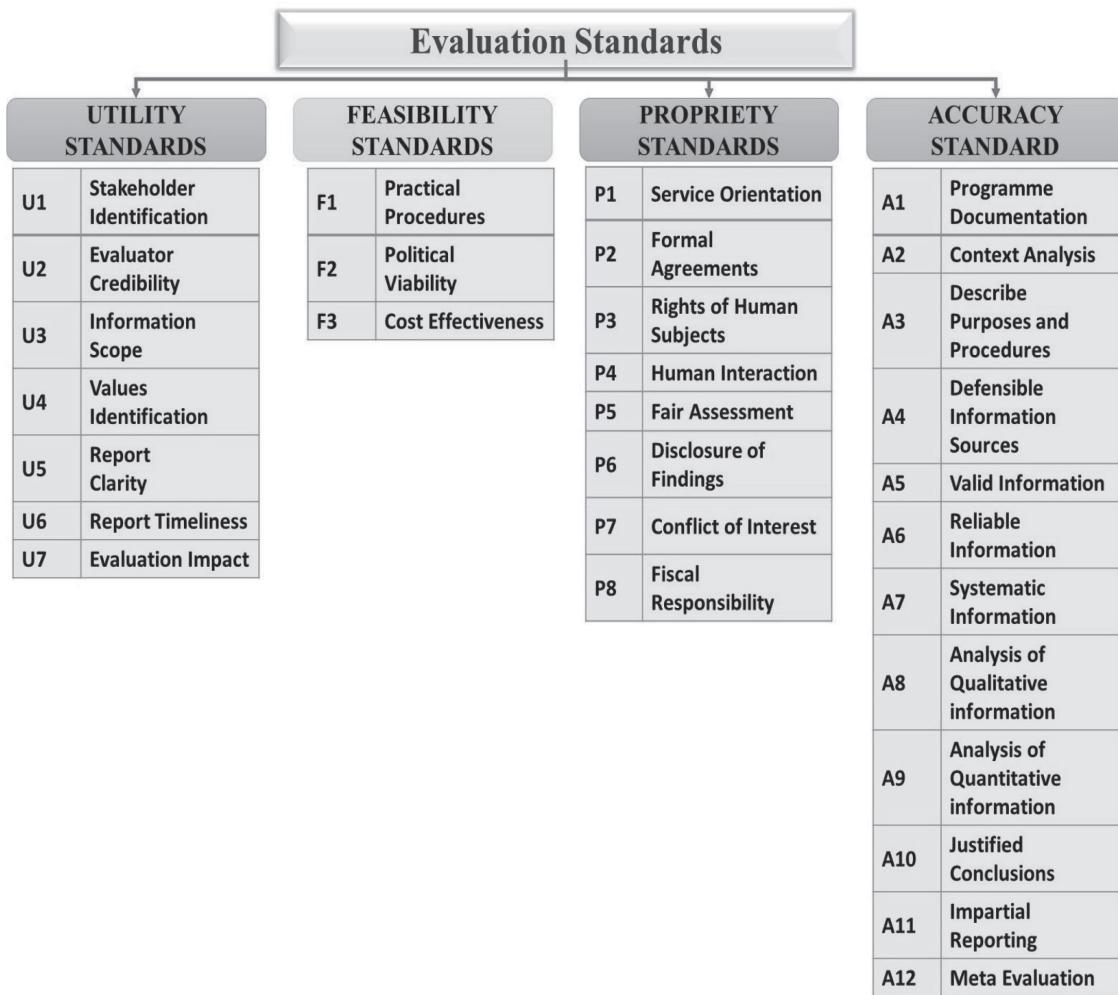


Fig 9: Diagrammatic Representation of Evaluation Standards (Kaur et al., 2023)

1. Utility standards

The utility standards are intended to ensure that an evaluation will serve the information needs of intended users.

- **U1 Stakeholder identification-** Persons involved in or affected by the evaluation should be identified, so that their needs can be addressed.
- **U2 Evaluator credibility-** The persons conducting the evaluation should be both trustworthy and competent to perform the evaluation, so that the evaluation findings achieve maximum credibility and acceptance.
- **U3 Information scope and selection-** Information collected should be broadly selected to address pertinent questions about the programme and be responsive to

the needs and interests of clients and other specified stakeholders.

- **U4 Values identification-** The perspectives, procedures, and rationale used to interpret the findings should be carefully described, so that the bases for value judgments are clear.
- **U5 Report Clarity-**Evaluation reports should clearly describe the programme being evaluated, including its context, and the purposes, procedures, and findings of the evaluation, so that essential information is provided and easily understood.
- **U6 Report timeliness and dissemination-** Significant interim findings and evaluation reports should be disseminated to intended users, so that they can be used in a timely fashion.
- **U7 Evaluation Impact-**Evaluations should be planned, conducted, and reported in ways that encourage follow-through by stakeholders, so that the likelihood that the evaluation will be used, is increased.

2 Feasibility standards

The feasibility standards are intended to ensure that an evaluation will be realistic, prudent, diplomatic, and frugal.

- **F1 Practical procedures-** The evaluation procedures should be practical to keep disruption to a minimum while needed information is obtained.
- **F2 Political viability-**The evaluation should be planned and conducted with anticipation of the different positions of various interest groups, so that their cooperation may be obtained, and so that possible attempts by any of these groups to curtail evaluation operations or to bias or misapply the results can be averted or counteracted.
- **F3 Cost effectiveness-** The evaluation should be efficient and produce information of sufficient value, so that the resources expended can be justified.

3 Propriety standards

The propriety standards are intended to ensure that an evaluation will be conducted legally, ethically, and with due regard for the welfare of those involved in the evaluation, as well as those affected by its results.

- **P1 Service Orientation-** Evaluations should be designed to assist organizations to address and effectively serve the needs of the full range of targeted participants.
- **P2 Formal agreements-** Obligations of the formal parties to an evaluation (what is to be done, how, by whom, when) should be agreed to in writing, so that these parties are obligated to adhere to all conditions of the agreement or formally to renegotiate it.
- **P3 Rights of human subjects-** Evaluations should be designed and conducted to respect and protect the rights and welfare of human subjects.
- **P4 Human Interactions-** Evaluators should respect human dignity and worth in their

interactions with other persons associated with an evaluation, so that participants are not threatened or harmed.

- **P5 Complete and fair assessment**-The evaluation should be complete and fair in its examination and recording of strengths and weaknesses of the programme being evaluated, so that strengths can be built upon and problem areas addressed.
- **P6 Disclosure of findings**- The formal parties to an evaluation should ensure that the full set of evaluation findings along with pertinent limitations are made accessible to the persons affected by the evaluation and any others with expressed legal rights to receive the results.
- **P7 Conflict of interest**-Conflict of interest should be dealt openly and honestly so that it does not compromise the evaluation processes and results.
- **P8 Fiscal responsibility**- The evaluator's allocation and expenditure of resources should reflect sound accountability procedures and otherwise be prudent and ethically responsible, so that expenditures are accounted for and appropriate

4 Accuracy standards

The accuracy standards are intended to ensure that an evaluation will reveal and convey technically adequate information about the features that determine worth or merit of the programme being evaluated.

- **A1 Programme documentation**- The programme being evaluated should be described and documented clearly and accurately, so that it is clearly identified.
- **A2 Context analysis**- The context in which the programme exists should be examined in enough detail, so that its likely influences on the programme can be identified.
- **A3 Described purposes and procedures**- The purposes and procedures of the evaluation should be monitored and described in enough detail, so that they can be identified and assessed.
- **A4 Defensible information sources**- The sources of information used in a programme evaluation should be described in enough detail, so that the adequacy of the information can be assessed.
- **A5 Valid information**-The information-gathering procedures should be chosen or developed and then implemented so that they will assure that the interpretation arrived at is valid for the intended use.
- **A6 Reliable information**- The information-gathering procedures should be chosen or developed and then implemented so that they will assure that the information obtained is sufficiently reliable for the intended use.
- **A7 Systematic information**-The information collected, processed, and reported in an evaluation should be systematically reviewed, and any errors found should be corrected.

- **A8 Analysis of quantitative information-** Quantitative information in an evaluation should be appropriately and systematically analysed so that evaluation questions are effectively answered.
- **A9 Analysis of qualitative information-** Qualitative information in an evaluation should be appropriately and systematically analysed so that evaluation questions are effectively answered.
- **A10 Justified conclusions-** The conclusions reached in an evaluation should be explicitly justified, so that stakeholders can assess them.
- **A11 Impartial Reporting-** Reporting procedures should guard against distortion caused by personal feelings and biases of any party to the evaluation, so that evaluation reports fairly reflect the evaluation findings.
- **A12 Meta evaluation-** The evaluation itself should be formatively and summatively evaluated against these and other pertinent standards, so that its conduct is appropriately guided and, on completion, stakeholders can closely examine its strengths and weaknesses.

Conclusion

Improvement can be made only when we locate weak points and make efforts to strengthen extension programmes. Evaluation helps to locate strong and weak points in any programme or plan. When the evaluation shows a negative result, we can change or work in line with what has been found and proceed with confidence with the results of evaluation studies and so the rural people can more intelligently participate in future planning of their own programmes. In programme building, much skill is required to enable people to bring all the facts together and to arrive at sound conclusions without domination by professional workers. It improves skill in working with people thus brings confidence and satisfaction to extension workers. Volunteer leaders, even more than paid workers benefit by the satisfaction they get from better results obtained. Considerable savings can be made by conducting formative evaluation at training stage. Moreover, it keeps the extension agency on right track and helps in differentiating means from ends. Evaluation is an integral part of education process. It is focused on the improvement of this process. Evaluation also provides fresh data regarding situations essential for improving programme functions. Evaluation provides realistic information to report to the public, parliament and legislative bodies, organisation, individuals and professional groups in the community which need to be constantly informed regarding the extension programme.

References

1. Boone, Edgar J (ed.) (1985) Developing programmes in adult education eaglewood, Cliff. N. J Prentice Hall.
2. Boyle, Patrick C and Johns Kans. (1970) in a Research Approach to programme development in cooperation extension. Madison, Wisconsin: National Centre for advance studies.
3. Kelsey L.D and C.C Hearne (1949) Cooperative Extension Work. Ithaca. Comstoc Publ. Co. New Delhi.
4. Lawrence, Roger L (1962) The programme planning development. Manual. Iowa State Univ. Ames, Iowa.

5. Leagans, J. Paul (1961) Extension Programme building. In: Extension Education in Community Development, Ministry of Food and Agric., New Delhi.
6. Musgraw, B. E (1962) Organization and operating agricultural county councils, Michigan, Illonis: Coop, Extension services.
7. Olson, Kenneth S (1962) What research tells us about building an extension programme-A programme Aid. Univ of Arizona, Tucson Ariz.
8. Saborasky, R. 1996. A critique of community services. American Journal Public Health, Vol 56, no. 3 Leagans (1961) says that an “extension programme” is a
9. Shufflebeam, D.L. (1971) Educational Evaluation and Decision Making. Itasca, Ill. Ithica: NY: Cooperative extension services
10. Tyler, Ralph. W. (1950) Basic principles of curriculum and instructions. Univ of Chicago Press, Chicago III
11. USDA (1956) Findings from Research on Meetings. USDA, Washington D. C.
12. Vandeberg, Gale L (1965) Getting the most from planning councils. Extension Services revie, Vol XXX, no 3.

Impact Assessment Approaches Towards Agri Interventions

Mukesh Kumar Sinha and Anjani Kumar

ICAR- Agricultural Technology Application Research Institute, Patna

Corresponding author: mukeshwtc@gmail.com

Abstract

Assessing the impact of research and development attempts to quantify the costs and benefits from different activities. The science of impact assessment has developed rapidly in the last few years. Despite significant advances, methods of impact assessment are required to be fine-tuned to site specific nature of agricultural research. The multiple objectives of agricultural research like food security, poverty, environmental protection, sustainability, etc. further complicate the outcome of such analysis of agricultural research program and projects.

What Is Impact Assessment?

Impact assessment attempts to estimate the effects that research had in the past or that it may have in the future. There are many different kinds of effects or impacts and different ways to measure them. An impact assessment may look at whether farmers accept or reject new technology, or it may focus on increases in yields and production that can be attributed to new technology. It can also estimate changes in income, employment, nutritional status, pollution, erosion, or rural-urban migration.

Impact can be examined from two perspectives: after research is completed (ex-post) or during planning (ex-ante). Agricultural research managers often use ex-post impact assessments for positive information on results to justify requests for continued funding and support. Ex-ante impact assessments may be done as an aid to priority setting to estimate the future benefits of different research projects. Most impact assessments are sponsored by development agencies and serve their own decision-making and accountability needs. Policymakers and Agricultural research managers also realize that impact assessment is useful in setting research priorities and demonstrating results. The most common types of impact studies carried out for agricultural research are adoption studies and economic evaluations (rate-of-return studies). Relatively few social or environmental impact assessments have been done, but there are increasing demands for them.

The subject matter of impact assessment consisted of

A. Economic Impact Assessment

Adoption studies

Economic studies (returns to investment)

B. Social and Environment impact assessment

Effect on poverty, gender issue, food security, etc.

Effect on pollution, sustainability and natural resources, etc.

Doing Impact Assessment

Impact assessment involves estimating the effects of agricultural research or new technologies. Many different types of effects may be examined, but assessing any one of them in any depth can take considerable time and money. For this reason, the first task in impact assessment is to focus the study by asking, why is it being done? What information is needed? What research effort or technology should be evaluated? And what types of effects should be assessed? The focus of an impact assessment should reflect the purpose of the evaluation, who is requesting it, what their interests and information needs are, and how the results will be used.

If the principal purpose of an impact assessment is to estimate the benefits of research in a way that is comparable to other public investments (such as public health or credit programs), then an economic rate-of-return study may be appropriate. If, on the other hand, there is an interest in understanding the distribution of benefits among different farming groups or different regions within a country, a more descriptive and illustrative adoption study may be called for. If there is a concern for the effects of a new technology (such as a pesticide or new tillage system) on pollution or soil erosion, then an environmental impact assessment may be needed. In each of these cases, the impact assessment would attempt to estimate the effects of research on the selected variable, be it agronomic, economic, social or environmental.

Adoption studies generally trace the results of innovations from the research station or on-farm trials through networks of adopters. These studies analyze the underlying patterns of adoption and the use of new practices. Adoption surveys use interviews with farmers to see if they are using improved technology, to look at its effects on farm production, and to determine how research activities can be reoriented to make technologies more useful. They attempt to determine why a technology is or is not being used and compare the benefits of old versus new technologies. Again, no single approach is best, but the general steps are as follows:

- Select the technology to be evaluated.
- Identify the central issues and questions to be asked.
- Design data collection and analysis.
- Field-test instruments and make adjustments if necessary.
- Collect the information.
- Analyze the information.
- Present the results and recommendations.

The results are normally presented in terms of percentages of adopters, changes in yield, and the reasons for the technology not being adopted or its use being discontinued. Analysis

of the reasons for the technology being rejected can be used to guide or reorient research strategies.

Economic impact assessments generally estimate the **economic** benefits produced by research in relation to associated costs. The methods employed in economic evaluations are concerned with the broader effects activity on **society** and the **natural environment**. Such assessments go beyond the examination of economic returns and look at the effects on such things as cash flow, labor, or health. There has been relatively little work in this area, partly because of its complexity. However, with increasing social and political concerns for environmental issues, this is now a growing area of interest.

Assessing the effects of agricultural research is complex and costly for three reasons.

- First, it is quite difficult to measure changes in yield, production, nutritional status, and erosion, and it requires costly fieldwork and analysis. Agricultural research organizations often lack the personnel and operating funds needed for this, especially when several growing seasons are required for changes to be measured in most yield and production systems. Trends in dryland agriculture, for example, cannot be measured in fewer than eight cropping seasons.
- Second, even where a change can be measured, it is extremely difficult to attribute it to specific research activities. For example, in an area where potato yields or milk production has increased, how can the contribution of research versus that of extension, credit programs and improvements in market conditions be estimated?
- Third, research managers, policymakers, donors, and the public all tend to be impatient and to want impact estimates when research is still underway or has just recently been completed. This is neither realistic nor possible. There is often a considerable time lag between the time research is started, a new technology is released, and impacts can be measured – often as long as 10 to 15 years.

More than other types of evaluation, impact assessments tend to be carried out as research studies leading to formal publications. They generally employ scientific methods drawn from economics and the social sciences and often use indirect measures or indicators of impact because the effects of technology on farm-level production, nutritional status, pollution, and the like cannot be directly measured. To cope with this problem, production-function models are often used to estimate the effects of research or technology on production, incomes and associated variables. Numerous assumptions are also often made to overcome data limitations and to simplify economic models.

Research managers and policymakers tend to be skeptical of the data and methods used in impact assessment; they may also find the reports difficult to understand, interpret, and apply. This highlights the need to plan impact studies in terms of real information needs (rather than peer interests), to pay close attention to data quality, and to make special efforts to summarize

the findings. It is extremely important for results and recommendations to be presented in terms that are meaningful to policymakers, managers as well for scientists.

Approaches for Impact Assessment

Two major approaches have been used to calculate returns to research and to estimate its impact on society:

1. The economic surplus approach (consumer- producer surplus, cost – benefit and index number (TFP) methods) estimates returns on investment by measuring the change in consumer and producer surplus from a shift to the right in the supply curve due to technological change.
2. The econometric approach (production, profit and supply function and their derivatives) treats research as a variable and allows a marginal rate of return on investment to be calculated.

Impact-evaluations are often used to try to convince policymakers that resource allocations to research represent good investments. Progress in terms of production, income, or marketable produce is usually the yardstick of success used by policymakers, so a high rate of return to research investment can be a strong selling point for research leaders when presenting the research budget for approval by government authorities.

Number of efforts have been made to use input and output data to carry out benefit / cost analysis of agricultural research. This has been done either in an **ex post sense** or **ex ante**.

Methods of Economic Evaluation

- a) Ex ante evaluation

Scoring model

Benefit cost analysis

Simulation approach

Mathematical programming approach

- b) Ex post evaluation

Economic surplus approach

Production function approach

National income approach

Nutritional impact approach

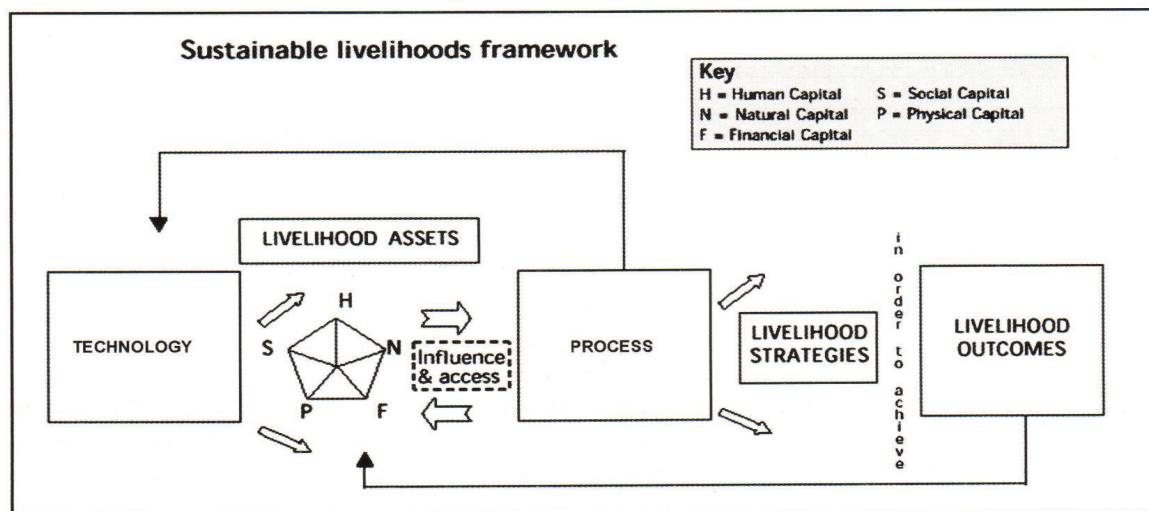
Benefit / cost analysis is widely used by governments and funding agencies for deciding on and evaluating investment in development projects. It is based on the concept of discounted cash flow. Benefit / cost analysis should include, at a minimum, the sequential estimation of eight distinct characteristics of a research programme and its impact. They are: the annual cost of research, its duration, its initially anticipated probability of success, on-farm implementation costs, on-farm benefits, the rate of adoption, the adoption ceiling, and the life of the innovation.

A major difficulty in conducting benefit / cost analysis is in knowing how to define and measure both input and output. A World Bank publication Schuh and Tollini 1979 has examined this subject in some depth. It stresses that the most important output of the research process is new knowledge, but this is not a quantifiable product nor is there a well-defined market for it, despite the fact that it has obvious economic value. Thus it is not possible to be precise in measuring the value of knowledge to society.

Measuring benefits of research has been approached through different methods. The benefits are estimated using economic- surplus method. The economic surplus method is bit difficult to apply and complex to the evaluator who is not from the field of economics or statistics. There is another method to estimate benefits of technology called Gross Efficiency Index which is a close proxy to economic surplus method.

Interventional and livelihood Analysis

Adoptions location-specific agricultural technology by the farmers have potential to enhance farm production and income with improved livelihood. A livelihood comprises of people, their capabilities and means of living including food, income and assets. Tangible assets are resources and stores and intangible assets are claims and access. People and their access to assets are at the heart of livelihoods approaches.



Department for International Development (DFID) framework (1999), five categories of assets or capitals are identified, which are:

- Human capital: skills, knowledge, health and ability to work
- Social capital: social resources, including informal networks, membership of formalized groups and relationships of trust that facilitate co-operation
- Natural capital: natural resources such as land, soil, water, forests and fisheries
- Physical capital: basic infrastructure, such as roads, water & sanitation, schools, ICT; and producer goods, including tools and equipment

- Financial capital: financial resources including savings, credit, and income from employment, trade and remittances

The variables under five types of assets are measured on the basis of the responses of farmers can be scaled during interview schedule survey and focus group discussion. Then standard of living of farmers can be assessed on the basis of their assets holding before and after adoption of a particular technology.

Benefits of impact assessment

The usefulness and benefits of impact assessment for researcher are as follows:

- Impact studies can *motivate researchers* by providing feedback from the farm community and other research clients on the use and effects of research results.
- Adoption studies can *help researchers refocus their research efforts* by providing insights into farmers' assessments of new technologies (vis-à-vis their current practices) and into farm-level adoption processes
- *Ex post* studies can provide managers with *evidence of the value of research* to argue for continued investments.
- *Ex ante* assessments can provide managers with *a basis for allocating resources* among competing research demands.
- Lessons learned from impact assessments can be used to *improve future research strategies, plans, and management*.
- Impact assessments *show how economic policies and technology interact* in determining the ultimate benefits of agricultural research. This can be useful for discussions between research leaders and policymakers.
- Impact assessments can *show how economic policies and technology interact* in determining the ultimate benefits of agricultural research. This can be useful for discussions between research leaders and policymakers.
- In agricultural research, impact assessments have been used mainly to estimate economic returns to research investments and the diffusion and adoption of new technologies. Economic studies (generally of successful cases) have produced very positive results, which have been used to justify continued support for agricultural research organizations and programs. The systematic use of impact assessments in planning or reorienting research is less common.
- Research managers and policymakers need a better understanding of how impact studies can be used for decision-making. But they also need to understand what is required to do impact assessments; they tend to underestimate the time and resources needed for these kinds of studies.

References

1. Biswas A.K. and Geping Q. 1987 Environmental impact assessment for developing countries. Tycooly, London.
2. Department for International Development. 1999. Sustainable livelihoods guidance sheets. Eldis Document Store (<http://www.eldis.org>)
3. Horton, D.E. 1986. Assessing the impact of international research and development programs. World Development 14, 453 - 468.
4. Kariuku, J.G. 1990. The economic impact of the adoption of hybrid maize in Swaziland. Farming Systems and Resource Economics in the Tropics 9. Wissenschaftsverlag Vauk Kiel, Kiel, Germany.
5. Khan, M.H. and Akbari, A.H. 1986. Impact of agricultural research and extension on crop productivity in Pakistan: A production function approach. World Development 14, 757 - 762.
6. Menz, K.M. 1991. Overview of economic assessments 1 - 12, Australian Centre for International Agricultural Research, Canberra.
7. Murphy, J., Casley D. and Curry J. 1991. Farmers' estimations as a source of production data: Methodological guidelines for cereals in Africa. Technical Paper No. 132. The World Bank, Washington, DC.
8. Sperling L and Loevinsohn, M.E. 1993. The dynamics of adoption: Distribution and mortality of bean varieties among small farmers in Rwanda, Agricultural Systems 41, 441 - 453.
9. Schuh, G.E. and Tollini, H .1979. Costs and Benefits of Agricultural Research: The state of art. World Bank Staff working Paper No. 360, World Bank, Washington.

Methods and Challenges for Impact Assessment of Frontline Extension Programs

Rajesh K Rana

ICAR-Agricultural Technology Application Research Institute, Ludhiana-141004, Punjab

Corresponding author: Rkrana2004@yahoo.com

Abstract

The frontline extension programs typically involve a network of trained extension agents who work closely with farmers to provide technical advice, training, and other forms of support. One of the key functions of the frontline agricultural extension system is to disseminate information and knowledge about best practices in agriculture. Extension agents are typically trained in the latest farming techniques and technologies, and they work to share this information with farmers in their communities. They may also provide training on different aspects of scientific agriculture and supplementary enterprises suitable to the local production and market conditions. Another important role of the frontline agricultural extension system is to provide farmers with access to inputs such as seeds, fertilizers, and pesticides. The frontline extension system supports state level extension machinery through Department of Agriculture and Farmers Welfare and Agricultural Technology Management Agency (ATMA). Frontline extension system also supports other ministries viz. Rural Development, Panchayati Raj, Information and Broadcasting, Water Resources along with the private agencies and NGOs.

Frontline Extension System

The frontline agricultural extension system plays a critical role in supporting and advising farmers in their efforts to increase crop yields, improve crop quality, and adopt sustainable farming practices. The system typically involves a network of trained extension agents who work closely with farmers to provide technical advice, training, and other forms of support. One of the key functions of the frontline agricultural extension system is to disseminate information and knowledge about best practices in agriculture. Extension agents are typically trained in the latest farming techniques and technologies, and they work to share this information with farmers in their communities. They may also provide training on different aspects of scientific agriculture and supplementary enterprises suitable to the local production and market conditions. Another important role of the frontline agricultural extension system is to provide farmers with access to inputs such as seeds, fertilizers, and pesticides. Extension agents may work with local suppliers to ensure that farmers have access to quality inputs at reasonable prices. Hence, the frontline agricultural extension system is a vital component of any agricultural development strategy. By providing farmers with the knowledge, skills, and resources they need to improve their farming practices, extension agents can help to increase crop yields, improve food security, and promote sustainable agriculture.

Indian Agricultural Extension system is one of the largest extension systems in the world. Frontline extension system takes care of technology backstopping and agro advisories.

National Agricultural Research System including ICAR and State Agricultural Universities (SAUs) along with Krishi Vigyan Kendras (KVKs) and Agricultural Technology Information Centres (ATICs) are the prominent pillars of frontline extension system in India. The frontline extension system supports state level extension machinery through Department of Agriculture and Farmers Welfare and Agricultural Technology Management Agency (ATMA). Frontline extension system also supports other ministries viz. Rural Development, Panchayati Raj, Information and Broadcasting, Water Resources along with the private agencies and NGOs.

Impact Versus Effect

Impact is generally associated with the negative or harsh outcome while effect reflects consequence of an activity or action. Impact can't be used as a synonym to result, consequence and outcome etc. while effect can be. However, effect simply refers to the consequences and does not refer to how the action or activity is going to affect someone or something. Hence, impact is an influence and effect is a consequence i.e. impact is the effect of effect. Leaving aside the association of impact with negative outcomes e.g., high impact sports (having stress/trauma), the assessment of impact is, no doubt, need of the hour as far activities and programs of the frontline extension are concerned.

Challenges

Krishi Vigyan Kendras (KVKs) have evolved like a developmental agency. A very large number of activities and programs spreading across all the branches of agricultural science were performed by the KVKs in addition to their mandated activities. During recent past the KVKs have also been assigned activities beyond agricultural and allied sectors. The number of activities and the volume of work leaves little energy and time with the KVK scientists to scientifically plan and undertake the research activities for bringing out quality publications. However, career promotion needs quality publications for the scientists working in KVKs too. Moreover, funding and monitoring agencies do regularly ask to provide impact of the actions and programs undertaken at the KVKs. For all this it is very important to systematically understand the mechanism of impact assessment of frontline extension activities.

Rapidly increasing number of landholdings in the country poses double challenge. On the one hand the number of farm families is increasing and on the other the land holdings are becoming uneconomical. As per the figures available from the Department of Agricultural Cooperation and Farmers' Welfare the number of landholding have risen from 129 million in 2005-06 to 146 million in 2015-16. Over this period the proportion of all landholding size categories have reduced except for the marginal farmers. The proportion of marginal farmers in the total number of farmers increased from 64.8% in 2005-06 to 68.45% in 2015-16. Small and marginal farmers are generally considered the economically vulnerable farm category and the proportion of such farmers was more than 86% during 2015-16. Hence, dealing with a 86% section of the farming community that is economically vulnerable is a real challenge for the frontline agricultural extension agencies in India (Table 1).

Table 1 Proportion of land-holdings under different farm categories over the time

Category of farmers	Percentage of land holdings during		
	2005-06	2010-11	2015-16
Marginal	64.80	67.10	68.45
Small	18.50	17.90	17.62
Sub-total	83.30	85.00	86.07
Semi-Medium	10.90	10.00	9.55
Medium	4.90	4.20	3.80
Large	0.80	0.70	0.57
Total Holdings (millions)	129.22	138.35	146.45

Source: Rana RK, Kaur R, Singh R, Shirur M, Padaria RN, Monga S, Singh RK, Singh R and Singh AK (2022) A Critical Review and SWOT Analysis of Important Extension Agencies in India for Improving Extension Management. Agricultural Reviews. doi: 10.18805/ag.R-2522.

Different Extension Agencies and Their SWOT Analysis

In India there are present various extension agencies those complement each other in the extension system in order to make it more efficient and vibrant. Krishi Vigyan Kendras (KVKs), ICAR Institutes, State/ Central/ private Agricultural Universities (SAUs), Agricultural Technology Management Agency (ATMA) along with all state line departments, private companies, farmers' groups, Non-Governmental Organisations (NGOs) and input sellers/ dealers are the major extension agencies in India. All these extension agencies have their specific strengths and weaknesses while managing agricultural extension programs at the field level. An insight into the strengths and weaknesses of these agencies, along with an analysis of their respective opportunities and threats, is very important in order to have a right selection of an extension agency for a particular activity and target group.

However, in order to pay focus on the frontline extension system this chapter describes only the concerned extension agencies. India has a well-established national network of extension agents, holistic approach to the farmers' problems, dissemination of pan-India robust technologies and high returns to the investment which are the core strengths of 731 KVKs in the country. However, increasing non-mandated activities, limited manpower, constant shift of talent to research system from the KVK system and highly time consuming/ multiple reporting mechanism are becoming weaknesses of the KVKs. Strong convergence with the other agencies, excellent capabilities to handle farming system approach, being the highly resilient extension agency and possibilities of strengthening KVK manpower through outsourcing services are some of the opportunities that make one of the most important extension agencies in the future. However, low scientific recognition/ prestige of the activities carried out by the KVK scientists, rapidly increasing non-mandated activities and shifting of workload of conventional extension system of the SAUs to the KVKs pose some of the future threats for this extension agency.

India also has a well-established and location specific network of sixty-three SAUs which are generating location-specific agri-technologies and facilitating their dissemination among

farmers have several strengths viz., SAUs are specialized institutions that focus solely on agricultural education, research, and extension; SAUs have excellent research facilities that are equipped with modern technology and equipment and a lot of farmers friendly technologies are developed; SAUs have strong linkages with the agriculture industry; SAUs also provide direct extension services to farmers, which includes disseminating the latest technologies to farmers, providing training and advisory services, and facilitating technology transfer. However, the SAUs also have several weaknesses in the agricultural extension system such as limited outreach that limits their effectiveness in disseminating new technologies and practices to all farmers; insufficient resources with SAUs limits their ability to provide effective support to farmers; inadequate training of the extension workers in order to effectively address the complex challenges faced by farmers; and limited coordination with other extension agencies results in duplication of efforts and limited impact. However, there are some important opportunities viz., two-way communication IT platforms to reach all farmers more efficiently and effectively, and higher Public-Private-Partnership in agricultural extension. Nevertheless, score-cards based promotion assessment having inadequate weightage for extension activities; weakened in-house extension system with excessive dependence on the KVK system; and emergence of specialized universities hampering systems approach to extension are posing serious threats to the SAUs being the important extension agencies in India.

ICAR has a large number of Research Institutes (102) and Agricultural Technology Application Research Institutes (11) in the country and these institutes especially the ATARIs are taking care of frontline extension management in India. High-quality technical input; efficient technology dissemination teams; better perception and inculcation of others' experiences and being very strong trainer of master-trainers compose key strengths of the ICAR institutes as an extension agency. However, lack comprehensive solutions to farmers' problems as most of the ICAR institute are highly specialised, limited reach to the farmers of the country, language-problem of ICAR scientist as they are from different parts of the county, inadequate supply of seed material in order to fulfil national demand of farmers for very strongly promoted varieties, inadequate significance of extension activities in the score-card of the ASRB and lack of scientists' insight into farmers' realities pose some of the distinct weaknesses of ICAR institutes as an extension agency. The higher ability to make use of outsourced manpower/services, easy collaboration with other agencies and higher recent emphasis on public private partnerships present some of the important opportunities for ICAR institutes for being an important agricultural extension agency in the future. However, un-sustainable rapport with the farmers and depleting technical staff in the ICAR institutes pose serious threats for them being the vibrant extension agencies in the future.

KVK Level Activities and Programs

The activities of the KVks can be grouped into support services, capacity building, technical support, On-Farm Testing, demonstrations, special projects and campaigns/ drives. The outcome indicators of most of these activities are generally yield or income enhancement. However, in some of the cases, restoration/ improvement in environmental attributes is also the impact indicator. If individual activities of the KVks are considered then healthy seeds/ planting material production of improved varieties and their provision to the farmers; soil, plant and leaf

analysis; improved scientific practices such as high density plantation of horticultural plants, balanced use of fertilizers, integrated nutrient management, integrated pest management, precision farming, high-tech agriculture and other scientific agronomic practices etc. can be best assessed for their impact on the socio-economic life of the farmers through higher yields, higher net income and/ or favourable environmental outcomes.

Capacity building of farmers is one of the most important and conspicuous activities of the KVKs. Various training programs are undertaken by the KVKs under specialised initiatives such as skill development for enhancing farm and non-farm income; natural farming project and ARYA project etc. along with the general training programs focused at plant protection, recommended scientific practices, post-harvest management and value addition, supplementary activities (solar energy farming, fishery, commercial floriculture, protected cultivation, other high value horticultural, medicinal and aromatic crops); Mushroom; poultry; goatery; piggery; dairy farming; vermicomposting; duck farming; apiculture; Scientific feeding of livestock (silage making, azolla making); mineral supplementation of livestock (UMMB licking, area specific mineral mixtures; and diseases and other pests management of livestock. The impact of these activities is largely on the yield of crops/ animals and net income of the farmers.

The technical support provided by the KVKs in terms of need-based advisories, field visits, kisan melas, field days, TV/ radio talks, publications (pamphlets, folders, booklets, posters), promoting direct/ digital marketing through FPOs/ SHGs, CHCs and serving indirect role through Kisan Call Centres, popularization of IT applications e.g., apps, do have impact on the socio-economic life of the farmers which is mostly perceivable in the form of higher yield and/ or higher net income of the targeted farmers.

Laying out demonstrations in the form of frontline demonstrations (FLDs), cluster frontline demonstrations (CFLDs) and method demonstrations are the significant contribution of the KVKs. CFLDs Pulses/ Oilseeds, demonstrations on integrated farming system/ drip irrigation, plastic mulch material, low-cost tunnels, low-cost green houses, high-tech green houses and shade nets etc., have desirable impact on the yield and net income of the adopters. On the other hands demonstration of natural farming and crop residue machines (e.g., Happy Seeder, DSR, Super SMS etc.) have favourable impact on net income of the farmers along with higher soil carbon, reduced pollution and water conservation etc. However, positive externalities/ impact of such demonstration in terms of environmental benefits can largely be assessed through various valuation techniques.

KVKs of India also undertake various campaigns and special drives in order to help farmers though spreading awareness on various government policies/ initiatives and other topical issues. Crop residue management, water conservation/ harvesting and nutritional awareness have been very important campaigns/ drives during recent past. Wall writing (message, slogans), rallies, village march/ Prabhat pheris and various competitions have been the popular modes of doing these. The impact of these activities is also assessable in terms of higher yield/ net income of the farmers along with higher environmental benefits. However, better body-mass index and haemoglobin etc. have been the dependable quantifiable indicators for assessing impact of nutritional awareness.

Attracting and Retaining Youth in Agriculture or Attracting Rural Youth in Agriculture (ARYA) project; Doubling Farmers' Income/ Enhancing Farmers' Income; National Initiative on Climate Resilient Agriculture (NICRA) project; Cluster Frontline Demonstration (CFLDs) Pulses and CFLDs Oilseeds; Tribal Sub Plan (TSP)/ Scheduled Cast Sub Plan (SCSP); Nutrition and Gender and Aspirational Districts and the important projects/ initiatives of the ICAR/ Government of India implemented in network mode for improving socio-economic and health standards of the targeted farmers/ farm-families. Impact assessment of these projects/ initiatives becomes imperative when it comes to justification of public money used to implement them.

METHODOLOGY

Data Requirement

We need to have reliable primary and/ or secondary data for having robust analysis of impact of various activities/ initiatives of the frontline extension system.

Primary data: Personal interviews on well-structured questionnaires is the most popular way of collecting primary data, however, there are other methods also. We should include all aspects of the effect and impact indicators of our interest while collecting primary data in the field. One needs to go well-prepared for this exercise so that in-depth and adequate information is collected. In frontline extension system there is much higher emphasis on documentation of success stories understanding factors responsible for the effect/ impact of some variable.

Secondary data: The source of the secondary information should be credible. One needs to undertake thorough verification/ authenticity of data before using it for drawing conclusions. In fact, it is the important responsibility of the researchers to ensure reliability of the secondary data. Citing source of secondary data for poor or unreasonable results by a researcher is a poor practice on his/ her part. Sometimes there are gaps in the time series data in many cases. Interpolation, extrapolation and smoothening of data is very important in such cases.

Sampling Techniques

The sampling techniques can be broadly grouped into two main groups viz., probability based sampling and non-probability-based sampling techniques.

Probability Based Sampling

Simple Random Sampling: Simple random sampling (SRS) is the best sampling technique in all respects however, in order to have representative sample size on a heterogenous larger area it might need very large amount of physical and monetary resources. For undertaking SRS one needs to have complete list of all the constituents of the population. The sample is drawn with the help of Random number table or computer-generated random numbers.

Multistage Sampling Technique: Making strata of population/ study area depending upon the pattern of variability in the variable of interest is one of the most commonly used techniques in the socio-economic field survey studies. The strata are formed in such a way that they should uniform within themselves and heterogeneous between/ among themselves. Generally, states are considered the first stage of sampling for national level studies followed

by districts as the second stage and so on at blocks and village level. Within a strata SRS is used for selection sample in all the stages. This sampling technique is very convenient and economical in the socio-economic studies spread of very large geographies.

Probability Proportional to Size (PPS): This sampling technique works on the principal of weighted averages. Though this sampling technique is a biased sampling technique yet there are statistical methods to handle it. This technique is mostly useful when effect/ impact is not randomly distributed and factors being a particular change are needed to be studied. This sampling technique is also useful in the studies on crops that are confined only to some specific locations. PPS is generally used to select area while probability proportional to number (PPN) is used to select the respondents. This survey technique is very efficient in terms of time and money in the specialized survey studies focussing on understanding reasons behind some problem(s) or development(s).

Stratified/ Cluster Sampling: This sampling technique is just like the multistage sampling but the strata/ clusters are formed within the same stage. However, strata/ clusters are formed in a way that they are uniform within themselves and heterogeneous among themselves. All further selections within the strata/ cluster are made using SRS.

Systematic Sampling: This sampling technique is used to zero down the population we want to study. Although this sampling technique is more efficient than SRS in terms of time and financial resources yet this is considered/ rated lower than the SRS. The period or interval of selection in this sampling technique depends upon variation in the population. Under this sampling technique one needs to select first respondent from the first period using SRS and further selections are made by selecting a number after the same period/ interval.

Non-Probability Sampling

Snowball Sampling: Snowball sampling is a non-probability sampling technique used in research where the researcher begins with a small number of participants and then asks them to refer other potential participants. The process continues until the desired sample size is reached. This technique is useful when the population under study is hard to reach or when there is no complete sampling frame available.

The major advantage of snowball sampling is that it allows the researcher to reach populations that are difficult to access, such as COVID-19 infested individuals, drug users, prostitutes, or immigrants. Snowball sampling is also useful when the population is small or is difficult to define. However, it is important to acknowledge that snowball sampling has some limitations. For example, it may not provide a representative sample because participants are recruited based on personal connections and referrals, which can lead to bias. Additionally, snowball sampling may not be suitable for larger studies or when there is a need for generalization of results at broader area. Although snowball sampling can be a valuable sampling method for certain types of research, yet, researchers should carefully consider the limitations of the method and the potential for bias before using it.

Quota Sampling: Quota sampling is one of the commonly used techniques in agricultural extension research that involves selecting a predetermined number of individuals from different groups to ensure that the sample accurately represents the population. In agricultural

extension research, quota sampling can be used to gather information about specific groups of farmers or other stakeholders in the agricultural sector.

One of the primary advantages of quota sampling in agricultural extension research is that it allows researchers to obtain information from a representative sample of individuals, even if the population is diverse or difficult to access. For example, if a researcher wants to understand the opinions of smallholder farmers in a particular region, they might use quota sampling to ensure that their sample includes a representative number of men and women, different age groups, and farmers with varying levels of experience. Quota sampling can also be an effective way to gather data quickly and efficiently. By identifying key groups and selecting individuals from each group, researchers can ensure that they collect a diverse range of opinions and perspectives in a relatively short time.

However, it's important to note that quota sampling has limitations. It can be challenging to determine the appropriate quotas for each group, and there is a risk of researcher bias in selecting individuals to complete the quotas. Additionally, quota sampling may not be appropriate for populations that are highly diverse or difficult to categorize. Though quota sampling is a valuable tool for agricultural extension researchers who want to gather data from a representative sample of individuals, yet, one should be careful in selecting individuals from different groups and the researchers need to ensure that their findings accurately reflect the opinions and experiences of the broader population.

Purposive Sampling: Purposive sampling is a popular technique used in agricultural extension research to select participants who are most relevant to the research objectives. In agricultural extension, purposive sampling allows researchers to identify and select individuals or groups who have specific knowledge, skills, or experiences related to the research topic. For example, if a researcher wants to study the factors facilitating doubling of farmers' income in the span of seven years then they may choose to purposively sample farmers who have actually done that.

The advantage of purposive sampling is that it allows researchers to gather in-depth, detailed information from participants who are knowledgeable about the research topic. It also enables researchers to make efficient use of limited resources by selecting participants who are most likely to provide valuable insights. However, the major drawback of purposive sampling is that it may introduce bias as the selected participants are not likely to be the representative of the entire population. Therefore, it is important for researchers to carefully consider the sampling strategy and ensure that it aligns with the research objectives. The estimates of such sampling may not be generalized over a broader area and this technique is particularly good in case studies, success stories, examples or lessons etc.

Sample Size

Determining the optimum sample size is an important aspect of agricultural survey studies as it affects the accuracy and reliability of the results obtained. The significance of determining the optimum sample size is to ensure that the sample is large enough to provide a representative picture of the population being studied, while at the same time not being so large that it becomes impractical or unnecessarily expensive to conduct the study. The size of the sample

is influenced by factors such as the level of precision required, the level of significance, the variability in the population, and the desired confidence level. Here are some simple statistical techniques for determining the optimum size of a sample:

1. Margin of Error Technique: This technique involves calculating the sample size required to achieve a specified margin of error or confidence interval. It involves determining the level of precision needed and then using a formula to determine the sample size required.
2. Power Analysis: This technique involves determining the sample size required to achieve a specified level of power in detecting a significant effect. Power is the probability of detecting a significant effect when it exists, and it depends on factors such as the effect size, significance level, and sample size.
3. Stratified Sampling: This technique involves dividing the population into subgroups or strata based on some relevant characteristics, and then randomly selecting participants from each stratum. The sample size required for each stratum is determined separately based on the desired level of precision.
4. Cluster Sampling: This technique involves dividing the population into clusters or groups, and then randomly selecting a few clusters to sample. The sample size required for each cluster is determined based on the desired level of precision.
5. Simple Random Sampling: This technique involves randomly selecting participants from the population, and the sample size required is determined based on the desired level of precision.
6. Systematic Sampling: This technique involves selecting participants from the population at regular intervals, and the sample size required is determined based on the desired level of precision and the size of the population.

These are some of the statistical techniques that can be used to determine the optimum size of a sample in survey studies. The choice of technique depends on the specific research question and the characteristics of the population being studied.

Data Analysis

Qualitative Research Methods: Qualitative research is a research method that aims to explore and understand complex social phenomena by focusing on people's experiences, beliefs, attitudes, and behaviours. This method is commonly used in agricultural extension research to gather insights and perspectives from farmers and other stakeholders about their agricultural practices and challenges. Some common qualitative research methods used in agricultural extension research include:

1. Interviews: Interviews are conducted to gather information from farmers, extension workers, and other stakeholders about their experiences, perceptions, and attitudes towards agricultural practices and technologies. These interviews can be conducted face-to-face, over the phone, or online.

2. Focus groups: Focus groups are group discussions conducted with farmers and other stakeholders to gather their views on specific topics related to agricultural practices and technologies. Focus groups allow for the exploration of diverse perspectives and the identification of common themes and issues.
3. Case studies: Case studies involve in-depth analysis of specific cases or examples of agricultural practices or technologies. Case studies can provide detailed insights into the context-specific factors that influence the adoption and impact of agricultural practices and technologies.
4. Participatory methods: Participatory methods involve the active involvement of farmers and other stakeholders in the research process. These methods include participatory rural appraisal (PRA), participatory action research (PAR), and farmer field schools (FFS). Participatory methods allow for the co-creation of knowledge and the development of locally relevant solutions to agricultural challenges.

Overall, qualitative research methods are useful in agricultural extension research because they provide rich and detailed insights into the complex social and cultural factors that influence the adoption and impact of agricultural practices and technologies. During recent years, research findings based on systematic qualitative research have been widely published by the leading research journals.

Quantitative Research Methods: Quantitative research is a research method that involves collection and analysis of numerical data. It is commonly used in agricultural extension research to study various aspects of agriculture and the extension of agricultural knowledge to farmers. Some common quantitative research methods/ techniques used in agricultural extension research include:

1. Surveys: Surveys involve collecting data from a sample of individuals using questionnaires or interviews. Surveys can be used to collect information about farmers' knowledge, attitudes, and practices related to agricultural practices, as well as their access to and use of extension services.
2. Experiments: Experiments involve manipulating one or more variables to observe the effects on a dependent variable. Agricultural extension research may use experiments to test the effectiveness of different agricultural practices or extension methods.
3. Statistical analysis: Statistical analysis involves the use of mathematical and statistical techniques to analyze quantitative data. This can include descriptive statistics, such as means and standard deviations, as well as inferential statistics, such as correlation and regression analysis.
4. Case studies: Case studies involve in-depth analysis of a particular individual, group, or organization. In agricultural extension research, case studies may be used to explore the experiences of farmers or extension agents in specific contexts.
5. Observational studies: Observational studies involve observing and recording behaviour without manipulating any variables. In agricultural extension research, observational studies may be used to gather data on farmer behaviour or extension service delivery.

Tests of significance to know uniqueness or similarities of population's attributes are precisely provided by this type of research. Hence, quantitative research methods provide a rigorous and systematic approach to studying agricultural extension and its impact on farmers and agricultural practices.

Mixed Methods: Mixed research methods is a research approach that involves collecting, analysing, and interpreting both quantitative and qualitative data in a single study or research project. In the context of agricultural extension research, mixed methods can be used to gain a more comprehensive understanding of the complex issues involved in agricultural extension, including the social, economic, and environmental factors that affect the adoption of new technologies and practices by farmers. Here are some possible steps that a researcher could take in conducting mixed methods research in agricultural extension:

1. Define the research question: The first step in any research project is to define a clear research question or objective. This could be something like "What factors influence the adoption of sustainable agricultural practices among smallholder farmers in a particular region?"
2. Develop a conceptual framework: Based on the research question, the researcher should develop a conceptual framework that outlines the key variables or factors that are hypothesized to affect the adoption of new practices. This could involve drawing on existing literature or conducting preliminary research to identify the most important factors.
3. Choose data collection methods: In mixed methods research, the researcher typically uses both qualitative and quantitative data collection methods. For example, the researcher might conduct interviews or focus group discussions with farmers, extension agents, and other stakeholders to gather qualitative data on their attitudes, beliefs, and experiences related to agricultural extension. At the same time, the researcher might also collect quantitative data through surveys or experiments to measure variables such as yield, income, or adoption rates.
4. Analyse data: Once the data has been collected, the researcher needs to analyze it using appropriate methods. This could involve statistical analysis of the quantitative data, such as regression analysis to identify factors that predict adoption. For the qualitative data, the researcher might use techniques such as thematic analysis to identify common themes or patterns in the data.
5. Integrate findings: Finally, the researcher needs to integrate the findings from the qualitative and quantitative analyses to draw overall conclusions about the research question. This could involve triangulation, where the findings from different data sources are compared and contrasted to identify areas of agreement and divergence. The researcher should also reflect on the limitations of the study and potential avenues for future research.

Overall, mixed methods research can provide a more comprehensive and nuanced understanding of agricultural extension issues by combining both quantitative and qualitative data. By carefully designing the study, collecting and analysing data using appropriate methods, and integrating the findings, researchers can generate valuable insights that can inform policy and practice in agricultural extension.

Commonly Recommended/ Used Analytical Techniques

Randomized Control Trials: Randomized controlled trials (RCTs) are widely used in agricultural extension research to evaluate the effectiveness of different extension interventions. In an RCT, a sample of participants is randomly assigned to either a treatment group or a control group. The treatment group receives the intervention being evaluated, while the control group does not. Researchers then compare the outcomes of the two groups to determine the impact of the intervention. RCTs are considered the gold standard for evaluating the effectiveness of interventions because they reduce bias and increase the reliability of results. They can be used to evaluate a wide range of extension interventions, including training programs, technology adoption, and behaviour change interventions. However, RCTs have to be planned and implemented at the time of beginning of a project/ intervention and it is not possible to do it at the time of evaluation or impact assessment.

Quasi Experimental Designs/ Methods

Quasi-experimental designs/ methods are widely used in agricultural extension research to evaluate the impact of various interventions, such as new technologies, training programs, or policies. These designs involve the comparison of treatment and control groups, where the treatment group receives the intervention while the control group does not. However, unlike true experiments, quasi-experiments do not involve random assignment of subjects to treatment and control groups, which may introduce bias. Therefore, researchers must carefully select the control group, consider confounding variables, and use statistical methods to estimate the treatment effect. Despite these limitations, quasi-experiments can provide valuable insights into the effectiveness of agricultural extension interventions, especially in situations where randomization is not feasible or ethical. Some very important quasi-experimental designs/ methods for the assessment of impact of agricultural extension research are as follows:

Difference-in-Difference (DiD): The difference-in-differences (DiD) approach is a popular quasi-experimental method used in impact assessment research in agricultural extension programs. It compares the changes in outcomes over time between a treatment group (those who receive the intervention) and a control group (those who do not). The DD approach then estimates the difference between the two groups' changes before and after the intervention, and the differences in changes over time. The difference between these two differences is interpreted as the causal effect of the intervention on the outcome.

In agricultural extension research, the DD approach can be used to assess the impact of interventions such as training programs, farmer field schools, and technology adoption. The approach is especially useful when randomization of the intervention is not possible or ethical. However, care should be taken in choosing the appropriate control group and ensuring that the groups are comparable before the intervention. In other simple words for using this technique the complete baseline information for adopter as well as non-adopter groups is also required. There are some studies that use memory recall method to collect baseline data at the time of impact assessment survey which is not the best practice to follow.

Propensity Score Matching (PSM): Propensity score matching (PSM) is a statistical technique commonly used in impact assessment research in agricultural extension to identify the causal

effects of a treatment or intervention. Agricultural extension research aims to improve the productivity and income of smallholder farmers through the dissemination of new technologies and knowledge. However, assessing the impact of agricultural extension interventions can be challenging due to the presence of confounding variables that can bias the estimates of treatment effects.

PSM is a non-parametric matching method that balances the distribution of observed covariates between the treated and control groups to reduce the bias caused by confounding variables. The approach involves estimating the probability (propensity score) of receiving the treatment or intervention based on observable characteristics of the participants. Then, the treated and control groups are matched based on their propensity scores, ensuring that they have similar distributions of observed covariates. The matching can be done using several techniques, such as nearest-neighbour matching, kernel matching, or stratification.

After matching, the treatment effect can be estimated by comparing the outcome variable between the treated and control groups. The PSM approach can provide more robust estimates of treatment effects compared to traditional regression methods, especially when the sample size is small or when there are many covariates to control for. However, PSM also has limitations, such as the assumption of no unobserved confounding variables and the need for a large sample size to ensure adequate matching quality. Hence, PSM is a valuable tool for impact assessment research in agricultural extension, as it allows researchers to obtain more accurate estimates of treatment effects and make better-informed policy decisions. However, taking into consideration the problems of confounders researchers have commonly been resorting to selecting nearly double non-adopter respondents compared to the number of adopter respondents.

Other methods: There is a large number of other research methods e.g., specialised regression techniques, which are also widely used for assessing impact of agricultural extension research. In addition to DiD and PSM, Instrumental variables (IV) regression and Regression discontinuity (RD) design are two other most commonly used regression techniques for assessment of impact of the agricultural extension research.

1. Instrumental variables (IV) regression: IV regression is used when the treatment assignment is potentially endogenous, meaning that it is correlated with unobservable factors that may affect the outcome of interest. IV regression uses an instrumental variable that is correlated with treatment assignment but is not directly related to the outcome of interest. This approach can help address endogeneity and provide unbiased estimates of treatment effects.
2. Regression discontinuity (RD) design: RD design is used when individuals are assigned to the treatment or control group based on a continuous variable (e.g., a score on a test). RD design compares outcomes for individuals just above and below a cutoff point for treatment assignment, assuming that individuals close to the cutoff point are similar in all other respects. RD design can help control for selection bias and can provide an estimate of the causal effect of the intervention on the outcome of interest.

These are just a few of the many regression approaches that can be used for impact assessment in agricultural extension research. The appropriate approach will depend on the

specific research question, data availability, and assumptions about the treatment assignment process.

Special Care for KVK Scientists

Special care is needed in the process of selection of non-adopted villages corresponding to the selected village as there should not be even the spill over effect of the activities of the KVKs in non-adopted villages in relation to the variable of interest. Moreover, the effect of other than KVK developmental/ extension agencies on the variable of interest should be evenly distributed in adopted and non-adopted villages. The adopted as well as non-adopted villages should be selected at the time of initiation of the project and not at the time of execution of impact study. The results of baseline data should be immediately published in order to provide higher confidence to journals' editors in the robustness of your study.

Quick Test for Appropriateness/ Representativeness of Sampling Plan

Whether the sampling plan of state level survey studies is appropriate or faulty, the average land-holding size provides very strong evidence (Table 2). Similarly, KVKs can compile average land-holding size information for various sub-levels e.g., district or block etc.

Table 2: State/ UT wise average size of holding in India (2015-16)

States/ UTs	Size (ha)	States/ UTs	Size (ha)
A&N Islands	1.78	Madhya Pradesh	1.57
Andhra Pradesh	0.94	Maharashtra	1.35
Arunachal Pradesh	3.35	Manipur	1.14
Assam	1.09	Meghalaya	1.29
Bihar	0.39	Mizoram	1.25
Chhattisgarh	1.25	Nagaland	5.06
D & N Haveli	1.38	Odisha	0.95
Daman & Diu	0.35	Puducherry	0.62
Delhi	1.39	Punjab	3.62
Goa	0.81	Rajasthan	2.73
Gujarat	1.88	Sikkim	1.13
Haryana	2.22	Tamil Nadu	0.75
Himachal Pradesh	0.95	Telangana	1.00
Jammu & Kashmir	0.59	Tripura	0.49
Jharkhand	1.17	Uttar Pradesh	0.73
Karnataka	1.35	Uttarakhand	0.85
Kerala	0.18	West Bengal	0.76
Lakshadweep	0.26	TOTAL	1.08

Testing and Demonstration of Technologies: Concept and Practices

Arvind Kumar

ICAR-Agricultural Technology Application Research Institute, Ludhiana-141004, Punjab

Corresponding author: arvindkumar.icar@gmail.com

Abstract

Krishi Vigyana Kendra (KVK) working as frontline extension institution in the district has transformed over a period of time so its mandate. Initially, the mandate of KVK was to provide need-based skill oriented vocational training to the farmers, farm women, rural youth and field extension functionaries in agriculture and allied areas. Now the mandate of KVK is Technology Assessment and Demonstration for its Application and Capacity Development. In order to achieve the mandate, KVK carried out various activities including on-farm testing to assess the location specificity of agricultural technologies under various farming systems. KVK works in clusters of 4-5 villages for testing and demonstration of technologies. However, other activities like capacity building, awareness, etc. are conducted keeping the entire district as the domain of the KVK.

Introduction

KVK provides a platform to National Agricultural system (NARS) for showcasing agricultural technologies/products at the grass root level. In Indian agriculture, NARS generates new technologies which comprise ICAR institutes, SAUs, other science and technology institutions and commodity boards. NGOs, corporate and farmer innovators also contribute to technology generation. Extension system comprises of state departments of agriculture, animal husbandry and veterinary, fisheries, sericulture etc. Agricultural Universities, ICAR institutes, commodity boards, NGOs and corporate sector also contribute to extension system. The KVK system conducting technology assessment as one of the major activities, positioned itself between the research and extension systems thus acting both as a feedback and feedforward mechanism. Client system comprises of the ultimate end-user i.e., the farmer. Although, KVK system does assessment and demonstration of new technologies as part of technology development process, some technologies get rejected even at farmer fields. Hence, client system even though being the final actor in technology development process, plays the ultimate decisive role (Venkatasubramanian et al. 2009).

Technology Testing

Crops, animals and their environments are highly complex systems with a multitude of variables that change from location to location in any district of India. Due to this complexity, practices optimised for a research station might not be so successful when transferred to farmer field. Though the new location anywhere in KVK district may appear similar to that of research station, there may be an undefined key limitation or combination of minor but different limitations that constrain potential production. This necessitates for assessment of

technology in microclimatic conditions of the KVK district. Technology Assessment refers to a set of procedures whose purpose is to develop recommendations for a particular agro-climatic situation/ location through assessment of recently released technology through participatory approach. It refers to the process or a set of activities before taking up new scientific information for its dissemination in a new production system.

Identified problems and related available technological options may be discussed at different platforms; i.e., district, agricultural university and zonal level before its testing. Technology assessment is conceptualized as finding out a more profitable and sustainable option than the existing one in a given environment. To find out such an option, one or two new technological options or practices are tested against the farmers practice and the recommended practice.

Concept OFT

On-farm trial (OFT) is the tool for technology assessment and its purpose is testing a new technology or an idea in farmer's fields, under farmers' conditions and management, using farmer's own practice as control. This activity is mainly focused to test developed technologies which might help to solve the most important and widely spread problems of group of farmers in a defined area in a farming system perspective. OFTs are normally planned, managed and evaluated by farmers themselves with facilitative role of KVK scientists through active participation and management. It should help to develop innovations consistent with farmer's circumstances, compatible with the actual farming system and corresponding to farmer's goals and preferences. OFT is not identical to a demonstration plot, which aims at showing farmers a technology of which researchers and extension agents are sure that it works in the area. It should be noted that OFTs are strictly to be conducted in collaborating farmer fields and not in KVK land.

Special features

- The OFT aims to address the problems that are important and faced by a large number of farmers in the area.
- Choice of technological options must be based on various factors prevailing in the farmer's situation to increase the production in selected crops and livestock. Emphasis must be given to test one technology at a time in order to convince farmers on the utility of technological options to solve the problem and to ensure adoption of the technology by the farming community.
- Due importance is to be given to conduct the trials with farmers' perspective, participation, and management in farmers' fields.
- All the essential/required observations have to be recorded in each and every trial. The collected data are to be processed, analysed and documented for drawing recommendations as well as for reference.
- Successful technological options must be up-scaled through frontline demonstrations in successive seasons in the same location as well as in other parts of the district.

- The FLD, training, mass media utilization, etc. are to be used to disseminate the best technologies. Further, feedback information on each technology tested through these trials is to be recorded for further modification or refinement, if any.

Steps Involved in Planning and Conducting of OFT

According to Venkatasubramanian *et al.* (2009), broadly there are five steps involved in the process of OFT. They are problem diagnosis, planning, experimentation, assessment and extrapolation.

1. Problem Diagnosis

The problem diagnosis involves collection and analysis of information by concerned Subject Matter Specialist (SMS) of the KVK to design an OFT. In this step, a study of farmers' circumstances and practices are made in order to understand the farming systems prevailing in the district and system interactions. Identify existing/possible productivity problems and to farmer practice, proven technology options, technology interventions, etc.

Farmers' circumstances include agro-climatic circumstances (Climate and weather conditions; soil & topography; and pests, weeds, diseases etc.) and socio-economic factors of the farmers like credit, markets, income and land holding, farmers' own resources, etc.

KVKS identify the farming systems/ system interactions through the following sources/ methods:

- Secondary data/ sources;
- PRA methods to be exercised by SMS in collaboration with local people;
- Interview with local officials/ opinion leaders;
- Informal farm surveys;
- Farmers' interview using structured/ semi-structured schedules; and
- Field observations.

2. Planning

A technical plan for conducting an OFT is developed. It is based on listing of problems, ranking problems in terms of severity, importance and frequency and identifies causes of problems and list possible solutions to well defined problems and screen possible solutions for feasibility. While identifying the solutions from on-farm trial, one should note that the technology should have various attributes like profitability and compatibility with the existing farming systems, reduces risk, and ease to test the technology by farmers.

3. Experimentation

OFTs are conducted in the fields of representative farmers and to evaluate the selected small numbers of experimental variables in participation with the local people/ farmers. While conducting OFTs, one can explore production problems, test possible solutions, verify recommendations and demonstrate them with farmers.

4. Assessment

The results of OFTs are analysed carefully in terms of performance of technology. The analysis requires assessment of farmers' feedback (farmers' perception about the technology), agronomic interpretation/ feasibility, statistical significance, economic analysis/ profitability and ability to solve the problems-cause and solution developed during diagnosis. The technological attributes (Profitability, Risks, Relative costs, Simplicity, Sustainability, Farmers safety and Farming system compatibility) are considered while assessing the results of OFT compared to the existing local ones (farmer practice).

Data in respect of all field trials including failed trials should be reported. Data are to be collected in collaboration with the participating farmers. If the yield of any particular plot or a group of plots was affected due any problem, reasons for the same should be recorded. Similarly, extent of damage due to abnormal conditions like hailstorm, drought, flood etc. during crop season, should also be recorded very carefully and interpreted appropriately.

The results are assessed based on the above technological attributes and technology may be recommended for FLD directly if found fully suitable for the micro-location of the district. In many cases, the technology after assessment may be found totally unsuitable for the district. then it is not to be recommended for the extension system or for FLDs by KVK itself. But the results have to be communicated to research system without fail.

5. Extrapolation

When KVK is convinced and satisfied with the results/outcome of OFTs, they formulate recommendations for demonstrations (FLD) on a larger area in the farmers' fields so as to popularize the technology amongst farming communities and to provide feedforward to extension system.

The KVKs should ensure that extension agents participate in the OFT and demonstration process (to transfer recommendations to farmers with skills and confidence) and farmers involvement in the demonstration process (to participate effectively in the diffusion of new technologies).

Technology Demonstrations

Successful testing of technology needs to be demonstrated at farmers' field for its wider application in the KVK district. Technology demonstration is the most effective way to show how a thing works, how to do the work, principles involved in an operation and to show the end results of the technology/methodology adopted. According to purpose of demonstration of technology, it can be classified into (i) method demonstration and (ii) result demonstration.

Method Demonstration

Method demonstration is conducted to show how to carry out an entirely new practice or an old practice in a better way to a group. Method demonstration is not concerned with proving the worth of a practice but with how to do something. Ideally, each individual attending the demonstration should have an opportunity to practice the new skill. It helps the learner to obtain practical knowledge about something they need to practice or do in their day-to-day life where

the emphasis is on effectively carrying out a job. It involves seeing, hearing, participation, and practicing in a group which shall stimulate interest and action. It is sometimes used a complementary to result demonstration. Some of the specific purposes for which method demonstration is useful are pesticide spraying, seed treatment, urea molasses treatment of paddy straw, milking operation, silage making, etc.

Result Demonstration

Result demonstration is conducted by a participating farmer on his/her farm under the guidance of an extension agent to prove by the evidence that the practice being demonstrated is superior to the one in existence. This is done by comparing the results of the practice demonstrated with those of the surrounding area so that the farmer may see and judge the results themselves. The result demonstrations are conducted in the farm of selected individual farmers and are utilized to educate and motivate people in their neighbourhood. A result demonstration requires a careful planning, a substantial period of time, proper guidance, time bound operations, adequate records, and organisation of field days at the time of comparison of results. A result demonstration may be short duration, long duration, a single practice, or a package of practices. It creates confidence amongst farmers in the practice demonstrated (Ray 2003). Therefore, in extension education the result demonstration serves as an important tool to convince the farmer about the value of a new idea or innovation that are introduced to them as an option to their existing practice. Unless the farmers see the outcome or results of the recommended practice in comparison with their existing practice with their own eyes and experience, it becomes difficult for the extension agent to make the farmer to adopt the recommended variety or practice. For example, result demonstration for showing an increased yield of a hybrid seed in comparison with a local variety.

Frontline Demonstration (FLD)

The concept of field demonstrations evolved by the Indian Council of Agricultural Research. The field demonstrations conducted under the close supervision of scientists of the National Agriculture Research System (NARS) is called frontline demonstrations because the technologies are demonstrated for the first time by the scientists themselves before being fed into the main extension system of the State department of agriculture, animal husbandry, forestry, etc. The objective is to demonstrate newly released production and protection technologies and their management practices in the farmers' fields under different agro-climatic regions and farming situations. KVKS conduct frontline demonstration only on those technologies suited to their micro location as proved by their own assessment through OFTs.

While demonstrating the technologies in the farmers' field, the scientists are required to study the factors contributing towards higher crop production, field constraints of production and thereby generate production data and feedback information. Frontline demonstrations are conducted in a block of 2-4 hectares land in order to have better impact of the demonstrated technologies on the farmers and field level extension functionaries. For this purpose, technologies of national importance and local relevance are generally selected.

Conclusion

The KVK role lies in providing timely supply of proven technologies specific to various micro-locations of the district thus alleviating the technology fatigue existing in the district. Thus, technology assessment of new and promising technologies is essential. In an OFT, if technology found suitable then it should up-scaled through FLDs and transferred to the main extension system for wider application the district. If the technology is not found suitable to the micro-location then KVK should give feedback to the research system about the failure of the technology in its micro-location for further research.

References

1. ICAR (2014) Report of the High-Power Committee on Management of Krishi Vigyan Kendra (KVK) for Suggesting Measures To Improve Relevance, Efficiency and Guidelines for Implementation. Agricultural Extension Division, Indian Council of Agricultural Research Krishi Anusandhan Bhavan, Pusa, New Delhi-110 012.
2. Ray, G L (2003) Extension Communication and Management. Kalyani Publishers, Ludhiana.
3. Venkatasubramanian, V.; Sajeev, M.V. and Singha, A.K. (2009) Concepts, Approaches and Methodologies for Technology Application and Transfer - A Resource Book for KVKs. Zonal Project Directorate, Zone – III, Indian Council of Agricultural Research, Umiam, Meghalaya-793103.

New Avenues in Marketing of Agricultural Produce

Shiv Raj Singh¹, A.K. Jha², S.M. Feroze³, Rohit Kumar², Bhola Nath²

^{1,2}*Sanjay Gandhi Institute of Dairy Technology, Bihar Animal Sciences University, Patna, Bihar-800014*

³*College of Agriculture, Central Agricultural University, Imphal*

Corresponding author: shivagritech2007@gmail.com

Abstract

India is an agrarian economy where agriculture is the backbone of the country. Despite this, the marketing of agricultural produce in India is still in its nascent stages, with a large number of farmers not able to access the market due to lack of infrastructure, lack of market information, and exploitation by middlemen. To overcome these issues India has implemented various reforms like Agricultural Produce Marketing Committee (APMC) Acts (2002), Foodstuffs Order (2003), State Agricultural Produce Marketing (Development and Regulation) Act (2003), Model APLM Act (2017) and Model Contract Farming Act (2018) to improve the marketing of agricultural produce in the country. Simultaneously, Central and State governments have implemented several programmes and schemes like National Agriculture Market (eNAM), Gramin Agricultural Markets (GrAMs), Agriculture Infrastructure Fund and various schemes of APEDA etc. to support the marketing of agricultural produce. In recent times, there have been several new marketing interventions and models successfully implemented and expended. These initiatives have led to a significant improvement in the marketing of agricultural produce in India. They have provided farmers with more options to sell their produce and have increased their incomes. However, there is still a need to address issues such as linkage of farmer with market, free and fair market regulation, price volatility, access to finance, strengthening of agriculture infrastructure and open trade to further improve the marketing of agricultural produce in India.

Introduction

Agriculture marketing is mainly confined to the domain of state government while central government support through the central sponsor schemes. Since 1950, various Five-year plans focused on the price support system through the Minimum Support Price, development of physical markets and infrastructure (warehousing facility, grading facility, quality testing facility), connecting agriculture markets with road infrastructure, formation and implementation of quality control norms etc. Agricultural marketing plays a pivotal role in promoting and sustaining agricultural production and productivity, leading to food security and inclusive growth of the country. Several internal and external factors played key role in shaping the market reforms. Marketing system improvement needs to be an integral part of any policy and strategy devised for agricultural development. The existing marketing system is the outcome of several years of Government support/ interventions. In India, large number of institutions have been established with a developmental mandate targeted towards one or more areas of agricultural marketing such as procurement, storage and warehousing, credit and cooperative marketing.

India has achieved impressive growth since independence in terms of production of food grains (305 MMT during 2020-21), fruits and vegetables (330 MMT during 2020-21) and production of milk (198.4 million tonnes in 2019-20) (Ministry of Agriculture & Farmers Welfare, 2021). However, marketing infrastructure is age old and it has not strengthened over the years. This is due to government prime focus was to increase the agricultural output and improving food security and not on farmer's income. The changes experienced in the economy and agricultural sectors have made marketing important for overall development of the agriculture and welfare of the farmers. Due to the technological breakthrough, the marketable surplus of crops has become more visible in recent years leading to the requirement to follow a market-oriented approach to agriculture. Indian agricultural has confronted the various changes on the front of production and trade. Farmers are also expected to cultivate as per the requirement of the market because of changes like better income due to economic development, growing population, urbanisation, globalisation and liberalisation and awareness for safe and healthy food among consumers. An efficient market environment is vital to operate under such a situation.

An efficient marketing system minimizes costs and maximizes benefits of different players participating in the food supply chain. It will facilitate farmers in realization of remunerative prices and make good quality food available at reasonable prices to the consumers. It will also ensure optimum margins for different players participating in the supply chain to allow them to continue in the business (Baskar, V.D.C. and Shalendra, 2022). Considering the importance of agriculture, Indian Government is working on a multi-facet strategy to help the farmers to provide efficient marketing system. In recent years Government has introduced various agricultural marketing related reforms like Foodstuffs Order (2002), State Agricultural Produce Marketing (Development and Regulation) Act (2003), National Agriculture Market (2016), Model APLM Act (2017) and Model Contract Farming Act (2018). Along with marketing reforms government has launched various schemes to improve and strengthen the agriculture marketing infrastructure. As a result of these efforts as per latest 77th NSSO (2019) survey report 2/3rd of farmers are selling their agricultural produce in local market and only meagre proportion of farmers are able to sell its produce in APMC market. About 60 per cent of farmers are satisfied with the existing marketing disposal system. These facts stress on the new age agriculture marketing related reforms, policy changes and institutional support.

Background of Agriculture Marketing Reforms

Before attaining Independence, policy focus was on keeping agriculture produce prices lower for the consumers and industry. Market regulation in India started as early 1886 with the establishment of Karanji Cotton Market under the Hyderabad Residency Order. Subsequently the Berar Cotton and Grain Market Act was passed in 1897. Prior to independence the Royal Commission on Agriculture (1928) was constituted to suggest regulations in agriculture and marketing keeping in view the importance of agriculture in Indian economy. Thereafter, Central Banking Enquiry Committee (1931) was constituted in 1931 and the Directorate of Marketing and Inspection was established in 1935 to bring the regulatory mechanism in agriculture marketing (www.agricoop.nic.in).

After post-independence country focus was on augmenting food production and incentivising farmers through remunerative prices, in a fair and transparent manner. States enacted Agriculture Produce Markets Regulation (APMR) Acts during the 60s and 70s, bringing all primary wholesale markets under their ambit i.e. only state governments could set up markets. For each market area, an Agricultural Produce Market Committee (APMC) was constituted to frame and enforce rules. The objective behind setting up of regulated markets was to ensure a fair and transparent environment for agricultural trade and commerce. In 1950, there were 236 regulated markets in India. Today, this number has crossed 6,600. There also exist 22,000+ Rural Periodic Markets, lacking basic amenities & infrastructure.

Recent Agricultural Marketing Reforms

Central and state government has done several reforms on the agricultural marketing reform front; these reforms have come closely on the heels of other agriculture related measures from the government. These reforms together form a part of government's larger mission to support the farmer's income and long term viability of agriculture sector. Each of marketing reform has supported and complemented to the other agriculture related schemes and programmes. The chronology of reforms is presented in the Table 1 as follows:

Table: 1 Chronology of Agriculture Marketing Reforms in India

S. No.	Name of Act/Scheme	Details of Act/Scheme
1	Agricultural Produce Market Regulation Act (APMRA) (During the 60s and 70s)	States enacted Agriculture Produce Markets Regulation (APMR) Acts during the 60s and 70s, bringing all primary wholesale markets under their ambit. Only State Governments could set up markets.
2	Agricultural Produce Marketing Committee (APMC) Acts (2002)	Inter-Ministerial Task Force on Agricultural Marketing Reforms (2002) recommended that the APMC Acts be amended to allow for direct marketing and the establishment of agricultural markets in the private and cooperative sectors.
3	Foodstuffs Order, 2002 and 2003	In response to the changes in trading environment during 1990s, the union government brought a series of reforms in quick succession, beginning from 2002. These included the Removal of (Licensing Requirements, Stock Limits and Movement Restrictions) on Specified Foodstuffs Order, 2002 and 2003. As per this order, wheat, paddy/rice, coarse grains, sugar, edible oilseeds and edible oils, pulses, gur, wheat products and hydrogenated vegetable oil or vanaspati were removed from the list of Essential Commodities Act (1955) and thereafter, a permit or licence was not required for their trading, storage and movement.

4	State Agricultural Produce Marketing (Development and Regulation) Act, (2003)	<p>The SAPM Act:</p> <ul style="list-style-type: none"> (a). allows direct sale of farm produce through contract farming sponsors; (b). allows for setting up “special markets” for “specified agricultural commodities” – mostly perishables; (c). permits private persons, farmers and consumers to establish new markets for agricultural produce in any area; (d). requires a single levy of market fee on the sale of notified agricultural commodities in any market area; (e). replaces licensing with registrations of market functionaries which would allow them to operate in one or more different market areas; (f). allows to establish the consumers’ and farmers’ markets to facilitate direct sale of agricultural produce to consumers; and (g). provides for the creation of marketing infrastructure from the revenue earned by the APMC. <p>The desired reforms in the erstwhile APMR Acts, to induce commensurate private investment in agricultural marketing. However, many States carried out partial reforms only, on a pick-and-choose basis, thereby defeating the objective of creating a uniform trade environment across the country.</p>
5	National Agriculture Market (e-NAM) (2016)	<p>The main objectives of the Scheme are as follows:</p> <ul style="list-style-type: none"> (a). to integrate markets first at the level of the States and eventually across the country through a common online market platform; (b). to streamline marketing/transaction procedures and make them uniform across all markets to promote efficient functioning of the markets; (c). to promote better marketing opportunities for farmers/ sellers through online access to more buyers/markets, removal of information asymmetry, better and real-time price discovery, transparency in auction process, prices commensurate with quality of produce, online payment etc. that contribute to marketing efficiency; (d). to establish quality assaying systems for quality assurance to promote informed bidding by buyers; and (e). to promote stable prices and availability of quality produce.

6	Model APLM Act, 2017	<p>The purpose of the Model APLM Act is to create a single agriculture market with a single license.</p> <p>Important objectives of the Law:</p> <ul style="list-style-type: none"> (a). The new model law suggests to set up a regulated wholesale agri-market at a distance of every 80 km. (b). Farmers and traders will be able to transact all such regulated agri-market within the state. (c). The greatest extent of a market fee is not more than 1% for fruits and vegetables and 2% for food grain. Commission agents' fee can go up to 2% for non-perishables and 4% for perishables. (d). Single license for trading within the State and at the National level. (e). It also has the provision to promote online or spot (e-national agriculture market) agriculture market platforms.
7	Model Contract Farming Act, 2018	<p>The Model Contract Farming Act, 2018 is aimed at regulating contract farming agreements between farmers and agri-business firms, processors and exporters. The act seeks to establish a legal framework to protect the interests of both farmers and buyers by ensuring transparency in the contract farming process, fair and remunerative prices to the farmers, and timely payment for the produce.</p> <p>Key features of the Model Contract Farming Act, 2018 include the following:</p> <ul style="list-style-type: none"> (a). Contract farming agreements will be voluntary and entered into in writing. (b). The agreement must specify the minimum guaranteed price, quality, quantity, and delivery schedule of the produce. (c). The contract will be for a pre-agreed period and cannot exceed the crop cycle. (d). The agreement must specify the liability of the buyer in case of default in payment. (e). The act suggests the government to notify the "Dispute Settlement Authority" and it resolve the dispute democratically by majority present. (f). The act suggested to states to establish the "Contract Farming and Services (Promotion & Facilitation) Board" for promotion of contract farming in state. Board to ensure proper implementation of this Act and to make suggestions to the State/UT for promotion and efficient performance of contract farming, service contract and such other contracts.

8	Gramin Agricultural Markets (2018-19)	<p>Gramin Agricultural Markets (GrAMs) is the ambitious programme to develop and upgrade 22,000 rural haats.</p> <p>Important objectives of the scheme are as follows:</p> <ul style="list-style-type: none"> (a). Farmers to transact sales with consumers at near-farm locations. (b). These market act as a primary aggregation/pooling/assembly centres of farm produce, to facilitate the onwards movement to other market destinations.
9	Agriculture Infrastructure Fund (2020)	<p>The scheme shall provide a medium - long term debt financing facility for investment in viable projects for post-harvest management Infrastructure and community farming assets through interest subvention and financial support.</p> <p>Important features of the scheme are as follows:</p> <ul style="list-style-type: none"> (a). All loans under this financing facility will have interest subvention of 3% per annum up to a limit of Rs. 2 crore. This subvention will be available for a maximum period of seven years. (b). Further, credit guarantee coverage will be available for eligible borrowers from this financing facility under Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) scheme for a loan up to Rs. 2 crore. The fee for this coverage will be paid by the Government. (c). In case of FPOs the credit guarantee may be availed from the facility created under FPO promotion scheme of Department of Agriculture, Cooperation & Farmers Welfare (DACPFW). (d). Moratorium for repayment under this financing facility may vary subject to minimum of 6 months and maximum of 2 years.

Successful Agriculture Marketing Avenues/ Models

(A). Direct Marketing:

Direct marketing is also known as farmer's markets. These channels are mostly adopted in the highly perishable agricultural produces. Farmers market were introduced with the aim to overcome the middlemen, so that they can sell their produce directly to the consumers at reasonable rates. In direct marketing farmers share in consumer rupee is high. Generally, direct marketing functioning under the guidance of the Agricultural Produce Market Committees. More than 16 states have introduced provision of direct marketing and markets under private/cooperative sectors. As an outcome of these initiatives, more than 50 private markets have been established/ licenses issued (dmi.gov.in). To promote direct sales to consumers, farmers' markets have been started in the following forms:

S. No.	Name of Direct Marketing Model	Important features of Direct Marketing Model
1	<i>Apni Mandi</i>	<ul style="list-style-type: none"> First <i>Apni Mandi</i> was established in 1987 in Punjab. It is also called '<i>Kisan Mandi</i>', as it is different from the traditional mandi or market yard. Currently working in Punjab, Haryana and Rajasthan. In <i>Apni Mandis</i> areas, the APMC has given the responsibility to provide all necessary facilities such as space, water, and weighing balances etc. The price spread in <i>Apni Mandi</i> is considerable low. These are working satisfactorily in the case of fruits and vegetables.
2	<i>Rythu Bazars</i>	<ul style="list-style-type: none"> Established on January 26, 1999 in Andhra Pradesh. Presently 95 <i>Rythu bazaars</i> are operating in all the 23 districts of the state. Each day's prices are fixed jointly by a committee of farmers and the Estate Officer. Generally, prices in <i>Rythu Bazars</i> are 25 per cent less than the local retail price and 25 percent above the wholesale rates. The maintenance expenditure of <i>Rythu Bazars</i> is being met from financial sources of APMC nearer to the <i>Rythu Bazars</i>. Fresh vegetable and fruits are major agriculture produce traded in <i>Rythu Bazars</i>.
3	<i>Uzhavar Sandies</i>	<ul style="list-style-type: none"> Established on 31st March 2001 in Tamil Nadu. The price of the vegetables is fixed in each day by a committee including Marketing Committee and Farmers Committee. In these markets, farmers enjoy better marketing infrastructure free of cost and also receive considerably high prices for the products. Farmers also get good quality seeds and other inputs in the market yard itself.
4	<i>Krushak Bazaars</i>	<ul style="list-style-type: none"> Established on 2000-01 in Orissa. Identified farmers are supplied with some required inputs for vegetable production also the storage facilities are provided. The price is determined taking whole sale price and retail market price of different products in the respective markets.

5	<i>Shetkari Bazar</i>	<ul style="list-style-type: none"> • <i>Shetkari bazaars</i> were established in the Maharashtra for marketing of fruits and vegetables. • This links producers and consumers directly, reduce price spread, and enhance producer share's in consumer rupee. • Thus these markets increase the farm income, wellbeing of the farmers and bring stability in prices of horticultural crops. • Direct market model with forward linkages. • Linking farmers to <i>Rythu Bazaars</i>.
6	Mother Dairy Booths	<ul style="list-style-type: none"> • Established on 1989 in New Delhi. • Mother Dairy, basically handling milk in Delhi, was asked to try its hand in retail vegetable marketing by direct purchasing vegetables from the farmers. • Mother Dairy moving vegetables in specially built vehicles, storing them in air conditioned godowns and distribute them to the consumers through its retail outlets in 1989 after the notorious onion and potato price crisis.
7	Vegetable and Fruit Promotion Council, Keralam (VFPCK)	<ul style="list-style-type: none"> • Established in 2001 in Kerala for marketing of vegetables and fruits. • The markets are organized and run by the farmers. • The VFPCK has established 300 plus Swasraya Karshaka Sangam (SKS), each of which has 15-20 SHG of farmers under them. • VFPCK-SKS-SHG model. • Farmers bring their produce to the SKS markets, where it is auctioned.
8	Safal Market	<ul style="list-style-type: none"> • Safal started in 1988. • Safal market (Delhi) is a move by NDDB to introduce a transparent and efficient platform for marketing of fruits and vegetables by connecting farmers to the marketing through growers association. • The NDDB started a unit of SAFAL at Delhi as a fruits and vegetables retail chain. • Later, NDDB established an alternative system of wholesale market for fruits & vegetables at Bangalore.
9	<i>Mahagrapes</i>	<ul style="list-style-type: none"> • Established in 1991 in Maharashtra. • It is having the characteristics of both a cooperative and a private sector. • The role of <i>Mahagrapes</i> as it is working to bring farmers on a single marketing platform which helps fetch better prices for their produce.

(B). Farmers Producer Organization

The idea of group marketing was operationalized in the case of milk by late V. Kurien in 1970s. Later in 2001, he extended the idea and conceptualized Farmer Producer Companies. In 2002, a Producer Companies Act was enacted. Later in 2013, policy and process guidelines for FPOs were framed by the Union Ministry of Agriculture and Farmers Welfare to enable cooperatives to convert themselves to companies. However, the real push from the Government came in the 12th five-year plan (2012-2017), when SFAC was mandated for promotion of FPCs and FPOs. With a clear plan and committed resources, the government has started a new dedicated Central Sector Scheme called “Formation and Promotion of Farmer Producer Organizations” with the goal of forming and promoting 10,000 new FPOs.

(C). e-National Agriculture Market

National Agriculture Market (eNAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. Small Farmers Agribusiness Consortium is the lead agency for implementing e-NAM under the aegis of Ministry of Agriculture and Farmers' Welfare, Government of India.

The vision of eNAM is to promote uniformity in agriculture marketing by streamlining of procedures across the integrated markets, removing information asymmetry between buyers and sellers and promoting real time price discovery based on actual demand and supply.

Why e-NAM is required?

- State governments oversee the commercialization of agricultural products.
- The agricultural markets are now fragmented, with each state acting as a distinct market due to a lack of compatibility and uniformity.
- Multiple market zones are further separated within each state. A separate APMC, which imposes its own marketing regulations, will manage these distinct territories that have been created.
- Increased prices for consumers without comparable benefits for farmers are the result of various handlings of agricultural produce and multiple levels of mandi fees.
- e-NAM addresses these issues by establishing a single market via an online trading platform at the state and federal levels.

(D). e-marketing:

Electronic Marketing (e-marketing) commonly referred to as Internet Marketing, Web Marketing, Digital Marketing, or Online Marketing. e-marketing is the practice of advertising a good or service online in order to reach the target market through gadgets, social media, etc. e-marketing is a component of integrated marketing communications (IMC), which aids in a brand's expansion across many media channels, just like many other media channels. e-marketing is becoming a key component of the marketing strategies used by businesses that use various digital media channels. Successful e-marketing models are e-Choupal, e-NAM, Kisan Rath etc.

Way Forward to Improve the Marketing of Agricultural Produce

1. Linking Farmers

Linkage of small and marginal landholding farmers with markets is one of the major issues in improving livelihoods. Linking farmers to market is a long term strategy to enhance income and ensure wellbeing of farmers. Farmers collectively can be organised in various institutional mechanism like FPO, Joint Liability Group, cooperative, SHG, etc.

2. Improving Infrastructure:

Poor transport, lack of infrastructure and marketing facilities creates the hindrance in getting good prices. The monopolistic systems encouraged by APMCs are also a hindrance. Infrastructure plays a vital role in agriculture at every single step like for the supply of input, sowing of crops and for the post-harvest management. Planned investment in agriculture infrastructure sector is important to enhance the productivity and to reduce the post-harvest losses this will also result in capacity building and higher income generation.

3. Storage Facilities:

In India modern storage structures are very limited; they are too expensive for individual farmers and government has not invested in them. Storage infrastructure such as warehouses and cold storages help save the harvested crops. Many farmers resort to distress sale of their produce to clear the loans from moneylenders. Storage facilities, even at the government-owned FCI, are lacking.

A network of rural storage centres should be built on a priority basis in order to prevent distress sales, wastage and loss arising out of inadequate and defective storage facilities. Storage structure should be built on various arrangements like public private partnership, build- operate-transfer basis, private warehouses etc.

4. Direct Sales:

Direct sale in agriculture has become increasingly popular in recent years as alternative to the traditional marketing system. By eliminating intermediaries, farmers can earn higher prices for their products, while consumers can purchase fresher and healthier foods at lower prices. Direct sales help bring the produce close to the customer. Some farmers are able to bring their produce at a highway and sell through makeshift stalls to passing vehicles. Direct sale in agriculture can be a viable and sustainable business model for small-scale farmers looking to sell their products locally.

5. Transportation:

Agriculture is a critical sector in India, and transportation plays a crucial role in its success. Due to lack of proper handling facilities at the village level, about 7 percent of food-grains, 30 percent of fruits and vegetables and 10 percent of spices are lost before reaching the market. India is the world's second-largest producer of agricultural products, and transportation is essential for the movement of agricultural produce to markets and processing centers. By improving transportation infrastructure for agriculture produce, farmers can access new markets and increase their profits, while consumers can enjoy fresher produce at lower prices. The use of

technology and logistics can help optimize transportation routes, reduce transportation costs, and improve efficiency. This includes using GPS tracking, real-time monitoring, and data analytics to make informed decisions about transportation.

6. Access to Finance:

Access to finance is crucial for farmers in India as it can help them to increase their productivity, income, and overall standard of living. The farmer is always under pressure to sell stocks to meet his burden of debt. Farmers lack of access to formal channels of finance in many parts of the country. Crops are not considered a financial asset against which farmers can take loans. Low-cost warehousing and negotiable receipts with an electronic registry for commodities can bring lenders closer to the farmers keen to pledge their crops.

7. Price Information:

Agricultural produce price information is crucial for the functioning of the agriculture sector in India. It helps farmers and traders make informed decisions about production, marketing, and sales of their crops. In recent years, several online platforms have emerged that provide agricultural produce price information. These platforms collect real-time data on prices from different markets and provide it to farmers and traders through mobile applications or websites. Some popular online platforms in India include AGMARKNET, Agri Bazaar and Krishi Network.

8. Food Processing Facilities:

A well-developed food processing industry increases farm gate prices, reduces wastages and ensures value addition. It assists farmers in getting knowhow from factories and promotes crop diversification. However, unless government rationalizes food laws, sets up the mega food parks and encourages foreign investment, facilities for food production are unlikely to come up in a big way. Integrated facilities for procurement, processing, storage and transport complement the food processing industry. Private sector and foreign investments can play a role and for that the government must allow 100 percent FDI in food processing, cold chain infrastructure and retail.

9. Free Trade and an Open Market:

There is an urgent need to open up the agricultural sector by encouraging free trade and an open market. Government intervention creates distortions, cartelization and inaccessibility. Moreover, even the most efficient farm will fail to produce profits if the harvest cannot be sold at the best possible price in a timely manner. That is why, only free trade will promote investment in better quality, crop diversification and packaging.

References

1. Baskar, V.D.C. and Shalendra (2022). Agricultural Marketing in India - Reforms for a Liberal and Competitive System. Hyderabad: National Institute of Agricultural Extension Management (MANAGE) & Rani Lakshmi Bai Central Agricultural University, Jhansi (Uttar Pradesh).
2. Chand Ramesh (2017). Doubling Farmers Income – Rational, Strategy, Prospects and Action Plan. NITI Policy Paper No. 1/2017. National Institute of Transforming India, Government of India.
3. Ministry of Agriculture and Farmers welfare (2021). Second Advance Estimates of Principal Crops. New Delhi.

Role of FPO in Enhancing Farmer's Income

Preeti Mamgai¹, H.K. Mavi² and Gurupdesh Kaur³

¹ICAR-Agricultural Technology Application Research Institute, Ludhiana-141004, Punjab

² Punjab Agricultural University, Ludhiana-141004, Punjab

³Krishi Vigyan Kendra, Patiala

Corresponding author: preetignauriyal@gmail.com

Abstract

Farmer Producer Organisations are presumed as a tool to organize and formalize the Indian farmers. In it farmers work together in cooperation with other farmers in sharing inputs and selling output so that their remunerative income can be improved and no one remains deprived. With a concept of doubling of farmers' income in the country, GOI launched the Central Sector Scheme of "Formation and Promotion of 10,000 Farmer Producer Organizations (FPOs)" to form and promote 10,000 new FPOs. FPO helps in the overall development of the individual farmers and the organizations under a single unified system/organisation. The production, post-harvest practices like storage, grading, packing, processing, transportation, import, export, etc can be taken under the best care of the FPO. It helps in enhancing farmers' income and improve their social conditions of farming community by providing better services, market and improving focus from the farm to non-farm level in achieving the objective of doubling farmers income.

Introduction

In India, nutritional and food security is as much important as farmers' income security. Although India has been able to achieve the objective of food security but nutritional along with farmers' income security is remained a challenge. As in India, the main challenges faced by the agricultural sector are small and fragmented land holdings, low growth rate, climate change, marketing of produce, sustaining investment, rising wages and scarcity in agricultural labour, lack of mechanisation, inadequate storage facilities, the inadequacy of institutions and lack of diversification. The majority of farmers have livelihood sustainability through small farm sizes of less than 0.5 hectares resulted in small produce where small farmers are not being able to get the benefit of economies of scale. Smallholders are especially vulnerable to climate change-aggravated weather. And they continue to suffer from market uncertainties as most agricultural policies (and institutional support) tend to favor large farmers and agricultural or food corporations, e.g., the industrial sector. These small farmers face many agricultural marketing constraints like small marketable surplus, presence of a large number of intermediaries, long & multiple marketing channels, inadequate transport facilities, improper warehouse system, lack of standardization and grading and lack of market information resulting in lower farm income. Farmers' income persisted low in relation to the income of those working in the non farm sector. In India, farmers are committing suicides because of low farm income, losses in farming and credit burdens. Farmers especially the younger generation are leaving farming due to low farm income. This kind of practice will put a negative effect on future agriculture

resulting in food insecurity. Hence, for farmers' welfare, doubling of farmers' income and parity among income of farmers and non-farm workers is the need of the hour (Chand, 2017).

For enhancing and securing farmers' income Government of India launched the Doubling of Farmer's income programme. In this programme, it was observed that for nutritional security along with income enhancement, according to agro-climatic conditions of the states, the area should be shifted from cereal crops to high-value crops like horticultural crops, pulses, etc. (GOI, 2018).

Along with this, farmers are organizing their own support system including extension delivery through forming their own organization to access information, advice and support on production and marketing. With this, they can ensure better income for the producers through an organization of their own. They will also have better bargaining power vis-à-vis the bulk buyers of produce and bulk suppliers of inputs. There is a relevant need to move beyond production activities and find ways to establish market linkages. Presently, an agripreneur has to contend not only with fellow farmers but also with big corporations. Primary producers' organizations (POs) are the only institutions that can protect small farmers from ill-effects of globalization or make them participate successfully in modern competitive markets (Dharni, 2019). Producer Organization (PO) is a legal entity formed by primary producers, viz. farmers, milk producers, fishermen, weavers, rural artisans, craftsmen. PO can be a producer company, a cooperative society or any other legal form which provides for sharing of profits/benefits among the members. The one type of PO where the members are farmers. Organization is a group of farmers with special interests and concerns with for its members and with a set of byelaws and rules. Producers' organizations not only help farmers buy or sell better due to scale benefits but also lower transaction costs for sellers and buyers, besides providing technical help in production and creating social capital (Trebbin and Hassler, 2012). Mobilizing farmers into groups of between 15-20 members at the village level (called Farmer Interest Groups or FIGs) and building up their associations to an appropriate federating point i.e. Farmer Producer Organizations (FPOs). In year 2021, the Government of India with the objectives to improve productivity by efficient, cost-effective and sustainable resource use for guaranteeing maintainable income-oriented farming, which can help farmers' to reduce production cost and increase earning to move forward for doubling the income of farmers, had launched the Central Sector Scheme of "Formation and Promotion of 10,000 Farmer Producer Organisations (FPOs)" to form and promote 10,000 new FPOs.

FPOs help in enhancing farmers' income in many ways. It is as stated below:

- With the help of FPO, good quality production inputs such as fertilizers, seeds, pesticides, herbicides, etc. can be supplied at reasonable wholesale prices which helps in the reduction in the cost of production.
- FPOs also make available machinery and equipment such as a cultivator, tiller, harvester, etc. which is required at the time of production or after production of the crops on a custom hiring basis for members helping in reducing per unit production cost.

- It also provides value-added facilities such as cleaning, sorting, grading, packing and processing facilities at a reasonably cheaper rate.
- FPOs help in providing storage and transportation and loading/ unloading facilities on a shared basis which help in the marketing of the produce.
- FPOs commence those activities which can generate higher income as seed production, beekeeping, mushroom cultivation, etc.
- It helps member farmers of the organization to aggregate their small lots and make them more marketable by adding value.
- It assists farmer members with the latest market information so that they can make production and marketing decisions accordingly.
- To get better and remunerative prices, FPOs help the member farmers in aggregating their produce so that they can negotiate with the consumers/buyers.
- FPO tries to collect multiple products from several farmers and sells those products under one roof. With this action, everybody will get some amount of revenue, and nobody is underprivileged.

The government is making arrangements to give proper training to the FPOs to strengthen them with knowledge, resources, and facilities. With support and guidance, an FPO and its members especially primary producers can be saved under the hands of intermediaries. With regular updates, FPO can set future goals to continuously improve living standards and farmers' income.

References:

1. Chand, R. 2017. Doubling Farmers Income: rationale, strategy, prospectus and action plan, NITI policy paper no 1/2017, NITI aayog, Government of India, New Delhi.
2. Dharni Khushdeep. 2019. Farmer Producer Organization (FPO): A Tool for Farmers' Prosperity. *Progressive Farming*, June, pp 27-28.
3. GOI 2018. Report of the Committee for Doubling Farmers' Income Volume VIII "Production Enhancement through Productivity Gains" prepared by the Committee for Doubling Farmers' Income, Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare., Government of India.
4. Trebbin, A and M Hassler. 2012. Farmers' producer companies in India: a new concept for collective action? *Environment and Planning A*, 44, 411-427.

Role of Food Safety and Quality Assurance in Food System

Anuradha Kumari

College of Dairy Science and Technology, Guru Angad Dev Veterinary and Animal sciences University,

Ludhiana

Corresponding author: anu.ndri@gmail.com

Abstract

Quality of life depends on the quality of food we take. The quality for any food system or service is defined as the totality of features and characteristics of a product or a service that bear on its ability to satisfy stated and implied needs. Food safety and quality assurance play a crucial role in the overall food system. They ensure that food is safe for consumption and meets certain quality standards throughout the entire supply chain, from production to consumption. In India, mainly legal standards and quality standards govern the sale of foods including milk and milk products. These includes Prevention in Food Adulteration act (PFA), Agmark, Bureau of Indian Standards (BIS) are the quality standards. FSSAI is also mandatory standard in India. Any food business operator (FBO) in India must do the FSSAI registration or apply for FSSAI license which depends on the capacity of that business. Overall, food safety and quality assurance are essential components of the food system, contributing to the protection of public health, regulatory compliance, risk management, traceability, brand protection, continuous improvement, and international trade. By prioritizing these aspects, businesses can establish consumer confidence, maintain market competitiveness, and promote the overall well-being of individuals consuming their products.

Introduction

The Food Safety and Standard Authority (FSSA) 2006 defines food as: "any substance, whether processed, partially processed or unprocessed, which is intended for human consumption and includes primary foods, genetically modified or engineered food or food containing such ingredients, infant food, packaged drinking water, alcoholic drink, chewing gum and any substance, including water used into food during its manufacture, preparation or treatment, but does not include any animal feed, live animals unless they are prepared or processed for placing on the market for human consumption, plants, prior to harvesting, drugs and medicinal products, cosmetics, narcotics or psychotropic drugs". Food is the main determinant of health, productivity and nutritional status of the population. So, the food we consume should be safe. The quality of life is dependent on the quality of food we take in our day-to-day life. The quality is the amalgamation of the characteristics that have significance in determining the degree of acceptability of the product by the consumer. ISO:8402:1994 defines quality as totality of features and characteristics of a product or a service that bear on its ability to satisfy stated and implied needs. In respect of food products quality is defined in terms of various parameters like sensory, physical, chemical, textural, microbiological, biochemical and nutritional.

Quality Control:

Quality Control is a process or a set of procedures followed by a company, in order to assure that the product meets the set standards and requirements. A system of maintaining standards

in manufactured products by testing a sample of output against specification. It ensures that products are within the well-defined and accepted standards thereby protecting the legal and health rights of consumers and financial interests of producers / manufacturers. It mainly focuses on product.

The process of quality control varies according to the industry

Ex: *Garment industry* - quality control of designs, specifications and needs of the consumer.

Food factory - health and hygiene aspects of the consumer,

Quality Assurance

Set of activities which ensures that the quality levels of products and services are properly maintained and that the supplier and customer quality issues are properly resolved. Quality assurance is a way of preventing mistakes and defects in manufactured products and avoiding problems. It mainly focusses on process and control over the quality of raw materials, control over the process at different levels and control over distribution set up etc.

National regulations

In India, we have mostly two types of standards, which govern the sale of foods including milk and milk products i.e. Legal standards and Quality standards

Legal standards

Requirements which pertain to the law of the Government and set up by the Government to meet certain minimum requirement in terms of chemical quality, bacteriological quality, and labeling and packaging requirements. Legal standards are compulsory

Quality standards

Means those specifications which are laid down by the Govt. or some expert body constituted by the Govt. for the purpose of producing high quality products. Quality standards are not compulsory. They are on voluntary basis.



Prevention of Food Adulteration Act

PFA Act passed in 1954 and framed in 1955 to protect consumer against inferior quality adulterated food. PFA standards are formulated and revised by an expert body called Central Committee for Food standards (CCFS).

Objective:

- To protect public from harmful and poisonous food
- To prevent the sale of substandard food containing harmful substances
- To protect society against unscrupulous and anti-social dealers

Agmark



Certifying agency : Directorate of Marketing and Inspection, Government of India

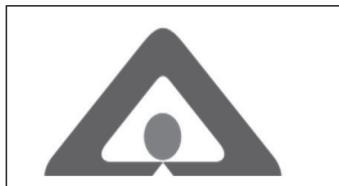
Effective : since 1937, 1986 (amended)

Product category : Agricultural products

Agmark stands for "Agricultural Marking". Coined by joining the words 'Ag' to mean agriculture and 'mark' for a certification mark. In order to have a systematic marketing of Agricultural Produce on the basis of well-defined quality, Indian Legislature in 1937 passed an act known as Agriculture Produce (Grading and Marking) Act, 1937. It is not mandatory. Grading of Agricultural items under these rules is called AGMARK GRADING or Agmark certification. It covers quality guidelines for 205 different commodities. Ex- Cereals, oil seeds, oils, creamery butter, ghee, honey, legumes, eggs etc. It categorizes products into various grades such as, special, good, fair, ordinary etc. depending upon the degree of quality (type of composition) in each case.



Bureau of Indian Standards



Formed : 23 December 1986

Headquarters: Manak Bhawan , New Delhi

Agency executive : Director General

Parent agency : Ministry of Consumer Affairs, Food and Public Distribution

Formulating National Standards for various types of articles (both edible & non-edible) i.e. food & non-food articles e.g. livestock feed, cattle housing, equipments, dairy products. The old name of this organization was ISI (*Indian Standards Institution*). The new name i.e. BIS came into existence from 1st April, 1987 under the BIS Act 1986.

Objectives and Functions

- To formulate Indian standards for various articles, processes, methods of test, codes of practices etc and promote their implementation
- To promote the Concepts of standardization and Quality control in industries
- To coordinate the efforts of producers and users for making improvements in the materials, products, processes and methods
- To operate ISI certification scheme
- To operate laboratory recognition scheme to meet the requirements of testing
- To offer technical and consultancy services within and outside the country
- To have cooperation and coordination with international standard making bodies like ISO
- To establish testing laboratories of its own

FSSAI (Food Safety and Standard Authority of India)

FSSAI stands for “Food Safety and Standard Authority of India”. It is a statutory body under the Ministry of health and family welfare, the Government of India. The FSSAI was established under the Food Safety and Standards Act, of 2006. The FSSAI aims to protect and promote public health with proper regulations and supervision on food safety.

The Food Safety and Standards Authority of India (FSSAI) has been created for laying down science-based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption. the Govt. of India has enacted new food laws known as —The Food Safety and Standards Act, 2006. This Act was passed on 23rd August, 2006. It extends to the whole of India. However, the Act came into force only recently in 2011. The FSSAI is in charge of

establishing food standards so that traders, consumers, producers, and investors all have to deal with the same organization.

Prevention of Food Adulteration Act, 1954
 Fruit Products Order , 1955
 Meat Food Products Order , 1973
 Vegetable Oil Products (Control) Order, 1947
 Edible Oils Packaging (Regulation) Order 1988
 Solvent Extracted Oil, De- Oiled Meal and
 Edible Flour (Control) Order, 1967
 Milk and Milk Products Order, 1992

All these acts repealed after
 commencement of FSS
 Act, 2006

The act aimed to create a single reference point for all matters related to food safety and standards. Ministry of Health & Family Welfare, Government of India is the Administrative Ministry for the implementation of FSSAI. The Chairperson and Chief Executive Officer of Food Safety and Standards Authority of India (FSSAI) have already been appointed by Government of India. The head office is

Role of FSSAI

The main role of Authority is to regulate and monitor, manufacture, processing, distribution, sale and import of food while ensuring safe and wholesome food to the consumers. The Act lays down the following main function for discharge by the Authority.

- (a) Prescribing the Standards & Guidelines in relation to food and specified appropriate system for enforcement.
- (b) Specifying limits for Additives, Contaminants, Pesticides & Veterinary Drug Residues, Heavy Metals, Processing Aids, Mycotoxins, Antibiotics and Pharmacological active substances and Irradiated Foods.
- (c) Lay down food labelling standards including claims on health, nutrition, special dietary uses and food category system for foods.
- (d) Lay down methods of sampling, analysis and exchange of information among enforcement agencies prescribing procedures and guidelines for accreditation of certification bodies and laboratories.
- (e) Taking up, summarizing and analyzing relevant scientific and technical data on incidence and prevalence of biological or emerging risk, residues of various contaminants, introduction of rapid alert system among others
- (f) Prescribing the procedure, and the enforcement of quality control in relation to any imported article of food in to India
- (g) Creating an information network across the country to disseminate rapid reliable and objective information about food safety and issues of concern.
- (h) Providing Training Programs for persons who are involved or intent to get involved in food businesses

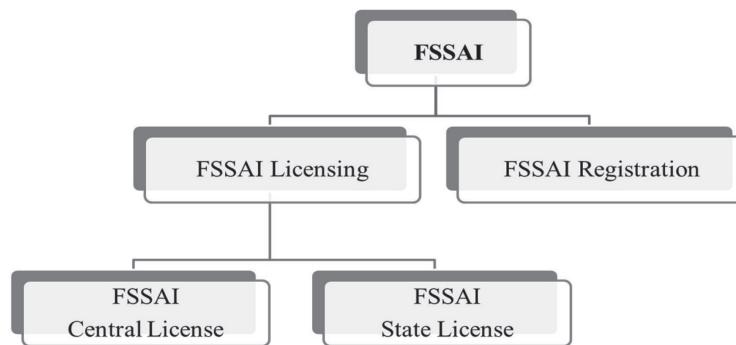
- (1) Promoting general awareness about food safety and food standards and promoting coordination of work on food standards undertaken by International Governmental and Non-Governmental Organization

Food categories

1. Dairy products and analogues
2. Fats and oils, and fat emulsions
3. Edible ices, including sorbet
4. Fruits and vegetables (including mushrooms and fungi, roots and tubers, fresh pulses and legumes, and aloe Vera), seaweeds, and nuts and seeds
5. Confectionery
6. Cereals and cereal products, derived from cereal grains, from roots and tubers, pulses, legumes (fresh pulses and legumes are covered in category 4.2) and pith or soft core of palm tree, excluding bakery wares of food category 07.0.
7. Bakery products
8. Meat and meat products, including poultry and game
9. Fish and fish products, including molluscs, crustaceans, echinoderms
10. Eggs and egg products
11. Sweeteners, including honey
12. Salts, spices, soups, sauces, salads and protein products.
13. Foodstuffs intended for particular nutritional uses.
14. Beverages, excluding dairy products
15. Ready-to-eat savouries
16. Prepared Foods/dishes including Composite foods
17. Products not covered into category 1-16
18. Substances added to food which are 'not for direct consumption food'

FSSAI Licensing and Registration

FSSAI Licensing is mandatory to start any food business in India.



Registration required for the Food Business Operator, who :-

- A. Manufactures or sells any article of food himself or a petty retailer, hawker, itinerant vendor or temporary stall holder; or
- B. Such food business including small scale or cottage or tiny food businesses with an annual turnover not exceeding Rs 12 lakhs and or whose-
 - Production capacity of food (other than milk and milk products and meat and meat products) does not exceed 100 kg/ltr per day or
 - Production or procurement or collection of milk is up to 500 litres of milk per day or
 - Slaughtering capacity is 2 large animals or 10 small animals or 50 poultry birds per day or less than that

State License required for the Food Business Operator, who –

1. Dairy units including milk chilling units process less than 50 thousand litres of liquid milk/day or 2500 MT of milk solid per annum.
2. Vegetable oil processing units having installed capacity less than 2 MT per day.
3. All slaughter houses equipped to slaughter less than 50 large animals or 150 or more small animals or up to 1000 poultry birds per day
4. Meat processing units equipped to handle or process less than 500 kg of meat per day or 150 MT per annum
5. All food processing units other than mentioned above having installed capacity less than 2 MT/day.

Central License required for the Food Business Operator, who –

1. Dairy units including milk chilling units process more than 50 thousand litres of liquid milk/day or 2500 MT of milk solid per annum.
2. Vegetable oil processing units having installed capacity more than 2 MT per day.
3. All slaughter houses equipped to slaughter more than 50 large animals or 150 or more small animals or 1000 or more poultry birds per day
4. Meat processing units equipped to handle or process more than 500 kg of meat per day or 150 MT per annum
5. All food processing units other than mentioned above having installed capacity more than 2 MT/day.
6. 100 % Export Oriented Units
7. All Importers importing food items for commercial use.
8. All Food Business Operators manufacturing any article of Food which does not fall under any of the food categories prescribed under these regulations or deviates in any way from the prescribed specification for additives therein.
9. Retail chains operating in three or more states.

10. Food catering services in establishments and units under Central government Agencies like Railways, Air and airport, Seaport, Defence etc.

REGISTRATION OR LICENSING FOR DAIRY UNIT



Documents for Registration process for small scale Dairy

1. Photo of Food Business Operator
2. Document for Identity Proof like Voter ID Card, PAN Card, Aadhar Card etc.
3. Location proof of premises

Process to apply for license/ Registration

Go to FoSCos site <https://foscos.fssai.gov.in/> and click on here to FoSCos box.

The screenshot shows the FoSCoS website interface. At the top, there are logos for FSSAI, FoSCoS, and Eat Right India. Below the header, a banner says 'Apply for New License/Registration'. Underneath, a question asks 'Where is the premise of operation?' with three options: 'General', 'Railway Station', and 'Airport/Seaport'.

MULTIDISCIPLINARY PORTRAIT OF AGRICULTURE: CONCEPT & PRACTICES

foscos.fssai.gov.in/public/fbo/open-eligibility/N

G 🔍 ⭐


FoSCoS
Food Safety Compliance System


Home | About FoSCoS | FSSAI | User Manual | [Login-Businesses](#) | [Login-Authorities](#)

Select the state where premises is located for which License/Registration will be obtained. [Select State](#)

Note: Each location will be issued separate license (except transporter where one license will be issued for all vehicle of a single transporter/ business). In case FBO is having premise/unit located in more than one state, FBO has to declare one premise as head office and shall obtain Central License for Head office and separate license for other location as per eligibility criteria (Central or State License or Registration).

A Food Business Operator (FBO)'s premise shall have only one FSSAI License or Registration on which any number of kind of businesses (KoB) can be endorsed.

DOCUMENTS REQUIRED	ADDITIONAL INFORMATION	FSS ACT, 2006	USEFUL LINKS
NEW/RENEWAL/MODIFICATION OF LICENSE NEW REGISTRATION FEE STRUCTURE	ANNUAL RETURN FORM D-1/FORM D-2 Importer Exporter	FSS RULES, 2011 FSS REGULATIONS GAZETTE NOTIFICATION	FoSTaC FPIVS FOOD SAFETY MITRA More Links

Dairy units	+
Vegetable oil and processing units	+
Slaughtering units	+
Meat processing units	+
Fish and Fish Products	+
Food or Health Supplements and Nutraceuticals etc.	+
General Manufacturing	+
Proprietary Food	+
Non-specified food and food ingredients	+
Substances Added to Food	+
Radiation Processing of Food	+

foscos.fssai.gov.in/public/fbo/open-eligibility/N

G 🔍 ⭐

Select Kind of Business (Multiple Selection can be made from each group)



If manufacturing/processing Dairy products, Vegetable Oil, Meat Products, Novel Food products and all food processing units including repackers.

Dairy units	-
<p>Dairy processing means handling, processing, manufacturing, packing, storing, distribution & transportation of milk and milk products.</p> <p>● More than 50,000 litres of liquid milk/day or more than 2500 MT of milk solid per annum ● 501 to 50,000 LPD of milk or 2.5 MT to 2500 MT of milk solids per annum ● Upto 500 LPD of milk or upto 2.5 MT of milk solids per annum</p>	
FORM B	
Clear Selected KOB	
Vegetable oil and processing units	+
Slaughtering units	+



FoSCoS
Food Safety Compliance System



[Home](#) | [About FoSCoS](#) | [FSSAI](#) | [User Manual](#) | [Login-Businesses](#) | [Login-Authorities](#)

View Eligibility

After assessment of kind of Business(s) selected and inputs provided, you are eligible for:

S.No	Kind of Business	License Category
1	Manufacturer - Dairy units	Central License

You are eligible for for Central License , Click here to proceed

DOCUMENTS REQUIRED
 NEW/RENEWAL/MODIFICATION OF
 LICENSE
 NEW REGISTRATION

ADDITIONAL INFORMATION
 ANNUAL RETURN
 FORM D-1/FORM D-2
 Importer

FSS ACT, 2006
 FSS RULES, 2011
 FSS REGULATIONS

USEFUL LINKS
 FoSTaC
 FPIVS
 FOOD SAFETY MITRA

Form "B" : Application for License / Renewal of license under Food Safety and Standards Act, 2006

Premises Detail
Product Selection
Communication Details
Required Document
Payments

Name of Company/Organization*

Address of Premises for which license is being applied

Address *	<input type="text"/>	State	<input type="text" value="Punjab"/>
District *	<input type="text" value="Select District"/>	Sub-District *	<input type="text" value="Select Sub-District"/>
Pincode *	<input type="text" value="Postal Pincode"/>		
GST No.(If any)	<input type="text"/>		
PAN No.(If any)	<input type="text"/>		
CIN No.(If any)	<input type="text"/>		

MULTIDISCIPLINARY PORTRAIT OF AGRICULTURE: CONCEPT & PRACTICES

FORM B

Dairy units							
Location and installed capacity of Milk Chilling Centers (MCC) / Bulk Milk Cooling Centers (BMCs)/ Milk Processing Unit/ Milk Packaging Unit/Milk Collection Center in litres owned or managed by the applicant :							
Sl.No	Name of MCC/BMC <small>(?)</small>	Address	State	District	Postal Pin-Code	Installed Capacity (in litres/day)	Action
	-Select-	<input type="text"/>	Select State <input type="button" value="▼"/>	Select District <input type="button" value="▼"/>	<input type="text"/>	<input type="text"/>	Save & Add

Average Quantity of milk per day to be used/handle (in litres) :

(A) In Lean Season

(B) In Flush Season

Milk products to be manufactured and their manufacturing capacity:

Production Capacity (MT/ Year) *				
Food Category	Sub-Food Category Name	Product	Kind of Business	Action
Select Food Category <input type="button" value="▼"/>	Select Sub-Food Category <input type="button" value="▼"/>	Add/Edit Product	Select <input type="button" value="▼"/>	Save & Add

Important Information:
 1. "Relabeller" means a food business operator who gets his/her product(s) manufactured/packed from a third party manufacturer/processor.
 2. "Repacker" means a food business operator who repacks a food product into different sizes without changing or affecting the nature, composition or formulation of the food product.

Other Detail

[Previous](#) [Save & Next](#)

FORM A (Registration of 500 l/Day)

Applicant Details

Name of Applicant / Company *

Designation : * Individual Partner Proprietor Co-operative Society Other(s)

Kind of Business

Manufacturer - Dairy units

Address of Premises where food business is located

Address : *

State : *

Punjab

District/Region/Zone: *

Select District

Sub-Division/Station/Division
(Railways): *

Select Sub-Division

Village: *

Select Village

Pin Code: *

Contact Details

Tel No:

Mobile No: *

+91 -

Fax:

Email-ID:

[Note: In case the number(s) are a Private Party or common number(s), please specify the name of the contact person as well]

Contact Person: *

Years you want to apply for

No. of years you want to apply for
*

Years

Details of food items proposed to be manufactured or sold

[Note: Only standardised food products are allowed to be manufactured as per the list available on FoSCoS.]

Manufacturer Unit					
Sl. No.	Category	Sub-Category	Product	Kind of Business	Action
	Select	Select Sub-Food Category	Add/Edit Product	Select	Save & Add

Food Safety Mitra Details(If Applicable)

FSM No. :	Enter FSM No.
Add	
Other Details	
In case of business – intended date of start :	DD-MM-YYYY
Source of Water Supply : *	<input type="radio"/> Public <input type="radio"/> Private <input type="radio"/> Other(s) <input type="radio"/> N/A
Whether any electric power is used in manufacturing of food items:	<input type="radio"/> Yes <input checked="" type="radio"/> No
Save & Next Cancel	

Conditions for License

- Display a **true copy of the license** granted in Form C
- Give necessary access to Licensing Authorities or their authorized personnel to the premises
- Inform Authorities about any **change** or modifications in activities /content of license.
- Employ at least **one technical person** to supervise the production process.
- Furnish periodic **annual return (1st April to 31st March)**, within upto 31st May of each year. For collection/ handling/manufacturing of Milk and Milk Products half yearly returns also to be furnished as specified (1st April to 31st September before 30th November and 1st October to 31st March).
- Ensure **that no product other** than the product indicated in the license/ registration is produced in the unit.
- Maintain factory's sanitary and hygienic standards and worker's Hygiene as specified in the Schedule - 4 according to the category of food business.
- Maintain daily records of production, raw materials utilization and sales separately.
- Ensure that the source and standards of raw material used are of optimum quality

Role of Food safety officer

- Food safety officer is responsible for inspection of food business, drawing samples and sending them to Food analyst for analysis
- Food analyst analyse the sample and send report within 14 days to designated officer with a copy to Commissioner of food safety

- Designated officer decides whether contravention is punishable with imprisonment or fine only

Enforcement of the Act

Offences: Causing food to be injurious by any means

- Deliberate adulteration
- Using any substance as an ingredient during food preparation
- Abstracting any constituent from food
- Nonconformance in Label information etc.

Penalties

- Substandard food : Upto Rs. 5.00 lakhs
- Misbranded : Upto Rs. 3.00 lakhs
- Misleading advertisement : Upto Rs. 10.00 lakhs
- Food with extraneous matter : Upto Rs. 1.00 lakhs
- Fail to meet the requirements as directed by FSO : Upto Rs. 2.00 lakhs
- Unhygienic / unsanitary preparations : Upto Rs. 1.00 lakhs
- Adulterant not injurious to health : Upto Rs. 2.00 lakhs
- Adulterant injurious to health : Upto Rs. 10.00 lakhs
- Unsafe food – but does not cause immediate injury : 6 months imprisonment with fine of Rs.1.0 lakh
- Unsafe food causing non-grievous injury: 1 year imprisonment with fine of Rs. 3.00 lakh
- Causing grievous injury : 6 years imprisonment with fine of Rs. 5.00 lakh
- Causing death : 7 years or life imprisonment and fine of Rs. 10.00 lakh Compensation in case of death : upto Rs. 5.00 lakh minimum
- Carrying business without license: 6 months imprisonment with fine of Rs. 5.00 lakh

Reference :

Food Safety and Standards Authority of India, <https://www.fssai.gov.in/>, <https://foscos.fssai.gov.in/>

Backyard Poultry Farming System for Rural Livelihood Enhancement

¹Reena Kamal, ²P.C. Chandran, ²Amitava Dey, ²Rajni Kumari and ²Pradeep Ray

¹ICAR-RCER, Farming System Research Centre for Hill & Plateau Region, Plandu, Ranchi-834010

²ICAR- Research Complex for Eastern Region, Patna-800014

Corresponding author: dr.reenakamal@yahoo.com

Abstract

Poultry as a micro enterprise with women empowerment as a model for rural economic sustainability. There are two benefits one can derive by way of rural backyard poultry farming namely Income generation by selling eggs or poultry for meat and the major benefit would be supplementing the household nutritional requirement by way of self-consumption to the needy. The backyard poultry production can be easily boost up with improved varieties of chicken and can promise a better production of meat and egg. To improve the socio-economic status of the traditional farmers, backyard poultry is a handy enterprise with low-cost initial investment, but high economic return along with guarantee for improving protein deficiency among the poor. The backyard poultry farming with improved birds provide a better livelihood security to the poor farmers paving a way for sustainable agriculture in rural areas.

Introduction

Livestock and poultry sector provide a major contribution to India's economy (Nath et al., 2012). Poultry farming in India has transformed into a techno-commercial industry from the status of backyard farming since three decades. India stands as third largest egg producer and fifth chicken meat producer in the world with about 60 billion eggs and 2.2 million metric tons of chicken meat. This production is achieved generally by commercial poultry operations; however a significant contribution comes from rural poultry also. The native chicken varieties adopted in free- range backyard conditions for centuries though contributing about 11% of total egg production in India (Kumaresan et al., 2008), is the most neglected one. This is in spite of the fact that their poultry eggs and meat fetch a much higher price than that from commercial poultry.

Rural Poultry is a good occupation for the rural masses for economic sustainability and nutritional security. Many countries have adopted Poultry as a micro enterprise with women empowerment as a model for rural economic sustainability. There are two benefits one can derive by way of rural backyard Poultry Farming namely Income generation by selling eggs or Poultry for meat and the major benefit would be supplementing the household nutritional requirement by way of self-consumption to the needy.

Desi or indigenous birds are generally poor performers in egg. Due to their low productivity i.e 50-60 egg/bird/year (Pathak and Nath, 2013) their contribution to the total egg output was almost static for the last few decades and their meat production is also very less.

The backyard poultry production can be easily boost up with improved varieties of chicken and can promise a better production of meat and egg. To improve the socio-economic status of

the traditional farmers, backyard poultry is a handy enterprise with low-cost initial investment, but high economic return along with guarantee for improving protein deficiency among the poor.

Having realized the importance of backyard rural poultry farming (RPF) in India, several research organizations developed different backyard chicken varieties which are presented in Table 1.

Table 1. Improved chicken that can be introduced in backyard poultry farming

Name	Feather pattern	Purpose	Organization
Gramapriya	Multicolour	egg	PDP Hyderabad
CARI- Nirbhic	Multicolour	Dual	CARI, Izatnagar
CARI- Shyama	Mixed colour	Dual	CARI, Izatnagar
Vanaraja	Multicolour	Dual	PDP, Hyderabad
Gramalaxmi	Mixed brown	Egg	KAU, Mannuthy
Nicobari	Black and white	Egg	CARI, Portblair

All improved chickens like Nicobari, Nirbhic, Hitcari, CARI- Shyama, Gramalaxmi, Gramapriya and Vanaraj due to its moderate body weight and high egg yielding capacity are more preferred under Semi-intensive farm conditions in rural/tribal areas.

Their Promising features/characteristics:

- Natural and attractive- multi- color feather pattern,
- High general immune competence, so perform better under adverse condition
- Perform better even with poor quality diets,
- Grow faster and produce more eggs than Desi hen and
- Produce brown eggs like Desi hen
- Because of moderate body weight the birds can escape from predators.

Table 2: Comparative performance of Vanaraja, Gramapriya and local chicken under backyard system

Parameters	Performance		
	Vanaraja	Gramapriya	Local chicken
Mortality up to 10 weeks	Less than 5%	Less than 5%	Less than 4%
Mortality up to 20 weeks	Less than 10%	Less than 12%	Less than 8%
Mortality during laying stage	Less than 12%	Less than 15%	Less than 10%
Average age at first lay (days)	152	145	184
Average body weight at first lay (Kg)	2.30	2.18	1.25

Average annual egg production (nos.)	171-190	178-200	60
Colour of egg	Tinted	Tinted	Tinted
Average Egg weight at 40 th weeks (g)	51	49	41

Requirements of farming practices for backyard chicken farming

Location of poultry shed

The main objective of farm is to ensure maximum security, from diseases, environmental pollution and other stress factors. The farm should be located far from any other commercial poultry operation to prevent contamination of environment and diseases, otherwise it will cause economic loss to the farm. Farm should be located in an elevated area with good air current and the location should be well connected by road for easy accessibility. The poultry house should be in east-west orientation to protect from summer wind and cold stress and also for direct sunlight in winter months. During summer direct sun light should be avoided to reduce the summer stress in birds.

Housing

Emphatically housing is more important for poultry management. Poultry house may be constructed with available low cost construction materials like bamboo, wooden planks, thatch grass, polythene sheets etc. For rapid growth of improved chicken, sufficient space is required for each bird which is presented in Table 3.

Table 3. Space requirement

Age (Weeks)	Floor space (ft ²)	Feeding space (cm)	Watering space (cm)
0-4	0.5	2.5	1.5
4-8	1.0	5.0	2.0
8-12	2.0	6.5	2.5

Preparation of poultry shed/house: After marketing of old flock the following operations are required to be created for clean and healthy environment in the poultry house.

- Remove all the movable equipment from the shed. Soak in water and clean thoroughly in tap water and finally dip in disinfectant solutions. Finally wash in clean water, sun dry and store.
- Litter should be removed from the shed and transported away from the farm in closed containers or in gunny bags and disposed off properly.
- Lightings and feed and water pans should also be taken out of the shed and cleaned properly.
- Accumulated dust and cob web formed on the wall, ceiling, mesh etc., should be removed.

- Insecticide is to be sprayed over the litter, walls, mesh, roof etc., Shed should be washed using a pressure washer.
- All the repair works of the shed including cages, equipment and mesh should be carried out.
- Flame guns should be used inside and outside of the houses. Walls should be white washed and metal surfaces should be painted if needed. The equipment and fitting should be re-assembled and the curtains be tied. Spray an insecticide to kill the insects.
- Shed should be kept under lock (shed rest) for a minimum of one-two weeks.

One day before arrival of chicks:

- Set heating system (switch on brooders) at 29-32°C (85-90°F) for cage brooding or at 32-35°C (90-95°F) at chick level for floor brooding.
- Cover the floor (litter) of brooder with news paper and arrange feeders, waters etc.,
- Check water system and adjust to proper height of chicks
- Disinfect and flush water lines.

On arrival of chicks:

- While placing chicks in the brooders, count the number of chicks placed in each portion cell to ensure proper stocking density.
- Fill waterers with clean water or operate water system.
- During the first six weeks, operate feeders to provide feed more than twice daily.
- Check brooder temperatures.
- On placing chicks, trigger water cups to encourage drinking.
- Provide the feed in mash or crumble form. Crumble/pellet feed will ensure more uniform growth.
- Provide adequate light continuously during the first two days.
- Electrolytes/antibiotics supplementation in drinking water will reduce transportation and environmental stress and also reduce initial chick mortality.

Litter Management

Litter management place a vital role in controlling the disease in the flock. When birds are housed on deep litter, placing of waterers and their maintenance should receive due attention to keep the litter dry. Suitable litter materials like saw dust, rice husk, pieces of hay and straw can be spread up to 5-10 cm thickness and that should be stirred frequently and treated with slaked lime to avoid caking. In case of humid coastal areas, add about 0.5 kg of superphosphate / hydrated lime may be thoroughly mixed up with litter spreading in 15 sq.ft. floor area. Birds

are allowed to feed ad libitum during the first few weeks of age. To ensure proper development of feathers skeletal growth and immune system birds should be provided feed all through the initial 4 and 5 weeks.

Chick management

Brooding: Brooding of chicks is very important operation in the early age of the chicks (0-4 week). Chicks are provided with required temperature by artificial means.

Brooding management: Chicks need brooding during initial 6 weeks of age to maintain the required body temperature and to protect from predators. Metal, wooden or any other low cost brooding materials can be used for the purpose and electric bulbs (2 Watts/ chick) can be used as a heat source. The movement of the chicks can be restricted near by the heat source with the help of chicks guard. Initially about 7-10 sq. inches space is recommended per chick under brooder.

Floor Brooding:

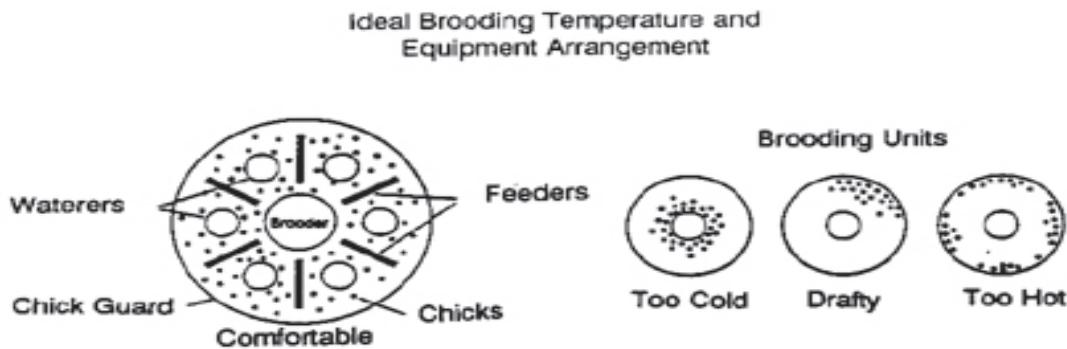
Spot brooding: This conventional method of brooding depends overhang on spot heating either by using electrical bulbs or gas brooders. In this system one over hanging or standing is provided for every 300-600 chicks. Hovers are reflectors which provide warmth to chicks using electrical bulbs or gas brooders. The air temperature under the hover is kept at a required level. Hovers are made up of metal, wood or bamboo baskets fitted with electrical bulbs, infra-red bulbs or heating elements and gas heaters.

Brooder guard: 2 to 2½ foot away from the hover, brooder guard is provided to prevent chicks straying away from heat source, feed and water. Brooder guards are generally made up of G.I sheet with foot height. For first 2 days, feed is sprinkled on the paper and after that chick feeders are provided. Chick waterers should be provided first day onwards. Feeders and waterers are arranged in cart wheel manner, so that chick need not have to walk long distance to access feed and water. **Temperature:** The temperature is regulated by adjusting the height of the hover with the number of bulbs/flame. During the first week, brooding temperature under hover (2 inches above litter at the top of the hover) should be 32 -34°C (90-95°F) with a weekly reduction of 5 till it reaches 21-22°C (70°F).

Table 4: Brooder temperature for chicks at different ages:

Age of chicks	Brooder temperature	
	°F	°C
1 st Week	90	32.2
2 nd Week	85	29.4
3 rd Week	80	26.7
4 th Week	75	23.9
5 th Week	70	21.1
6 th Week	70	21.1

The correct temperature of brooder is known by the behavior of the chicks. When the chicks are comfortable, they will spread out evenly within chick guard area. If the hover temperature is too low the chicks will huddle together under hover, whereas when the brooder temperature is high they tend to move away from hover. The brooder should be started 8-10 hours before arrival of the chicks.



Feeders: During the first day, feed may be sprinkled or provided in the trays/news paper for encouraging the new born chicks to pick up feed. From day two onwards feed is provided in trough type of feeders. As the chicks grow bigger suitable feeders are used. The feeders should be at proper height for the birds to eat properly. As chicks grow the feeder should be lifted up by adjusting their height to the back level of the bird. The level of feed in feeder has a direct correlation with feed wastage. As a thumb rule, 10 percent feed is wasted if the feeders are two thirds full compared to 3 percent wastage if they are half full and only 1 percent if they are one third full. Therefore, feed should be offered more frequently with small quantity at each time and helps to gain weight more uniformly. Feeder space allowance: Trough feeders 2.5cm – up to 2 weeks and 5cm –up to 6 weeks.

Waterer space: Clean and fresh water should be provided to the chick's waterers from day old chicks should be conveniently placed close to the hover and alternatively to feeders. Water may be provided using troughs, bell shaped drinkers and caps. With these drinkers 0.75 inches (2 cm) of water space per bird is recommended. Water should be provided before the chicks are released under the brooders. Bell type chick drinkers are essential during first three days of brooding irrespective of type of brooding. In deep litter brooding drinkers should be evenly distributed. Height of the drinkers needs to be adjusted according to the chick height. One chick drinker is enough for 100 chicks up to 2 weeks of age and regular bell drinker is sufficient for 50 birds from third week onwards

Chick feed: Grounded maize should be provided 2 hours after chicks are placed under the brooder. During first week, frequent feeding of small quantity should be practiced to stimulate feed consumption.

Floor space: The chick should be provided sufficient hover and floor space. Growth and feed conversion ratio (FCR) are proportionate to floor space available for chicks, apart from the genetic potential of the bird. Overcrowding results in stress and mortality, chick requires 8

square inches of hover space. In deep litter brooding 0.3 sq. ft. floor space per chick is to be provided during the first week. During the 6-week, 1 sq. ft. floor space per chick is essential.

Relative humidity: During the first week of brooding, the relative humidity should be 65.70% when the relative humidity drops below 50% it results in dehydration of chicks, which may affect growth, uniformity and livability of chicks. In houses where gas brooders and nipple drinkers are used, relative humidity can drop down to as low as 25%. To maintain the required humidity frequent spray of sanitized water is advised.

Ventilation: Supply of fresh air to the chicks is highly essential. Brooding will cause depletion of oxygen and buildup of carbon dioxide, ammonia etc., the airtight curtains should be avoided. It is recommended to keep a gap of 3.5 inches between the ceiling and side curtains to facilitate gas exchange between the house and environment. In extreme weather conditions curtains, windows, doors and fans need to be effectively used to maintain optimum ventilation.

Beak trimming: Trimming of beak is an important managemental practice. This is done to prevent cannibalism and wastage of feed. Beak trimming is a sensitive operation and it should be done by trained people. The beak trimming is done at 3rd week One third of the beak should be trimmed. There are different methods, cutting and cauterization with hot iron method is popular. Cauterization helps in arresting and destroys the tissue responsible for generating beak growth. Proper care should be taken not to burn the tongue of the chick. Use electrolytes and vitamin (K and C) in the water two days before and after beak trimming. Deeper feed should be provided for several days

Management under open range system

Rural chicks need brooding care during the initial 6 weeks of age. At 42 days of age, these birds will attain 650- 750 g weight and by the time they are ready to keep in free range system. These birds can be let out under backyard free- range conditions (10-20 birds/ household) depending upon the housing area and natural feed base available. These birds are let loose in day time for foraging while they require shelter at night time. The birds need to be initially habituated/trained to return to the nest in the evening for night shelter/security/safety. Clean drinking water should be provided before letting them out from the night shelter. The male can be sold when it attains marketable weight of 2-2.5 kg and female should be raised for egg production. Two to three males in a flock of 10-20 birds should be kept to get fertilized eggs for hatching.

Feeding: Improved birds under free-range can easily pick up its food the backyards once it learns to scavenge in the household surrounding. Under free range conditions the necessity of supplementary feed/ feed ingredients mostly depends on the free area available in the backyards, intensity of vegetation and availability of waste grains, insects, grass seeds etc. Generally, the birds under free- range conditions can meet their protein requirement through scavenging, but, the possibility of energy deficiency is common. Therefore, feeding the birds with different locally available cereals (like maize, bajra, ragi, jowar, broken rice, with equal parts of rice polish or rice bran) is always beneficial to sustain the production under free range conditions (Bhattacharya et al., 2005). If the problem of broken/ shell less eggs observed, calcium source (lime powder, shell grid etc.) should be supplemented @ 3-4g/ bird/day.

Grower Management

The importance of growing systems is to provide growers an ideal environment to obtain optimum body weight at sexual maturity so as to perform better during laying phases and production phase. The main objective of the grower management is to achieve target body weight and flock uniformity

Housing: Generally, the stock remains in the same building during brooding and growing. A floor space of 2.75 and 2.80 sq. ft. per bird is required. During growing period as feed restriction is followed. The level of feed restriction is as low as 40% of ad libitum feeding.

Beak trimming: The second beak trimming is done between 12-14 weeks of age

Prelay management

Objective of this period is to ensure optimum skeletal development body conformation and leg strength to sustain reproductive ability and fitness throughout the laying period. Growth during this period greatly influences uniform sexual maturity. Uniform flock will ensure to get all the birds into lay at the same time. The rate of body weight gain increases every week. This is achieved by giving weekly feed increments from 17 to 20 weeks.

Lighting: Light affects the physical activity, metabolic rate and other physiological functions. Total lighting required during lay is up to 16 hours. Birds growing during the period of increasing day length (January to June) mature earlier and perform better than those grown during decreased day length (July to December).

Bio-security: Bio-Security: Bio-security is the system used to prevent and control of infectious diseases in poultry. Consider that people, vehicles, equipment's, birds etc., entering the farm may carry infections agents, hence measures to be taken for restriction of their movement. Disinfection of sheds, equipment's and internal shed surfaces should be done following flock depletion

Health management: The most important diseases that affect birds under free range farming is the Newcastle (Ranikhet) disease. Night shelter should have good ventilation, adequate light and protection from predators. The materials used for night shelter such as wood and bamboo offer a good hiding place for external parasites. Therefore, periodic cleaning of night shelter is essential. Since the chicks move in free range, there is a possibility of parasitic infestation. The deworming at 2- 3 months interval is required. Under free-range conditions, adult birds should be vaccinated against Newcastle disease at 6 months interval, preferably before the onset of summer

Table 5. Vaccination schedule for Vanaraja/Gramapriya birds

Age	Name of the vaccine	Strain	Dose	Route
1 st day in the hatchery	Marek's Disease	HVT	0.20 ml	S/C injection
5 th day	Newcastle Disease	Lasota	One drop	Eye drop
14th day	Infectious Bursal Disease	Georgia	One drop	Oral drop
21st day	Pox Fowl	pox	0.20 ml	IM/SC injection
28th day	Newcastle Disease	Lasota	One drop	Eye drop

9 th week	Newcastle Disease*	R2B	0.5 ml	S/C injection
12th week	Pox*	Fowl pox	0.20 ml	S/C injection

*Repeat these two vaccines at every 6 months interval (Pathak and Nath,2013)

Table 6: Medication

Prevention	Age	Drug	Route
Anti stress	1 day	Electrolytes	Water
Early chick Mortality	1-5 days	Antibiotic	Water

Suggestions for obtaining high returns from backyard poultry farming

- a) Protect from predators.
- b) Provide additional concentrate feed.
- c) Provide clean and fresh drinking water.
- d) Provide optimum space to avoid overcrowding.
- e) Proper vaccination, de-worming and veterinary care.
- f) Regular disinfection of poultry house and surrounding.

Conclusion:

The backyard poultry farming with improved birds provide a better livelihood security to the poor farmers paving a way for sustainable agriculture in rural areas.

References

1. Bhattacharya M., Buragohain R., Ahmed FA., Pathak PK. and Ghosh MK., 2005. Laying performance of Vanaraja birds in high altitude areas of Arunachal Pradesh under backyard system of rearing. Conference and National Symposium, Indian Poultry Science Association, Project Directorate on Poultry, Hyderabad, from 2-4 February 2005. pp 198.
2. Central poultry development organisation and training institute management guide for rural poultry. Hessarghatta, Bangalore – 560 088
3. Ghosh MK., Ahmed FA., Buragohain R., Pathak PK. and Bhattacharya M. 2005. Growth performance of Vanaraja birds in high altitude areas of Arunachal Pradesh under Backyard system of management. XXII Annual conference and National Symposium, Indian Poultry Science Association, Project Directorate on Poultry, Hyderabad, from 2-4 February 2005. pp 198
4. Kumaresan A., Bujarbarua KM., Pathak KA., Chettri B., Ahmed SK. and Haunshi S. 2008. Analysis of a village chicken production system and performance of improved dual-purpose chickens under a subtropical hill agro- ecosystem in India. Tropical Animal Health Production, 40, 395-402
5. Nath BG., Pathak PK. and Mohanty AK. 2012. Constraints Analysis of Poultry Production at Dzongu Area of North Sikkim in India. Iranian Journal of Applied Animal Science, 2 (4), 397- 401.
6. Pathak P.K., Nath B.G. (2013). Rural Poultry Farming with Improved Breed of Backyard Chicken . J. World's Poult. Res. 3(1): 24-27.

Self-Resilience through Diversified Commercial Poultry Farming

Jaydip Jaywant Rokade, Sruthy Ravi and Tiwari A. K.

ICAR- Central Avian Research Institute, Izatnagar, Bareilly, U.P.,

Corresponding author: jaydeepvet@gmail.com

Abstract

India acquired its top position as 3rd in egg production with 129 billion eggs in 2021-2022 and the poultry meat production was 6th with 5.1 MMT. The Indian poultry market size reached INR 1,905.3 billion in 2022. Looking forward, IMARC Group expects the market to reach INR 3,477.8 billion by 2028, exhibiting a growth rate (CAGR) of 10.18% during 2023-2028 (Biswas et al., 2021). Diversified poultry farming is the area where quite a need to explore its potential commercially to build self-reliance in farmers. The diversified poultry species includes turkey, quail, duck, guinea fowl, emu, etc. Diversified poultry farming is a key pathway to this newer farming technique where the beneficial role of these species could be identified and exploited (Prabakaran et al., 2020). The demand for diversified food items obtained from these species is rising drastically. The nutritional benefits of egg and meat of diversified birds over chicken like low cholesterol content, high protein value is also gaining attention of consumers. Similarly, as a good source of protein with less capital investment, these birds can alleviate hunger related problems. Hence, the advantageous facts about the various diversified species of poultry to attain sustainability are explained in this chapter.

Introduction

Eggs and meat from poultry have become a constant part in human diet since decades, but more attracted to chicken. Other diversified species egg and meat have better nutritional value as compared to chicken to some extent. But their availability is still questionable despite of gaining huge demand. Also, the management is comparatively less expensive than chicken due to less capital expenditure and diverse feeding habits. The benefit can be utilized by small scale and marginal farmers to stand steady in rising commercial poultry industry. This can be achieved by building proper market channel to avoid the fluctuations in price for diversified poultry products and incorporating value addition technology and byproduct utilization (NABCONS, 2022). Further, to maximize the production performance, scientific methods of rearing of these species should taught to farmers using teaching and training methods. The government also must support the farmers with insurance schemes for diversified species. They are known to supply the best proteins rich in essential amino acids, which tackle the protein deficiency in rural areas.

Diversified poultry farming is the area where quite a need to explore its potential commercially to build self-reliance in farmers. The diversified poultry species includes turkey, quail, duck, guinea fowl, emu, etc. There are many challenges faced by the rural poultry farmers due to the intervention of commercialization in poultry industry. In order to cope up with these challenges new farming techniques must be discovered. Diversified poultry farming is a key pathway to

this newer farming techniques where the beneficial role of these species could be identified and exploited. The demand for diversified food items obtained from these species is rising drastically. The nutritional benefits of egg and meat of diversified birds over chicken like low cholesterol content, high protein value is also gaining attention of consumers. Similarly, as a good source of protein with less capital investment, these birds can alleviate hunger related problems. Hence, the advantageous facts about the various diversified species of poultry to attain sustainability are explained in this chapter.

Turkey Farming

Turkey occupies an important position next to chicken and duck, contributes about 1 and 5 percent in total poultry population and meat production respectively. Over all turkey population in the world is about 450 million (FAO, 2020) and the sector is playing a pivotal role in changing the nutritional and economic status of mixed population. Domestic turkey production was started in Europe in the 16th century and the bird is native North America. They are mainly reared for meat, which is leanest among other domestic avian species. They are marketed at 16 weeks with an average weight of 8 kg for hens and 12 kg for toms. The consumption of turkey meat became a tradition at Christmas which the spread to other countries by British and Spanish. It is very much accepted in western countries and the leading countries in turkey production are United States of America, Brazil, Germany, France and Italy. Since the USA being the top country share 43 percent to world turkey population and 229 million metric tons meat which accounts 2.692 percent of total production (FAO, 2019). But Indian turkey production is in its beginning stage with a population of 0.43 million in backyard and 0.02 million in commercial side (20th livestock census). The turkeys are most concentrated in and around the cosmopolitan cities of India but less in numbers. Among the states, Kerala, Tamil Nadu, eastern districts of Uttar Pradesh are prime areas where Indigenous and non-descriptive turkey birds are noticed in good numbers (Prabhakaran, 2014).

General Characteristics of Turkey

Turkey (*Meleagris gallopavo*) is a large gallinaceous bird of the family Meleagridae with no specific breed, instead seven varieties of turkey have been recognized by American standard of perfection for poultry which includes, Bronze, White Holland, Bourban Red, Narragansett, Black, Slate, Beltsville white. In India, Board breasted bronze, Broad breasted white and Beltsville small white are more common on the commercial side. Among these, white turkeys appear to be more suitable for Indian farming conditions. The central and state institutes also developed many varieties which includes Nandanam turkey I and II and CARI-Virat (white), CARI-Black (black) and CARI-Chitla (multicolored) by Tamil Nādu Veterinary and Animal sciences University and Central avian Research Institute respectively. The male birds of turkey are heavier than females and the incubation period is 28 days. The turkey will start laying from the 30th weeks of age and its reproductive period is 24 weeks from the point of lay. It is possible to get around 60-100 egg per year by proper feeding and artificial lightening management. About 70 percent of the eggs will be laid in the afternoon by these birds. A turkey egg weighing 85 g contains 55.9% albumen, 32.3% yolk, and 11.8% shell. The protein, lipid carbohydrate and

mineral content of turkey egg are 13.1%, 11.8%, 1.7% and 0.8% respectively. The cholesterol content is 15.67-23.97 mg/ g of yolk. In addition, turkey eggs are characterized by higher energy of 171 kcal per 100 g of egg (Kokoszyński, 2017). Similarly, turkey meat has high nutritional and sensorial properties which make it almost ideal for consumption. People prefer turkey meat because of its leanest nature compared to other poultry meat. Also, it has high breast meat percentage of 73 compared to chicken (25-30%). The turkey meat contains 21.8% protein, 2.57% fat and have an energy value of 118 kcal/ 100 g of meat. It is rich source of essential amino acids, vitamins, minerals and poly unsaturated fatty acids but low in cholesterol content (68%). The meat of turkey has nutritional and sensorial properties which make it almost ideal raw material for rational and curative nutrition. They can produce 30 g of digestible protein from 100 g feed and the dressing percentage of turkey is 80-87%, which is highest among all farm species.

Turkeys can be reared under free range, semi-intensive or intensive system. In free range system, about 200-250 adult turkeys can be reared in one acre of fenced land. Since, turkeys are very good scavengers, it can consume earthworms, small insects, snails, kitchen waste and termites, which are rich in protein, hence reduce the feed cost by fifty percent. Apart from this leguminous fodder like Lucerne, Berseem, Desmanthus, Stylo etc., can be fed to turkey in this system of rearing. Popular commercial turkey production is through semi-intensive system of rearing in which, turkey poult raised up to 4-6 weeks in a closed confined houses after which they are allowed to forage for a few hours in an open yard during the day. During the forage time, turkey consume the sparse cultivated grass and greens available in the open yard, hence feed cost is reduced. Hence the turkey farming is suitable for small and marginal farmer as it can have raised under free range or semi-intensive system with minimal investment. In case of intensive system of rearing (deep litter), general managemental conditions are similar to that of chicken but care should be taken to provide adequate floor, waterer and feeder space to accommodate the large bird.



Cari Virat



Cari Chitala

Quail Farming

During the past two decades, Japanese quail has gained more popularity than other diversified species of poultry, especially in South India, not only because of their specific gamy taste but also help to meet out the animal protein demand and also being an inexpensive alternative to chicken. The bird is known to start domesticated in Japan in 1595 where it was originally reared as a pet song bird. Intensive production of the species started in Japan in the 1920s. The major quail meat producing countries worldwide include China, Spain, France and the United States of America while the top quail egg producing countries are China, Japan, Brazil and France (Berthechini, 2012). Japanese quails were introduced to Indian sub-continent by the centre of Advanced study in Poultry science at Veterinary Research Institute, Izatnagar under UNDP and ICAR collaborative Research project on post-graduation education and research in the year 1974. Central Avian Research Institute (CARI) is the premier Institute for introduction of quail farming technology in India. Five pure lines of quails are being maintained at this institute which have been developed, adopted for Indian conditions and are being exploited for commercial production of broiler and layer quails. The varieties of quail developed by CARI include, CARI Uttam (meat type), CARI Brown (meat type), CARI Ujjawal (meat type), CARI Peral (egg type-white egger), CARI Sweta (egg type-white feathered), CARI Sunheri (dual purpose). Many SAU and ICAR institutes also developed breeds /varieties which are suitable for Indian environment like Nandanam 1,2 & 3, Namakkal gold, Namakkal quail, etc. Presently, quail population in India is 5.81 millions in which, around 20 lakhs in backyard and 50 lakhs in commercial sector (20th livestock census) and is the 3rd largest avian species by number followed by chicken and duck. The state Tamil Nadu stands first in quail Production Followed by Telangana And Andhra Pradesh.

General Characteristics of Quail

The Japanese quail (*Coturnix coturnix japonica*) a small, stocky bird with short legs and varied plumage, belonging to the order Galliformes and family Phasianidae. Quail breeding is also known as coturniculture. There are over 140 species of quails worldwide (Travis, 2018) but two main breeds are common and most suitable for production purposes. These include the European quail (*Coturnix coturnix coturnix*) and the Japanese quail (*Coturnix coturnix japonica*) (Idahor *et al.*, 2015). It is a sexually dimorphic bird, where females are larger in size than male birds. A sex ratio of 1:3 for commercial utilization and 1:1 for research and development is practiced usually in quail. The quail is also called as "bater" in Hindi. The birds are quite hardy and can adapt to various climatic and environmental conditions. Also, it is resistant to most of the diseases of poultry. They are commercially reared for both egg and meat. The average egg weighs about 10-15 g (1/5th of chicken egg) which is about 8% of female body weight. The eggshells are spotted, with colors ranging from white to brown and incubation period is 18 days. The birds are usually marketed at 5-6 week (average body weight-180-200 g) and adult body weight is 200-250 g. It is a prolific bird with short generation interval and completes 3-4 generations per year. Feed conversion for egg production in Japanese quail is better than in laying hens. Quail hens need less than 2 kg of feed to produce 1 kg of egg, while laying hens need between 1.9 to 2.5 kg of feed to make the same amount of egg. Quail bird farming is five times better than chicken and turkey rearing, and a person with 400 quail laying birds is

better than a person with a capacity of 2000 laying chickens. Many people are interested to rear quail on commercial basis due to lower initial investment and risk rather than commercial broiler farming (Islam *et al.*, 2014). Most of the farmers reared Japanese quail under deep litter system to avoid high initial investment. The demand of commercial quail production is increasing day by day in the country. The reasons are mentioned below:

- Quails are smaller sized bird (mature male-140 g; female-200 g), so they can be raised within small place.
- Quail are less susceptible to common diseases.
- Quails grow very fast and gain maturity faster than any other poultry birds
- Japanese quail as laboratory animal in many areas of biological and medical research.

They start laying at 6th week of age, reach 50% production by 8 week and peak production (80%) is attained by 10th week of age. The high yielding quails lays about 260-300 eggs in a year with a total feed intake of about 8 to 12 kg. The quail eggs are higher in protein content 13 g compared to chicken, hence called as protein bomb. About 60% of the mass of the quail egg is comprised by the albumen (Nowaczewski *et al.*, 2010a) and yolk comprises almost one third of the weight. The share of the shell weight in the total mass of quail egg (7.4%) is the lowest compared to other poultry eggs (12%). The quail egg is also rich in essential amino acids and minerals like calcium, phosphorus and magnesium which are crucial in human nutrition and should be consumed irrespective of high cholesterol content (844 mg/ 100 g of egg). Quail eggs are gaining popularity because of their unique taste and is a valuable addition to the human diet. Quail meat has the lowest fat content, contains good levels of phospholipids and found to be rich in essential amino acids. There a demand for quail meat in India still many farmers are experiencing marketing problems due to lack of appreciable value. sector weak. There is no well-known quail meat product brand available in India despite of the higher demand. Hence the introduction of value added and branded meat products of quail would a good strategy to improve the market and generate income. Similarly, the high nutritional value of quail eggs can be availed by value addition and proper marketing strategy. It is good alternative to chicken in terms of taste and medicinal value as reducing risk of developing Alzheimer's disease in human beings.



CARI Pearl (egg type)



CARI Uttam (Meat type)



CARI Sunheri (Dual type)

Quail farming	Chicken farming
Low capital requirement	High capital requirement
Floor space - 0.2 sq ft/ bird.	Floor space - 1 to 2.5 sq ft/ bird
Highly resistant to diseases, hence hardly, no vaccines are needed.	Highly susceptible to common diseases and vaccination is must.
Feed @ 25-30 g/bird/day required.	Feed @ 110- 120 g / bird/day required.
8.4 -10 kg feed is required to produce 300 eggs with avg. egg weight of 10- 14 g	42-48 kg feed is required to produce 250 -260 eggs with avg. egg weight of 54-58 g
25-30 times more eggs than its body weight/year.	8 -9 times more eggs than its body weight.
Starts laying egg @ 6 wk and at 10 wk attain peak production which continues up to 54 wks.	Starts laying @ 20 th wk and reach peak production at 27-29 wks and continue to lay up to 72 wks.
Broiler quails are sold at 35 days	Chicken broilers are sold at 35-40 days
Less quantity of cholesterol in meat	More fat & cholesterol in meat
Quail meat is good for asthma & those suffering from arthritis	Having no such medicinal properties
Housing is cheaper, can be reared in multi-tier battery cages	Housing is substantially costlier than that in quails
Culled birds fetch more money in terms of body weight	Culled birds fetch lesser price than quails in terms of unit body weight.

Quail farming Vs Chicken farming:

Duck Farming

Among the diversified poultry species ducks hold the second position in terms of egg and meat production. They were domesticated by Egyptians, Chinese and Europeans and raised for meat, egg, and down feathers. A few are also kept for show, as pets, or for their ornamental value. Ducks contributes about 3 and 4 percent in total poultry population and meat production respectively (FAO, 2020). As per 20th livestock census, duck population In India is about 33.58 million (3.94%) in which backyard and commercial sector contributes around 32.50 and 1.08 million respectively. The well-known exotic breeds of ducks are Pekin, Aylesbury, Indian runner, Khaki Campbell, Rouen, Call, Crested white, etc. In India about 90-95% of ducks are of indigenous or non-descript origin which are highly suitable for extensive system of rearing or integrated systems of rearing. The common Indian ducks breeds are Arani ducks of Tamil Nadu, Chara and Chemballi (Kuttanad ducks) of Kerala, Sythet mete and Nageswari of eastern region. Pati (Assam) and Maithili (Bihar) are the only two duck breeds recognized by ICAR-NBGA. West Bengal, Assam, Kerala, Manipur, Jharkhand, Tripura, Bihar, Andhra Pradesh, Odisha, Uttar Pradesh and Orissa are the top ten leading states in India in terms of duck population. Central Poultry Development Organization, Bengaluru has imported Vigova Super-M variety of White Pekin ducks from Vietnam in 1996 and laid the foundation

for commercial duck broiler farming in the country. There are a total of 38 Govt. duck farms in India, majority of which are located in Assam.

General Characteristics of Quail

Duck (*Anas platyrhynchos*) are originated from wild mallard ducks and belongs to the order Anseriformes and family Anatidae. The size of the duck egg is larger than hen egg by about 15 to 20 g and 95 – 98% of eggs laid in the morning before 9.00 am. They require lesser attention and thrive well in scavenging conditions. Ducks can supplement their feed by foraging as they can eat fallen grains in paddy fields, insects, snails, earthworms, small fishes and other aquatic materials. From commercial point of view, ducks have a longer profitable life and lay well even in second year. They do not require any elaborate housing conditions like chicken and are quite hardy, more easily brooded and more resistant to common avian diseases. The incubation period of duck egg is 28 days. They drink copious amounts of water and have a much higher capacity to digest oil and probably fibre than chickens at all ages. Indigenous duck practices near coastal areas provide self-employment for landless, small and marginal farmers. Marshy river side, wet land and barren moors upon which chicken or no other type of stock will flourish, are excellent quarters for duck farming. They are very much suitable for integrated farming systems such as duck-cum-fish farming, duck farming with rice cultivation. In duck-cum-fish farming the droppings of ducks serve as feed for the fishes and no other feed or manuring of the pond is necessary for fishes (200-300 ducks per hectare of waste area). Under integrated duck farming with rice cultivation, the ducks perform four essential functions viz., intertillage as they search for food, their bills loosen up the soil around the rice plants-weeding, insect control and manuring. Ducks are good exterminators of potato beetles, grasshoppers, snails and slugs. In areas plagued liver flukes, ducks can help correct the problem. Ducks can be used to free the bodies of water from mosquito pupae and larvae. Ducks are quite intelligent, can be tamed easily, and trained to go to ponds and come back in the evening of their own.

Duck egg (60-90 g), is an important source of nutrition in many developing countries due to the low capital input required to raise laying ducks. The duck egg. The weight percentages of the eggshell, egg white and egg yolk to that of the whole egg, accounts for 11–13%, 45–58, and 28–35%, respectively. Duck eggs are more stable during storage at room temperature than chicken eggs and has a special flavor which distinguish it from chicken eggs. Moisture, protein, fat, and ash in duck egg are 88.3, 8.8, 0.13, and 0.53%, respectively. Duck egg yolk has relatively higher fat and cholesterol content (17 mg/g yolk) than hen egg yolk (14 mg/g yolk). Duck carcasses contain less meat, in particular breast muscles, and a higher percentage of skin with subcutaneous fat. Duck breast muscles are rich source of favorable amino acid such as leucine, lysine, tryptophan, phenylalanine, and tyrosine and characterized by a higher proportion of polyunsaturated fatty acids, including linoleic and linoleic fatty acids, when compared broiler chickens.

Commercial duck fanning is very simple and profitable as the requirements are minimum but the output margin is big. Hence there is lots of possibility for enhancement of duck farming to meet the protein demand of the nation. On production basis it is superior than chicken with

low cost of production. Hence, the value addition technologies in duck egg and meat can be employed to obtain more income by small and marginal farmers.

Guinea Fowl Farming

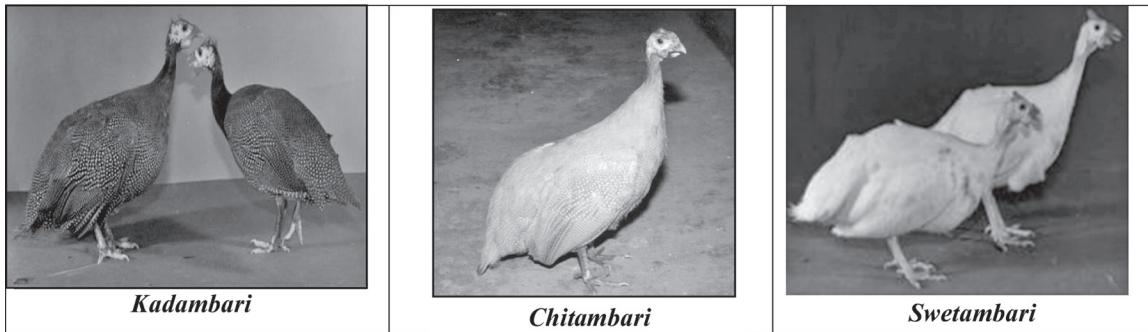
The guinea fowl is ground feeding bird resembles turkey or pheasant, which contributes around 2 percent to world population along with goose (FAO, 2020). The birds are raised commercially in huge number in Europe and the United States of America but in India, these birds are raised as free-range scavenging birds in rural areas. In Africa these birds are commonly reared under semi-intensive systems and extensive systems with low input cost. They are easier to manage by resource poor farmers because capital investment is less and are resistant to most poultry diseases at the adult stage. Housing is rudimentary and health management practices depend, largely, on ethnoveterinary medicine. Guinea fowl, often referred to as guineas, are gamebirds that are increasingly popular among farmers of small scale. Recently, many dual-purpose varieties of guinea fowl such as Peral, Lavender, Royal purple and White have been introduced to various regions of the world, among which pearl variety is gaining more popularity on production side (Kgwatalala *et al.*, 2020). The reputed central avian research Institute have conducted research studies to break the seasonality in egg production in pearl variety to shorten the age at first egg so that laying period got extended which eventually improved the egg production. The researchers received egg production of 180-120 eggs every year as a valuable outcome. Further, by this research series, birds lay eggs at 21 weeks of age as compared to previous 36 weeks. There are three GUNCARI varieties of guinea fowl viz. Kadambari, Chitambari and Swetambari developed CARI, which have pearl, lavender and white plumages respectively. Similarly, TANUVAS has released Nandam Guineas fowl-1 and TANUVAS white guinea fowl are also popular in India.

General Characteristics of Guinea Fowl

Guinea fowl (*Numida meliagris*) a game bird originated from Guinea coast of West Africa belongs to the family Numididae in the order Galliformes. The Guineas are also known as “pet speckled hen” or “original fowl” and the commonest variety of guinea fowl available is the Peal helmeted guinea fowl. Guineas are vigorous, hardy, and largely disease-free birds and the hardy nature makes the bird adaptable to diverse Indian agroclimatic conditions. The birds are also raised to act as watch dog in farms as it makes loud voice to discourage the entry of predators apart from meat and egg purpose. Also raising guinea fowl is an effective means to control pest. In addition, the bird is well known as poor man’s poultry as they consume more quantity of non-conventional feed than chicken. They are most resistant species among poultry birds to aflatoxin and phytotoxin. Moreover, the bird is excellent for crop-livestock integrated farming system.

Guinea fowls are seasonal egg layers with average production of 90-110 egg from March to September. This is the major limiting factor which resist the large-scale guinea fowl production. The unique features of guinea fowl egg include thick egg shell, high proportion of yolk, high levels of vitamins and minerals than chicken egg. The harder and thick egg shell prevents the entry of microorganisms in to the interior of egg. The eggs weigh around 28-32 g and incubation period is 28 days. In extensive system the usually lays egg in deep tapering nest.

The eggs are light brown in color, have a specific flavor and large sized golden yolk. Likewise, meat of guinea fowl also special as it differ from other poultry meat because of its high protein and low fat content. The darker color with unique gamey flavor also appeals the consumer. The excellent nutritional quality of egg and meat of guinea fowl is a bigger opportunity for value addition technology. The less housing requirement and diverse feeding habit of these birds make guinea fowl farming more efficient and profitable to the small and large-scale farmers.



Emu and Ostrich farming

Emu and ostrich are under the ratites group which are flightless birds. Ostrich is the largest avian species on earth followed by emu. Both these are birds now became popular among the farmers because of dark red meat similar to beef and its ornamental value in artifact industry. Ostrich (*Struthio camelus*) lays the largest egg in the world which weighs around 800 g-1.2 kg. It has an incubation period of 42 days. The bird has been originated from Africa and can have a weight of 150 kg. The bird can run at a speed of 70 km/h hence the fastest bird. They are well adapted to extreme weather conditions. Ostrich is the only bird with two toes on each foot. The inner toe, more developed and equipped with a long claw, is a formidable weapon against its terrestrial predators and provides it with good support when running. The biggest eyes of all land animals despite the tiny head. They are omnivorous in nature and their diet consists mainly of roots, leaves, and seeds, but ostriches will eat whatever is available. They also swallow sand and pebbles which help them grind up their food in their gizzard, a specialized, muscular stomach. Their presence is useful because they alert other animals when danger is near. Ostriches produce red meat that is very similar in taste and texture to veal and beef and also high in protein but low in fat and cholesterol. It is a good source of iron, hence can be incorporated in the diet of children. Feathers and hide of ostrich are famous because of its ornamental value. Ostrich skin (hide) is considered to be one of the most luxurious leathers, which is thick, durable and extremely soft and can be utilized in manufacture of shoes, bags, purses and jackets.

Emu (*Dromius Noveahollandiae*) native to Australia is famous for their byproducts like oil, meat, feather and skin. They are mostly seen in U.S.A, China, Australia including Asian countries with significant population. But in India, number is less, around 2 lakhs as per 2012 estimate. An NRI of West Godavari district in Andhra Pradesh started Emu farming for the first time during 1998. Later breeding flocks spread - States of Andhra Pradesh, Tamil Nadu,

Maharashtra, Karnataka and parts of Kerala. Emu lay around 25 eggs per annum, weighs ranges from 475-650 g and appears greenish and looks like tough marble. Natural food of emu is insects, tender leaves of plant and forages. It also eats different kinds of vegetables and fruits like carrot, cucumber, papaya etc. the emu red meat is 98% fat free almost similar in appearance to other red meat like beef, mutton, veal etc. it is low in fat and cholesterol with gamey flavor. Emu oil is semi solid white mass, which is generally located all along back of bird which has dietary, therapeutic (anti-inflammatory) and cosmetic value. The unfertilized eggs which are emerald green are cleaned and used in crafting antique mementos for sale with different carving on the shell. Emu nails are also been used as key chains, pendants in necklaces. The byproducts utilization is best in these two species along with their superior meat quality act as alternate pathway to generate income by farmers.

Conclusion

A balanced diet with all essential nutrients is must for normal growth, health and maintenance of the human body. Eggs and meat from poultry have become a constant part in human diet since decades, but more attracted to chicken. Other diversified species egg and meat have better nutritional value as compared to chicken to some extent. But their availability is still questionable despite of gaining huge demand. Also, the management is comparatively less expensive than chicken due to less capital expenditure and diverse feeding habits. The benefit can be utilized by small scale and marginal farmers to stand steady in rising commercial poultry industry. This can be achieved by building proper market channel to avoid the fluctuations in price for diversified poultry products and incorporating value addition technology and byproduct utilization. Further, to maximize the production performance, scientific methods of rearing of these species should taught to farmers using teaching and training methods. The govt also support the farmers with insurance schemes for diversified species. They are known to supply the best proteins rich in essential amino acids, which tackle the protein deficiency in rural areas.

Reference

1. Prabakaran R, S Ezhil Valavan and AK Thiruvenkadan, 2020. Diversified poultry production: An overview. Journal of Entomology and Zoology Studies 2020; 8(2): 211-217.
2. NABCONS (2022). Study to determine post-harvest losses of Agri produces in India.
3. Biswas, Avishek*, Divya, S., Tyagi, Pramod K., and Mandal, A.B. (2021). Physio-biochemical, antioxidant and oxidative stability of Turkey meat fed diet incorporated with different level of organic Chromium. Animal Biotechnology; 32(1):106-112.

Good Management Practices for Profitable Livestock Farming

Ravikant Nirala, Vinita Yashveer, Ravi Ranjan Kumar Sinha and Archana Kumari

College of Veterinary Sciences, Bihar Animal Sciences University, Patna-800014

Corresponding author: dravikantnirala@gmail.com

Abstract

Good management practices are crucial for ensuring profitable livestock farming. Therefore, for profitable livestock farming and to maintain the quality of the milk, both pre and post secretory management at the farm level should be focused under good Managemental practices. By implementing these good management practices, livestock farmers can enhance productivity, optimize resource utilization, minimize risks, and ultimately improve profitability in their operations. A farmer for profitable livestock farming must adopt good standard practices as suggested in the chapter.

Introduction

India has emerged as the highest milk producing country in the world with an annual production of more than 210.84 million tonnes with annual growth rate @6%. The per capita per day availability of milk has also increased to 300 grams in 2022-23, which depicts sustained in the availability of milk and milk products. Dairy has emerged as strengthening India's rural economy, income and employment generating opportunities for our masses. Moreover, there is need of good management practices to get optimum yield from lesser number of animals. There are many misconceptions regarding milk quality among the common people and to many, it may refer to fat contents as, it is believed that thicker the milk better it is. However, health awareness, disease pattern in the masses and the globalization has added a new dimension with regard to quality and hygienic milk. Therefore, producing clean milk has become right now the utmost necessity to make survive dairy industry in the open market. Clean milk does not mean making the milk free from extraneous matters by passing it through sieve or muslin cloths. It actually means, the milk coming from healthy dairy animals, possessing good flavor, handled under hygienic conditions devoid of dirt and filth and contains relatively small numbers of bacteria and free from pathogens. Therefore, good animal management practices are essential for maintaining the health and well-being of livestock, including dairy animals. Here are some key aspects of good animal management:

Housing Management

Clean housing and shed at a well-elevated place with good drainage is important to have healthy animal, which will produce hygienic and healthy milk. Design of the shed should be appropriate and well ventilated with windows admitting day light, otherwise metabolic gases like methane, moisture and carbon dioxide produced by the cow and ammonia gas produced by the microorganisms acting on the dung will not find easy exit. Shed should have pucca flooring and adequate slope for drainage. The shed should be fitted with fly- proof wire

mesh as far as possible. It is recommended to clean dairy shed at least 30 minutes before milking and dry as well wash the floor every day, so that the flying dust is allowed to settle on the grounds. Water for dairy use must be either an approved, piped supply or chlorinated (50 ppm) before use. Moreover, to keep the shed clean spray kerosene in the “dung pit”, fly repellent such as phenyl, bleaching powder and detergents should be sprayed inside the shed and premises. Further, remove dung more than once a day, preferably away from the shed. Basic housing requirements should be followed.

Health Management

Health is the state or condition of body when all systems function normally and animal is able to perform ‘sufficient amount of work without feeling unduly fatigued. According to WHO health is a state of complete physical, mental and social well-being, and not merely the absence of disease. Disease: Any deviation from healthy or normal state is called disease. (dis = Not, ease = Comfort). Health and disease are subjected to a complex of contributory factors associated with the animal organism itself or with the environment in which it must manage to exist. Animals should be properly vaccinated against important diseases. Proper deworming at regular interval and screening for the infectious diseases must be practiced, generally twice a year that will help in clean milk production. Exclude milk from clinical mastitis cases to avoid high bacterial counts. Use mastitis control routines at every milking to reduce the proportion of infected cows and clinical mastitis. Milk from diseased animals must be discarded. Further, discard the milk from the animal treated with antibiotics for the prescribed days as the milk may have antibiotic residues and antibiotics, which will affect quality of the milk and health of the consumer.

Factors affecting health of livestock

There are a variety of factors which affect the normal physical state or physiological functions of the body. The major factors affecting health are climate, environment and lack of sanitary measures. Nutritional inadequacy or deficiency, lack of preventive measures, improper routine management, heredity, stress or strain, disease, age, poisoning etc. These can be described as below:

- Qualitative and quantitative deficiency of feed, which is inadequate in nutrients like proximate constituents (carbohydrates, protein, fats etc.) as well as minerals, vitamins etc.
- Climatic or seasonal changes affecting mainly the health of animals as certain diseases are climate specific and their frequency of occurrence increases in that particular environment.
- Faulty Managemental practices induce the diseases.
- Inadequate or lack of sanitary measures in animal houses, particularly in milking parlours and rearing stalls.
- Inadequate indoor environment viz. inadequacy of housing in terms of space, ventilation, drainage, over-crowding, faulty layout of animal house, faulty flooring, wet bedding etc.

- Outdoor environment including topography, soil type, population density, feed and water supply and waste disposal affect the normal health of animals.
- Climatic stress, high environmental temperature, high humidity, chilled weather.
- Industrial waste, chemical running in pasturelands contaminating the pasture and inducing toxicity, industrial fumes and smokes and agricultural pesticides also affect the health of animal.
- Non-observation of proper quarantine period.
- Any type of toxicity, dietary mistakes, sudden change in feed and faulty feeding practices.
- Un-hygienic polluted drinking water supply.
- Animals living in hot climatic conditions in tropical zone, if transferred to cool temperature region or vice versa, become more susceptible to stress.
- Lack of preventive measures like scheduled vaccination against infectious or contagious diseases and failure in control measures against spread and reduction of disease are the important factors causing disease.
- Consumption of some poisonous herbs, grasses, shrubs, forage, plants, licking of salt or other metals, directly or indirectly may affect the health of animals.
- Ageing is apparently associated with decline of health; the young animals have high vitality and resistance, which fall with advancing age.

Signs of health and disease: -The symptoms shown by an animal will help to Diagnose whether it is healthy or diseased. Some of the important symptoms of ill health in animals are described below:

1. The general posture of the animal, its movement and Behaviour will change in case of illness. Animals standing with head down or showing undue weariness or a tendency to separate from the herd are warning symptoms.
2. Healthy animals eat greedily. Loss of appetite and stoppage of rumination in case of ruminants are early signs of diseases. One has to; however, make sure that because of animal going off-feed is not due to unsuitable feed, dirty feeding troughs or lack of water.
3. The skin of animals should be soft, elastic and pliable. Skin texture can be felt by grasping a fold of skin over the side of neck between thumb and fore finger. A coarse and dry skin especially in pigs indicate disease. Pigs with swine erysipelas are covered with purple patches. Parakeratosis in swine is related to zinc deficiency.
4. Raised hair coat, falling of brittle and lusterless hair is undesirable. The coat should, not have patches. Patches usually indicate rubbing to relieve; irritation caused, by parasites such as lice. The condition of the coat will vary with housing condition and grooming, but when cattle are infected with worms, or having wasting diseases, their coat loses bloom. In sheep the coat must not be dull and showing signs of falling off.

5. Muzzle and nostrils of healthy animals will be moist and free from any discharges. The muzzle will be dry in animals having high temperature.
6. Variation in body temperature can be measured by inserting a clinical thermometer into the rectum of an animal for half a minute. High temperatures are usually associated with the increased activity of the body in fighting off disease. Young animals, female-in Late pregnancy and excited animals frequently show -higher temperatures than normal. On chilly days, weak and debilitated animals may have sub-normal body temperature. The eyes in healthy animals are bright and alert. Sunken eyes with a fixed staring look often accompany the onset of fever. Lacrimation or glued eyes should be specially noted. Trouble in one eye indicates local condition while discharges from both the eyes a systemic ailment.
7. Dung of healthy cows should be semi solid in consistency, rich green in color and free from gas bubbles or blood clots and mucous. Dung of sheep and goats is in the form of aggregates of small globules. Constipation or scouring should be particularly noted.
8. Urine should be clear and straw-colored. It should not be dark or bloody in color, nor should it have any abnormal odor ex. sweet odor in ketosis.
9. Vulva and tail should not show any evidence of discharge from the genital organs. Pus containing discharges indicate septic conditions of the reproductive organs, which should be particularly attended to.
10. Change in quality and quantity of milk yield **is** one of the early symptoms in several diseases. Milk yield in dairy cows will fall even if -the cows' have only a slight chill or heat exhaustion. Blood and clots in. milk indicate mastitis.
11. When cattle lie down, they first sink on their knees, bring their hind legs under them, and sink down on to the sternum and side. When rising, they get on their hind legs first. After arising, a healthy animal should stretch.
12. Chewing wood or mud or unanimated material in mineral deficiency diseases is observed.
13. The muzzle becomes dry in the animals having high body temperature whereas the muzzle and nostrils of healthy animals are moist and free from any discharge.
14. Change in voice of animal i.e., groaning, grunting and grinding of teeth indicates the evidence of pain
15. Inflammatory conditions and edema of any body part. Presence of nervous signs and change in colour of visible mucous membranes are other symptoms of illness. Change in standing posture and movements, while walking.

Feeding Management

Animal feed must be of good quality. Older, stale and mouldy feed should not be fed to the animals. Healthy cow will be disease free and will yield clean milk. Vegetables like cabbage, turnip, onions, garlic etc. are bound to cause off flavors, so it should be avoided. There should not be sudden change in feeding, which may lead to variation in composition of fat. Entry of insecticides and pesticides in the feed materials must be checked, as it may come in the milk

that might be hazardous to consumers. Animals should not be allowed to drink dirty water, which may cause disease. Clean the water tubs and the manger every day with clean water. Do not feed the animal with leftover food, which is spoiled and having mould growth. Automation in feeding schedule may be adopted at large dairy herd like use of automatic concentrate dispensers, automatic milk replacer dispensers etc.

Water requirement

Water constitutes about 70% of animal's body weight and almost 87% of milk. Lack of water will cause more loss than deficiency of any other nutrient. A loss of 7 to 10% of body water results in death. Drinking water should be clean, pure and palatable and should be free from toxic substances and excessive amounts of minerals, infective organisms and internal and external parasites, etc. Large quantities of water are also required to keep animals and their habitations clean. Water requirement of domestic animals is mainly based on type of animal, body size, nature of food, functional activity and season. Dairy cows and buffaloes under average feeding conditions require about 27 to 28 litres of water/ day for maintenance and 1 liter of water for each 0.5 kg of milk produced. Buffalo calves need 12 liters of water in winter and 28 liters in summer for drinking. Buffalo heifers need 27 liters in winter and 55 liters in summer. Adult dry animal needs 45 liters in winter and 56 liters in summer. Lactating animals need 58 to 60 liters in winter and 63 to 65 liters in summer. Dairy cows and buffaloes should be provided with water at least 3 times a day in summer and 2 times a day in winter.

Milking Management

The milker should be in good health and free from any communicable diseases like TB or flu. She/he should follow hygienic practices from beginning to end. The milker should wear clean clothing and cover their head at the time of milking. He/she should maintain adequate personal cleanliness, like cutting the nail regularly, because nails may cause injury to teats. Washing of hands with soap and dry the hands with clean towel, before milking must be practiced. The milking barn should be thoroughly washed and scrubbed after each milking, so that the barn will be clean and dry, before the subsequent milking is commenced. No dusty and mouldy feed should be fed during milking. Milker should groom the back, belly and insides of thighs to remove the dried dust and fallen hairs from the body coat, so that they do not enter in the milk. Milking vessels preferably be made of stainless steel, without any holes and patch up, and may be easy to clean. It must be properly cleaned, disinfected or sterilized. The milking pail should have small opening to avoid contamination from outside. The udder should be wiped with a cloth dipped and squeezed in some weak antiseptic solution. In winter, the cloth may be dipped in warm antiseptic solution. Milking should be conducted gently, quietly, quickly, cleanly and completely. Comfortable animals, yield more milk than a roughly handled and excited animal. Maintenance of clean condition in the milking barn results both in better udder health and production of milk that remains wholesome for longer time. The act of milking should be finished within 5 to 7 minutes, so that the udder can be emptied completely so long as the effect of oxytocin is available. Complete milking has to be done. Microorganisms will act on the left-over milk in the udder, which will ultimately result in mastitis. A milk strainer should invariably be used before milk of each animal is poured into the milking can. Experienced

milkers should be put on first calver cows. An ideal proposition is to rotate milkers among a group of cows, so that the cows will get accustomed to all. Any change in timing of milking or even change in ration should be brought about gradually. In India, Stripping and full-hand milking are the two commonly used methods of milking. The full hand method comprises of holding the whole teat in the first finger encircling the teat. Many milkers tend to bend their thumb in, against the teat while milking which is called knuckling. This practice should be avoided as it injures the teat tissues. Full hand milking removes milk quicker than stripping, because of no loss of time in changing the position of the hand. Cows with large teats and she-buffaloes are milked by full-hand method; but stripping has to be adopted for cows with smaller teats for obvious reasons. Full-hand method is superior to stripping as it simulates the natural suckling process by calf. Stripping causes more irritation to teats due to repeated sliding of fingers on teats; and so, discomfort to the cows. In spite of these drawbacks, when all the milk available is drawn out by full-hand method. Stripping should be resorted with a view to milk the animals completely; the last drawn milk is called stripping and is comparatively richer in fat. Disinfect the teats by teat dip (with disinfectants such as iodophore) after milking, to avoid entry of microorganisms to the teat canal. In India milker has hidden tendency to dip the fingertips in milk or apply oil, which is not desirable because, it may allow the dirt to enter the milk. After getting of milk, it must be covered with cloths. The object of milking is to obtain the maximum quantity of clean milk within the shortest period without causing injury to udder or teats. If the milking is incomplete there is a tendency for the cow to dry off too soon and chances of udder **infection** are more.

The milking animals should be housed in a clean hygienic barn. Before milking clean the animals thoroughly especially the hindquarters. No husky feed should be given at the time of milking. Wipe the udder with a clean cloth dipped in a mild antiseptic lotion. Milker should be clean, wear clean clothes, wash the hands and trim the nails. Animals are creatures of habit; hence stick on to the time of milking. Letting down of milk occurs within half to one minute and milking should be completed within 5 to 7 minutes.

Management during collection and transportation of milk

It is essential to reduce the time gap between milking and its reception at the chilling centers. Milk collection place and other room should be maintained clean to prevent contamination. There must be adequate provision for cleaning and sanitizing the vessels used for milk collection. Sanitizer should be kept away from the milk collection place. It should be ensured that the milk cans are in shade, when kept for loading in the truck. Trucks without the cover or hood should not be used. As they expose the milk to sunlight and hence, accelerate the growth of microorganisms. Careless handling of cans leads to dents/damages, which act as points for growth of microorganisms. Most of the growth of microorganisms takes place during the time lag between milk collection and the milk receipt at the dairy/collection docks. It should be ensured that this time has to be reduced to the possible extents. Therefore, the first step may be to organize speedy transportation of milk from village societies and collection centers, closer to dairy plants.

So, there is an urgent need to produce healthy and clean milk if we want to withstand in this competitive world and to get maximum benefits. Government of India has also started one

scheme with the objectives like creation of necessary infrastructure for production of quality milk and milk products at the farmer level. Further, training and strengthening of infrastructure (by providing seamless buckets, milking pails, disinfectants, etc) as well as creating mass awareness about importance of clean milk production will ensure the hygienic milk. This will strengthen the growth and development of the dairy industry of our country. But there is still need to augment our extension infrastructure for the dissemination of current knowledge to the farmers.

Management During Different Physiological Stages of Animals

Care and management of heifers: -

Productive and reproductive performance of cows depends on the care and management at their heifer stage. Heifers of zebu breeds mature and calve much later compared to European breeds. Rearing period of heifers can be divided into two stages, viz. from weaning to first service and from first service to calving. Heifers can be reared indoors or outdoors. The animals of different ages are kept separate for proper feeding and management. The size and age of the heifers should be the basis for giving first service. Undersized heifers show stunted growth and give birth to weak calves. Routine periodic weighing and comparison with a normal growth curve for the breed can help identifying poor growers early and applying necessary corrective measures. On an average the body weight of heifers at first service should be 200 to 250 kg for crossbreds. Attainment of proper body size and maturity is mainly controlled by nutritional regimen adopted. Heifers should be treated with kindness and 2.5 to 3 sq.m of covered floor space should be provided for each. The normal variation in the period of oestrus is 18 to 24 hours. The duration of heat is shorter in zebu. The short duration of heat and the fact that the heat period often occurs at night, complicates the breeding management. Identify the heifer in heat by routine checking. Observe the heifers at least 3 times a day for signs of behavioral heat; one should observe especially early in the morning. The heifer in heat will be awake and on feet quite ahead of other animals. Standing heat is the best sign of heat in which the heifer will stand and allow other animals to mount her.

Care and management of cow during pregnancy and parturition: -

All pregnant animals need care and protection. Proper nutrition and other Managemental practices ensure better production, a healthy calf and a healthy mother. Pregnant animal ration should contain all nutrients in adequate quantity. They should be spared of all forms of violent exercises. They should not be made to walk long distances, run fast, chased, frightened or allowed to fight.

Usual signs of pregnancy are: Cessation of oestrus, alteration in temperament; fattening tendency, easily induced fatigue, enlargement of abdomen, enlargement of mammary gland, increase in weight and 'quickening' i.e. signs of life exhibited by foetus in uterus. The gestation period in cows is a little more than 9 months (280-285 days); 310 days in buffaloes, 340 days in mares; 378 days in camels; 145-150 days in sheep and goats; and 114 days in pigs. A record should be kept indicating date of service so that date of parturition can be calculated.

In cattle, 0.5 to 1 kg extra concentrate mixture depending on the condition of the animals should be given from sixth month of pregnancy for meeting the demands of the developing foetus, building-up body reserves during preparation for the ensuing lactation and growth. Therefore, heifers and first calvers should be fed extra ration for growth in addition to other requirements. It is usual to add 0.45 kg starch equivalent and 0.15 kg digestible crude protein to the cows' ration during pregnancy. Feeding in preparation to calving is called "steaming up" or challenge feeding. It is usual to start with 1.5 kg concentrate/day from two months before calving and increase it to 4 to 5 kg two to three days before parturition. Steaming up increases daily milk yield, lengthens the lactation period and also increases the butter fat percentage.

As a preparation to calving, animals should be transferred to a quiet, comfortable, hygienic and well bedded place at least one week before calving. It should be kept on a light, laxative diet and given water to drink throughout. Clean freshwater should be provided. The feed should not be reduced too much before or after parturition.

Common signs of approaching parturition are swelling of external genitals with a clear mucous discharge, enlargement of the udder and engorgement of the (cats, relaxation of pelvic ligaments and muscles around the tail head and pin bones. Temperamental alterations are also observed.

Care at calving: -

The golden rule is not to interfere with the normal calving process. In unnatural presentation or difficulty in parturition, professional help should be sought. Animals should not be allowed to eat placenta as it may cause indigestion. Normally placenta is expelled within 4 to 8 hours of parturition. In case of retention of placenta, it can be removed manually after 12 to 18 hours. Care should be taken that no portion of it is retaining inside. Once the placenta has been expelled and the calf is on foot, it is considered as a successful parturition. The cow can be returned to the milking herd after 3 or 4 days.

Animals in milk should be dried off after about 300 days of lactation. This practice enables them to recoup and get ready for the next lactation without subsequent reduction in yield during the ensuing lactation. Usual methods of drying are stopping milking forth-with, which is considered as the best method, incomplete milking, which is time consuming and, intermittent milking which is the least satisfactory. In all these methods proper udder protection measures should be adopted to obviate mastitis.

Care of newborn calf: -

Calf is the future of the herd. The future of a stock depends upon the care and management of the newborn. In cattle rearing, good dairy herds are raised rather than purchased. The care and feeding of calves truly begin before they are born. Pre-weaning nutrition can have profound impact on the development of calf that enhances first lactation and lifetime productivity. Holistic approach to calf nutrition, health and housing is required to achieve lifetime performance from the dairy replacement heifer. Calf rearing practices viz. pre-partum management, naval dipping, timely colostrum feeding, scientific milk feeding regime, introducing calf starter early in life, reducing weaning stress, ideal housing and bedding, timely deworming and vaccination;

all are necessary to exploit the production potential and to make it a step ladder for profitable dairy farming

Care soon after birth: -

- Cleaning the mucous sticking with nose, eyes and mouth with a clean hand/ finger using hygienic cloths.
- If the calf does not start breathing, artificial respiration should be given
- Inserting some straw/ twig in the nostril to initiate respiration.
- Picking the calf with his rear legs and keeping it hanging with head downwards for some times.
- Pouring cold water on calf head, which causes the gasping reflex in the calf
- Opening the mouth and pulling the tongue
- Artificial respiration
- Sucking out the mucus through nostrils.
- Blowing in air through the calf's nostrils & closing its mouth.
- Alternate pressing and relaxation of the chest should follow it.
- Initiate respiration by stimulation.
- Immediately after birth, any membrane or mucous adhering to the mouth, nostrils, eyes and ears of the newborn should be carefully removed to facilitate normal breathing.
- Use a clean dry cloth for this. In dairy cattle, a cow will lick her calf dry.
- Sprinkling a little common salt on the calves' body can induce licking.
- In total weaning, a calf should be thoroughly cleaned before shifting it to a warm, well-ventilated house.
- This can be done by pressing and relaxing alternatively the chest wall or if the young one is smaller hold it by the hind limbs, lift it with the head down and swing it.
- Care is taken so that the young one is not slipped out of hands.
- Record the birth weight of calves.
- Disinfection of the navel cord is the next process. The navel cord of the calf is tied 2.5 cm away from its body and cut about one centimeter below the ligature. Apply antiseptics to the stump for 2-3 days. A normal healthy calf gets up within 30 minutes time.
- Weaker calves need assistance.

- Feeding colostrum within the first hour of life is essential. Colostrum feeding should be continued for the first 4 days of life. The calf needs 3-4 liters of colostrum daily in 3 equal feeds. Colostrum feeding has many advantages. The primary function of colostrum is to fortify the calf's disease resistance. This is due to the antibodies in colostrum. To be effective, the gamma globulins, which are nothing but antibodies, must be absorbed as such into the blood stream. This is possible only in the first few hours after birth when the permeability of intestinal mucous membrane for the large globulin molecules is high. Thus. The earlier the calf gets the colostrum the better it is. Colostrum has large quantities of vitamins and minerals. It has twice as much dry matter as milk. It acts as a laxative and has a disinfectant action on the bowels and it clears the meconium. Calves should receive sufficient colostrum for the first 3 or 4 days. In case of non-availability of colostrum from mother, colostrum from other cows or preserved colostrum can be provided. In the absence of colostrum, a mixture of 2 eggs in 30 ml castor oil is good. In such cases injection of mother's serum to augment antibody will be very useful. Within two hours of first suckling 'meconium' is passed.
- If meconium is not passed an enema with 1 teaspoon of soda-bicarb in one-liter lukewarm water may be given. Weaning at birth or complete weaning is one method and weaning after the colostrum period is the other. It has many advantages.
- Dam's milk production can be recorded properly for future selection and progeny testing. Calf feeding is made scientific.
- Calf is not required for letting down of milk and weaning prevents teat injuries. Fresh warm whole milk is fed to calves @ 1/10th of its body weight. One kg gain per 1.39 kg dry matter in milk is true growth. Never exceed 4.5 kg milk or milk substitute per day.
- All calves must receive sufficient milk during the first 3 months. Small quantities of dry meal should be fed to them. Example of a good meal for calves consists of one part of linseed-meal, 2 parts of oatmeal, 2 parts of well-crushed maize and one part of bran in gruel form. Little common salt and mineral mixture can also be added to it.
- Calves, after weaning, can be trained to drink milk from clean bucket or trough. In recent years a number of efficient calf starters have been developed. These should be given for healthy growth of calves. Calf should receive sufficient milk during the first 3 months.
- About 110 kg of whole milk in 4-5 weeks with a calf starter of high-quality protein and low fiber content ensures a healthy calf. Trace minerals copper, iron, magnesium, manganese, zinc, etc. which are deficient in milk, are usually added to the calf starter as a mineral mixture. Rub a small amount of starter on the calf's mouth, after each

milk feeding for a few days when the calf will be accustomed to it green fodder can be offered from 15 days onwards.

- Calves should be liberally fed as they are continuously growing: over feeding however should be avoided and scrupulous cleanliness observed in every stage of feeding and general management. Prevent licking in group housing.
- Dehorning and disbudding are adopted in horned cattle breeds. Disbudding is done in 3 to 10 days. The process of dehorning is accomplished by applying caustic potash on the horn button. Cut the hair and clean the area with a mild antiseptic. Apply Vaseline on the periphery of the clipped area to protect the adjoining tissue. The horn button is vigorously rubbed with a caustic potash stick till a slight bleeding appears. Hold the caustic potash stick wrapped in cotton wool or paper so that burning of fingers is avoided.
- Pressing hot iron to burn the horn tissue or use of an electric dehorner are other methods available. Dehorning should not be done during extremes of weather conditions and during fly season. Marking for identification is another important management practice. Identification of animal's aid in daily management decision. It is a must for breeding decisions, registration of animals, merchandising, health and reproductive records, ensuring animals and issuing certificates. Whatever be the system of identification involved, it should provide reliability, visibility and should not be costly.
- Different system adopted in identification is: keeping colour sketches and photographs. This is easily done in computer graphics in large farms.

Particulars	Enhanced / accelerated / intensified feeding programme		Conventional restricted feeding programme		Particulars	Enhanced / accelerated / intensified feeding programme
Milk	Greater milk allowances		10% of the body weight		Milk	Greater milk allowances
Advantage	Greater growth rate prior to weaning		Reduced feed costs		Advantage	Greater growth rate prior to weaning
Ingredients	Maize	GNC	Wheat bran	Gram	Mineral mixture	Common salt
Composition	42	35	10	10	2	1

Type of worms	Deworming schedule		
Roundworms	First dose at 10 days of age and thereafter at monthly intervals up to 6 months. After 6 months of age, deworming to be done at an interval of 2 months		
Liver flukes	Twice a year in endemic areas (before and after monsoon)		
Tape worms	Twice a year (in January and June in calves in problem herds)		
Disease	Strategy	Type of vaccine	Remarks
Food and Mouth disease	First vaccination at 4 month then every 6 months (Feb-March and August-September)	Polyvalent tissue culture vaccine	
Anthrax	First vaccination at 6 month then once a year pre-monsoon	Spore vaccine	Only in endemic areas
Black Quarter	First vaccination at 6 month then once a year	Killed vaccine	Before onset of rainy season (May-June)
Hemorrhagic Septicemia	First vaccination at 6 month then once a year	Oil adjuvant vaccine	Before onset of rainy season (May-June) or during outbreaks
Brucellosis	At about 6 month of age (calf hood vaccination)	Cotton strain 19 (live bacteria)	

Record management

Record keeping is a meticulous and essential management practice. Complete and accurate herd records are a valuable asset to the management of cattle, buffaloes and other livestock. The information on date of birth, sex, colour, tattoo and growth rate are recorded initially. In addition to these records, breeding and performance are helpful in selecting herd replacements and aid in culling of animals. The financial predictions of a livestock enterprise are mainly based on records. These days, computer aided management information systems (MIS) are efficient tools for management, record keeping and decision making in large farms.

Nutritional Management for Profitable Dairy Farming

Madhu Suman, Devesh Thakur, Manoj Sharma and Rakesh Ahuja

Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya (CSKHPKV), Palampur

Corresponding author: madhu.rana5@gmail.com

Abstract

Nutritional management is important for profitable dairy farming. A well-balanced ration is prerequisite for optimal growth, production and reproduction. With good nutrition, dairy cows can demonstrate their full genetic potential whilst maintaining their good health. The ration should meet the cow's energy, protein, minerals and vitamins requirements for maintenance, milk production, growth and reproduction. Precision feeding optimizes performance by manipulating the feed quantity/quality wise as per the nutrient requirement of the animal thus leading to production of economically and ecologically sound animal products which are highly acceptable to the consumers. Thus, any managemental step to reduce the cost of feeding will definitely improves the overall profitability of livestock farming.

Introduction

The feeding management and formulation of least cost rations is vital for optimal productive and reproductive performance of dairy animals and farm profits. The feeding cost of dairy animal's accounts for 60 to 70% of the recurring costs on the farm. The quality and quantity of feeds selected need to be ensure the availability of required nutrients for maintenance, health, and production. It is challenge to fulfill the nutritional needs of the high-yielding cow for optimum production and reproduction. It is not only the quantities of different nutrients, but also their quality that plays a vital role for optimum production and reproduction. Main objective of rearing livestock is to produce unadulterated wholesome food in the form of either milk or meat to the consumers. The feeding of dairy animals should be done precisely to meet its nutritional requirements for optimum productive efficiency and to contribute cleaner environment by reducing the enteric emission of methane, excretion of nitrogen (ammonia), phosphorus and other compounds into environment (Reddy *et al.*, 2009).

Precision Feeding: Precision feeding optimizes performance by manipulating the feed quantity/quality wise as per the nutrient requirement of the animal thus leading to production of economically and ecologically sound animal products which are highly acceptable to the consumers. Thus, any managemental step to reduce the cost of feeding will definitely improves the overall profitability of livestock farming. In phase feeding the feeding is planned to closely match the animal's nutrient requirements and minimize the over- and under-feeding of nutrients. Ideally, to get maximum benefit from phase feeding, diets to be fed and feed budgets are established based on actual animal performance and profitability/performance goals. However, the disadvantages of moving from one feed to a phase feeding system includes greater complexity in ordering feed and the potential need to install additional feed bins on the farm (ICAR, 2013). However, with increased pressures on profitability, these disadvantages must be weighed against the benefits of improved animal performance and profitability. Five

distinct feeding phases can be defined to attain optimum production, reproduction and health of dairy cows.

Phase 1: Early lactation: 1 to 70 days (peak milk production) after calving (postpartum).

Phase 2: Mid lactation: 70 to 140 Days in Milk (Peak DM feed intake).

Phase 3 : Late lactation: 140 to 305 Days in Milk (Restoration phase).

Phase 4: Dry period: 60 to 14 days before parturition.

Phase 5: Transition or close-up period—14 days before and after calving.

Phase 1: Early Lactation - 0 to 70 Days Postpartum

In dairy animals, milk production reaches its peak usually at four to eight weeks postpartum, but dry matter intake does not increase proportionately to meet energy requirements until 10-14 weeks postpartum. Thus, dairy cows will typically suffer a 6–8-week period of negative energy balance during the postpartum period (Butler and Smith 1989). When animals are in negative energy balance, they undergo several physiological and metabolic changes which may predispose them to several negative effects like poor reproduction performance (irregular cycles, increase interval to first service and reduce conception rates), poor immunity and failed to reach peak milk production. The immune system relies on energy availability through oxidative phosphorylation; therefore, the immune system (e.g. macrophage function) is impaired in association with hypoglycemia and ketosis. Reduced immune response results in several negative events like mastitis, lameness, respiratory diseases and metritis (Moyes *et al.*, 2009). High energy diets are needed to be formulated and challenge feeding has to be adopted to prevent negative energy balance.

Challenge feeding

Challenge feeding starts two weeks before the expected date of calving (Steaming up). High milk producing animals are fed increasing quantity of feed challenging them to produce at their maximum potential. This helps in adaptation of the rumen microbes with the grain/concentrate during the ensuing lactation period when nutrient requirement cannot be met, especially in high-yielding (more than 20kg milk) cows without grain or concentrates. Feeding concentrate mixture should be started initially at 500 g per day and increase it gradually to a level of 500 -1Kg per 100 kg body weight.

Combating Strategies to prevent negative energy balance:

- **Dry matter intake:** Feed intake is the key factor in maintaining high milk production. Cows should be encouraged to maximize their intake during early lactation. To increase DMI, the animal should be allowed ad lib feeding and ensure availability of feed in the manger most of the time. The roughages should be of high quality with not more than 40-45 % NDF. The roughage should not be ground or pelleted but should be chopped to a length of 2 inches or longer. Aromatic compounds are of particular relevance for cattle since they have almost three times more taste receptor cells than humans do. Many phytogenic or botanical substances contain sensory-relevant compounds that

make feed tastier for cows. These include essential oils, herbs, spices and extracts that provide flavouring properties, particularly aromatic phenolic compounds found in thyme, clove, etc. Feed conversion efficiency can be improved by supplying helpful rumen microbiota with functional components such as nucleotides and glucans. The increase in microbial population leads to improved feed digestibility.

- Mobilization of body reserves during early lactation can be prevented by feeding oilseeds such as cotton seed sunflower seed and soybean which supply both protein and long chain fatty acids (LCAs) for post ruminal digestion (by pass protein and bypass fat).
- The energy content of the ration can also be increased by using fats or oil at 4% in the concentrate mixture.
- For Cows or buffaloes yielding more milk, the ideal protein content of the ration should be 18-20% with 30-35% RDP. Requirements for metabolizable methionine and lysine should also be considered during this period of need, as these amino acids determine the yield of milk / milk protein. Crude protein requirements vary according to the stage of lactation i.e. in early lactation 16-18 %, mid-lactation 14-16%,late lactation 12-14% and in dry period 10-12%CP in the ration.
- Lactating dairy cows need 60–70 litres of water each day for maintenance, plus extra 4–5 litres for each litre of milk produced. Water requirements increase by 6 lts/day for every 4 °C raise in air temperatures.
- **Manipulating dietary fibre level and particle size**

For optimal animal production, the rumen should operate to its maximal efficiency in terms of mixing, rumination and emptying. But for effective rumen mixing and rumination, care must be taken to ensure sufficient fibre level with optimum physically effective fibre (PEF) length in the total mixed ration (TMR). Animals yielding 25–30 litres/day, the R: C ratio should be 50:50, 60:40 and 70:30 in early, mid and late lactation; and animals yielding 30–40 litres/day the R: C ratio during early lactation should be 40:60. Rumen pH is stabilized by a proper balance of slowly (fibrous) and rapidly fermentable NFC and optimum PEF length to stimulate rumen mixing, rumination and saliva production. Low rumen pH caused by shorter length of PEF reduces production efficiency by increasing rumen emptying time, reducing rumination, decreasing DMI, impairing rumen contractions, fibre digestibility, and microbial yield from the rumen and milk fat depression (Allen, 1997). Coarse, fibrous feeds stimulate more saliva production during eating and stimulate rumination than do finely ground feeds or fresh pasture. It has been reported that reducing forage particle length (<6 mm) may reduce feed bunk sorting behaviour of dairy cattle. Rations containing a greater proportion of longer particles (>19 mm) are likely to have a larger difference between the feed originally offered and that consumed throughout the day because of sorting activity (Zebeli *et al.*, 2008). Forage/silage/hay particles length (shorter 6 mm or longer 19 mm) can affect the production and health of dairy cows.

- **Rumen-stable and rumen-protected fats**

Protected fats, including calcium soaps and prills, which are not available to ruminal modification, may provide energy in forms that have less effect on feed intake and can provide specific fatty acids (Lean *et al.*, 2010). By protecting the fats from ruminal degradation, the fat content of the ration can be increased up to 6- 7% of the DM intake and supplementing ration of lactating animals with bypass fat enhances energy intake in early lactation and reduces deleterious effect of acute negative energy balance on lactation (Tyagi *et al.*, 2010). This in turn would help in improving milk production and reproduction. Use of the bypass fat should be in the ration of dairy animals for 10 days before and 90 days after calving. It can be supplemented in the ration of dairy animals @ 15-20 g per kg milk production or 100 -150 g per animal per day. Feeding bypass fat does not hamper fibre digestion and is always beneficial than feeding ghee/oil.

- **Bypass protein: The best way to increase milk protein**

The protein requirement of high-yielding cows cannot be fulfilled by rumen microbes, so the diet of such cows should include proteins of relatively low degradability or rumen undegraded protein that will escape breakdown until they reach the intestine. Supplementation of rumen bypass protein during prepartum and postpartum period increases milk yield as well as milk protein content (Robinson *et al.*, 2000). Undegradable or bypass protein (UIP) should be 35 to 40 percent of the CP in early lactation and 30 to 35 percent of CP in late lactation.

- **Feeding frequency**

Increased feeding frequency reduces daily variations in rumen pH and thus helps stabilizing the rumen environment. The proper range and consistency of ruminal pH is critical in fiber digestion.

- **Feeding sequence**

If forage and concentrates are being fed separately, forages should be fed first in the morning followed by a portion of the concentrates.

Phase 2. Mid lactation: 70 to 140 days in Milk (Peak DM feed intake)

During this phase the feed intake is near maximum and can supply nutrient needs. In this phase feed intake is maximum, so animals not losing body weight, and are either maintaining weight or slightly gaining weight. Animals are expected to take dry matter at 4 % of body weight. Concentrate intake should not exceed 2.5 percent of the cow's body weight and intake of good quality forage should be minimum 1.5 percent of the cow's body weight (DM basis) to maintain rumen function and normal levels of milk fat.

Phase 3. Late lactation: 140 to 305 days in Milk (Restoration phase)

In this phase milk production is declining, the cow is pregnant, and the animals begin to replace body weight lost during early lactation. Concentrate feeding should be at a level to meet milk production requirements. Consider NPN as a source of supplemental protein.

Phase 4. Dry period - 60 To 14 days before parturition

The dry period is a critical phase of the lactation cycle to increase milk yield during the following lactation and minimize metabolic problems at or immediately following calving. In the dry period the secretory tissue of the udder involute and the renewal process takes approximately six weeks and, if a cow is allowed no dry period at all, will result in a loss of milk of at least 30% in the subsequent lactation. The high-producing cow will have severely depleted her body reserves of minerals, especially calcium and phosphorus, during her lactation. Adequate mineral nutrition during the dry period is very important to replenish minerals. Rations should be formulated to specifically meet the nutrient requirements for maintenance and fetal growth. Pregnant animals are to be offered extra nutrients during the last two months of gestation, so the cows not only gain their initial body weight but also put on an extra 25 to 30 kg of body weight, which is necessary to enable the animal to withstand the stress of parturition and to maintain the persistency of milk production during the subsequent lactation period, DM intake will be near 2 percent of the cow's body weight and minimum of 12 percent CP in the DM is recommended. Provide adequate amounts of vitamin A, D, and E in rations to improve calf survival and lower retained placenta and milk fever problems.

Phase 5. Transition period - 14 Days before and after parturition

In the transition phase the most critical time within this period is the 14–21 days before and 14–21 days after calving (Grummer, 1995). It is the returning point in the reproductive cycle of dairy animals where abrupt, metabolic endocrine and physiological changes are well pronounced. An impairment related to adverse managemental practices in this period leads to aberrant results during subsequent productive and reproductive cycle reflected in term of disturbed production performance, development of subclinical and clinical post-partum diseases like hypocalcaemia, ketosis, abdominal displacement, metritis, poor fertility and poor production (Roche *et al.* 2013). Feeding during transition period determines the cow's productivity during the preceding lactation period. Providing the right nutrition during this period greatly improve the calving ease, calf welfare, milk production and reproductive performance.

Nutritional Strategies for improvement of production performance in dairy animals during transition Period

- **By increasing feed intake and feed conversion efficiency (FCE):** Total Dry matter intake in the ration should be 1.75-2.0% of Body Weight with more than 50-55% of fibre and NDF above 35-40% of total ration DM. The adaptive process in the rumen involves the elongation of ruminal papillae and an increase in absorptive area of the papillae. Further, there is a need to allow rumen microbial populations to form a stable ecosystem based on greater activity of amylolytic that is starch-utilizing bacteria. A failure to successfully adapt rumen physiology to diets higher in starch places the cow at risk of sub-acute ruminal acidosis (SARA) and lactic acidosis. It has been suggested that the lower absorptive area of ruminal epithelium may reduce the rate of absorption of volatile fatty acids and lactic acid from the rumen (Lean *et al.*, 2010). The transition or close-up dry cow feeding program is critical to adjusting dry cows to

the lactation ration and preventing metabolic problems. During the last 3 days prior to calving, the amount of concentrate mixture should be reduced and a little warm bran is fed to keep the animal in laxative condition before calving.

- After parturition, the cow /buffalo should be given fresh warm water and a mash consisting of 1 kg wheat bran, 1-1.5 kg ground grain, 0.5 kg jaggery and 25 g each of common salt and mineral mixture. This mash may be continued for 3 to 4 days after calving; the regular feed may be gradually introduced to the cow.
- Increase protein in the ration to between 14 and 15 percent of the ration DM. Feeding some of this additional protein in the form of undegradable protein may be beneficial in supplying amino acids for fetal growth.
- **Role of cation-anion Supplementation in Diet:** The newly calved cow, where the sudden demand for calcium at the onset of lactation severely tests the calcium homeostatic capabilities of the animal. Hypocalcemia is a predisposing factor for dystocia, prolapsed uterus, retained placenta, and early metritis). Negative dietary cation-anion difference based diet influence the acid-base balance and calcium metabolism in the animal by increasing dietary acidity ([Chan et al., 2006](#)). Increased hydrogen ion concentration induces a mild metabolic acidosis. Acidogenic diets are hypothesized to increase bone resorption, blood Ca and intestinal Ca absorption ([Horst et al., 1997](#)). About 90 g anionic mixture is recommended per day for 3 weeks pre-partum (ICAR, 2013).
- **Role of feed supplement and trace minerals in diet:** Feed supplements (biotin, niacin, calcium propionate and choline etc.) and trace minerals (Co, Zn, Se and Cr etc.) effective for optimum productive and reproductive efficiency.
- **Benefits of feeding Buffer, ionophores in the Diet:** Free-choice Bicarbonate may benefit early lactation or high producing cows and cows under heat stress and helpful in maintaining pH and microbial Flora of Rumen and decreases the incidence of ruminal acidosis followed by lameness.

Conclusion:

Optimum nutritional management is a way of improving productive and reproductive performances in dairy animals. Nutritional imbalances, is the root cause of pre and post-partum illness and depressed performance in dairy animals. Precision feeding practices manage to reduce nutrients/feed intake which leads to less nutrients excreted in feces or urine while maintaining or even improving animal production and the economic viability of an animal operation. Failure to transition successfully can result in reduced DM intake, milk production, delayed oestrus, failure to conceive and increased incidence of metabolic and infectious diseases, many of which are inter-related. Other factor is lack of awareness among farmer about feeding management further exacerbate the situation. So proper nutritional management according to metabolic and physiological changes prevails in that period should be done for the improvement of production and reproductive performance of dairy animals.

Reference

1. Reddy D.V. and Krishna N. 2009. Precision animal nutrition: A tool for economic and ecofriendly animal production in ruminants. *Livestock Research for Rural Development*, **21**(3).
2. ICAR. 2013. Nutrient requirements of livestock and poultry. Indian Council of Agriculture Research, New Delhi, India.
3. Butler, W. R. and Smith, R.D. 1989. Interrelationships between energy balance and postpartum reproductive function in dairy cows. *Journal of Dairy Science***72**:767-783.
5. Moyes K.M., Drackley J.K., Salak Johnson J.L., Morin D.E. and Hope J.C. 2009. Dietary-induced negative energy balance has minimal effects on innate immunity during a streptococcus uberis mastitis challenge in dairy cows during midlactation. *Journal of Dairy Science*,**92**(9): 4301-4316.
6. Allen, M. S. 1997. Relationship between fermentation acid production in the rumen and the requirement for physically effective fiber. *Journal of Dairy Science*,**80**:1447–146.
7. Zebeli, Q., M. Tafaj, B. Junck, D. Mansmann, H. Steingass, and W. Drochner. 2008. Evaluation of the effects of dietary particle fractions on fermentation profile and concentration of microbiota in the rumen of dairy cows fed grass silage-based diets. *Archives of Animal Nutrition*,**62**:230–240.
8. Lean,I and DeGaris.,P.(2010). Transition Cow Management A review for nutritional professionals, veterinarians and farm advisers. Produced by dairy Australia's grains2 milk and in calf programs.
9. Tyagi, N., Thakur S. S. and Shelke S. S. 2010. Effect of bypass fat supplementation on productive and reproductive performance in crossbred cows. *Tropical Animal Health and Production*,**41**: 1749-1755.
10. Robinson P.H., Chalupa W., Sniffen C.J., Julien W.E., SatoH., Fujieda T., Ueda T., Suzuki H. (2000): Influence of abomasal infusion of high levels of lysine or methio-nine, or both, on ruminal fermentation, eating behavior, and performance of lactating dairy cows. *Journal of Animal Science*, **78**:1067–1077.
11. Grummer, R. R. 1995. Impact of changes in organic nutrient metabolism on feeding the transition dairy cow. *Journal of Animal Science*, **73**:2820–2833
12. Roche, J. R., Bell A. W., Overton T. R., and Loor J. J. 2013. Nutritional management of the transition cow in the 21st century – A paradigm shift in thinking. *Animal Production Science*. **53**:1000–1023.
13. Chan, P.S., West, J.W. and Bernard, J.K. 2006. Effect of prepartum dietary calcium on intake and serum and urinary mineral concentrations of cows. *Journal of Dairy Science*, **89**: 704-713.
14. Horst, R.L. and Goff, J.P. 1997. Milk fever and dietary potassium. In: Proceedings. *Cornell Nutr. Conf. Feed Manuf.*, Cornell University; pp-181.

Forage Based Balanced Ration for Sustainable Livestock Production

Deepak Upadhyay, M. M. Das and S. K. Mahanta

Indian Grassland and Fodder Research Institute, Jhansi (U.P.)

Corresponding author: dpkvet@gmail.com

Abstract

A forage-based balanced ration is a key component of sustainable livestock production, particularly for ruminant animals. By formulating a forage-based balanced ration, livestock producers can optimize nutrition, improve animal health, reduce reliance on external feed sources, and promote sustainable livestock production practices. In this chapter importance of forage in livestock feeding have been explained. As well as forage based balanced ration have been suggested for different stages of livestock production. An overall scenario of feed and fodder have also been explained. Different ways of fodder conservation and their requirements have been explained in detail.

Introduction

India has 2.29% of land area of the world but accommodates 17.4% of world human population and 10.7% of livestock population. This explains the huge pressure on land by various enterprises. Further with the increasing human population demand for food is also on increase. In particular with the increase in individual income and urbanization the demand for animal-based food products is on increase. It has been estimated that to fulfil the food demand of human population we need to double the production. This is the reason why the intensive system of livestock rearing is gaining popularity. However, it is pertinent to note that feed cost accounts for 70-75% of the total cost of livestock production. Therefore, to make it sustainable proper feeding strategies need to be followed with proper inclusion of green and nutritious fodder. The availability of land for cultivation of green fodder crops in India is around 5% of the total cropped area. Which almost remain stagnant during last several decades. Crop residues are the single largest bulk feed material available easily to the farmers for feeding ruminants. Cultivated fodders and gathered grasses are two important sources of green fodder for livestock in India. However, supply of feed resources has always remained short resulting in non-realization of the true production potential of livestock. Indeed, the actual milk yield of bovine animals is reported to be 26-51% below the attainable yield under field conditions, (Dikshit and Birthal, 2010). A balanced diet is therefore required to keep an animal healthy and productive. Further to make the livestock production sustainable there must be inclusion of forage component in the diet.

Fodder Resources

1. **Crop residues:** meeting >50% of feeding demand.

2. **Cultivated fodder** from arable land (irrigated and rainfed): Sorghum, Berseem, Lucerne, Maize, Bajra, fodder cowpea and oats (cultivated in >50 % of the land under fodder).
3. **Fodder from common property resources** (like forests, permanent pastures, grazing lands etc.): grazing intensity in the country is as high as 12.6 adult cattle units (ACU)/ha as against 0.8 ACU/ha in developed countries.

Table 1 Scenario of green fodder availability and future requirement

Year Deficit as % of demand (actual demand)	Supply (in million tones)	Demand (in million tones)	Deficit as % of demand (actual demand)
1995	379.3	947	59.95(568)
2000	384.5	988	61.10(604)
2005	389.9	1025	61.96(635)
2010	395.2	1061	62.76(666)
2015	400.6	1097	63.50(696)
2020	405.9	1134	64.21(728)
2025	411.3	1170	64.87(759)

Source: Draft Report of Working Group on Animal Husbandry and Dairying for Five Year plan (2002-2007, Govt. of India, Planning Commission, August -2001)

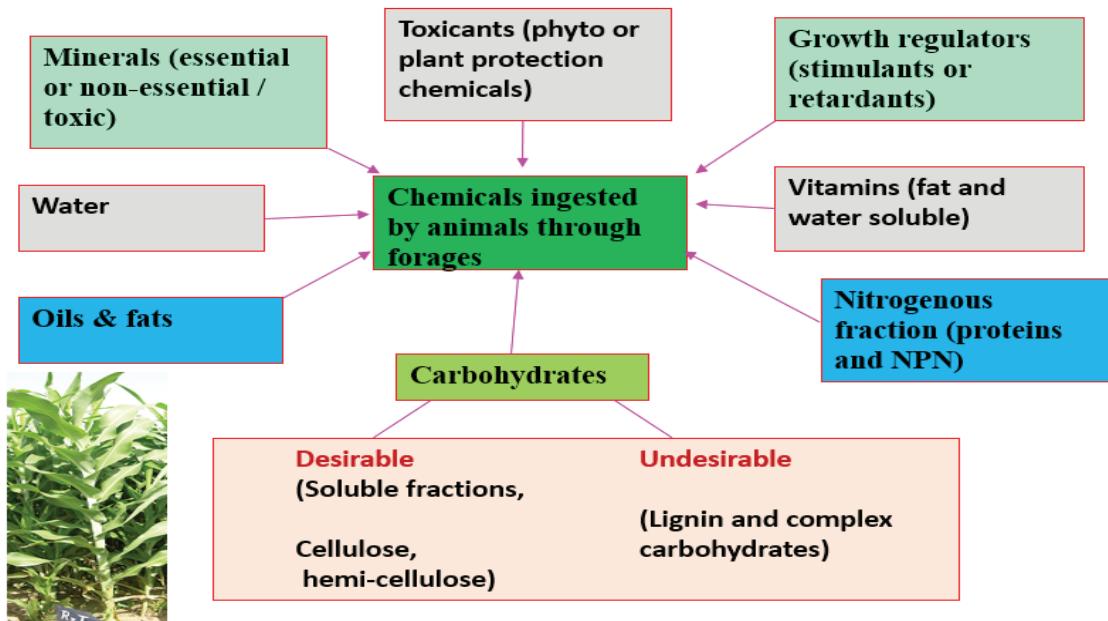


Fig : Chemicals ingested by animals through a forage plant

Benefits of Green Forages Feeding

- Required to maintain normal health and reproduction of all herbivores
- Over-all cooling effect on the body, being-
 - Easily digestible
 - More palatable
 - Slightly laxative
 - Provide fresh nutrients in a most natural form resulting in efficient utilization of the feed without any strain on the body organs
 - Longevity and production are adversely affected when cattle are reared on without green forages
 - In absence of greens, cows reported to give birth to weak, deformed and blind calves
 - Feeding concentrates at higher level without sufficient green forages, adversely affect the digestive system of the animals in the long run
 - Animals yielding 10 litres of milk can be maintained solely on green fodders without any complaint and reducing feed cost by 20% over normal dry roughages and concentrates-based rations

Feeding Value of Forages

Typically, it is desirable to make the maximum use of the forages, which can be effectively grown or obtained locally. Generally supplemental feed is needed for milch animals and calves. When formulating the additional feed, a reasonable knowledge of the nutrients provided by the forages is essential. The animal utilizes various nutrients from forages for many functions like maintenance, production and reproduction. The health and production functions are the reflections of the quantity of nutrients available to the animal per unit of time (Fig 1).

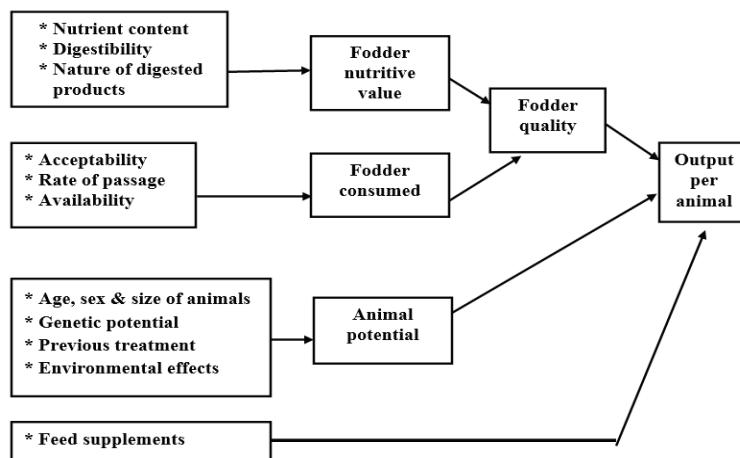


Fig 1: Fodder quality and output per animal- an interaction

Forage Feeding Systems

The forage feeding systems of livestock in vogue in different parts of India and other developing countries are as follows-

- Exclusive grazing
- Grazing supplemented with roughage
- Grazing supplemented with concentrates
- Stall feeding on exclusive forages

Animals may be fed on single forage or a mixture of two or more forages. The combinations mostly are as follows:

- Dry forage feeding
- Green forage feeding
- Mixed forage feeding
- Stall feeding on forage and concentrate
- Stall feeding of compound feeds

Limitations of existing systems

Due to lack of knowledge about the feeding value of different feeds and nutrient requirement of different categories of farm animals by the livestock farmers, the above-mentioned feeding systems suffer from many limitations.

- Animals are either underfed or overfed
- Supply of nutrients is unbalanced
- Inefficient utilization of feed nutrients
- Animals suffer from deficiency disease syndromes
- Adverse effect on milk production and growth of animals
- Most uneconomical when considered in terms of health, growth, milk production and reproductive efficiency of animals

Feeding of Dairy Animals

Feeding of calves

Adequate feeding of young calves during the first three months is important on a dairy farm for their optimum growth and to raise them as herd replacement. As the newborn calf does not have the functional rumen, its nutrient needs are more similar to those of simple stomach animals than the matured ones. Hence the newborn calf is a baby which requires special nutritional and management cares. Guidance for feeding schedule of calves from birth to

3 months has been presented in Table 1. The milk should be heated to luke warm (body temperature) and given to calves twice daily i.e. morning and evening.

Table 2. Feeding of calves from birth to 3 months of age

Age (day)	Whole milk (kg)	Calf starter* (g)	Legume forage (g)
Day 1-3	1/10 th of body weight	nil	nil
Day 4-7	1/10 th of body weight	nil	nil
Day 8-35	1/10 th of body weight	ad. lib.	ad. lib
Day 36-45	1/15 th of body weight	ad. lib.	ad. lib
Day 46-56	1/20 th of body weight	ad. lib.	ad. lib
Day 57-90	Nil	ad. lib.	ad. lib

Legumes should include berseem, lucerne, cowpea, etc. either in green or hay form. Green fodder should be free from soil and other external contamination. It should be mixed with good quality wheat straw @ 500g wheat straw or chaffed rice straw per kg of green fodder. This is important to avoid rapid consumption of green berseem/ lucerne/ cowpea as it may cause tympani/ bloat in growing calves.

* Calf starter constituent	Parts
Oat /Barley/Maize grain (crushed)	50
Groundnut cake/Linseed cake/Til cake	30
Wheat bran/Rice bran	08
Good quality fish meal/dried skim milk	10
Mineral mixture	02

To 100 kg of above mixture ingredients like Rovimix- 10 g, Common salt- 0.5 kg and Eurofac/ TM-5 (antibiotics)- 20 g may also be added to fortify the quality of calf starter:

Feeding of Growing Calves/ Heifers

Compared with baby calves, growing calves/ heifers are relatively easy to feed and this is one reason that these categories of dairy animals are often neglected. Initially the growing calves should receive substantial share of its nutrients from concentrates. As they become older the proportion of forage can be increased gradually in the ration. But the amount of concentrate depends upon the quality of forage. With better quality forage, less concentrate is needed. However, with more typical quality forage, some concentrate may be needed for their good growth and early maturity. The calculation of nutrients requirement of growing calves requires specific knowledge of chemical composition of each feed ingredients and nutrients requirement for a particular body weight. Some examples (Table 2) are given for the guidance in formulating suitable forage-based feeding regimes for growing calves.

Table 3. Forage based rationing of growing cattle/buffalo calves (after 3 months to maturity)

Category of animal (age)	Concentrate mixture (kg)	Forage mixture
1. 3-4 months (b.wt. 70-90 kg)	a) 1.0-1.5	Green oat/maize/silage 5 kg + good quality hay 0.5 kg
	b) 0.5-1.0	Green berseem 5 kg + good quality hay 1.0 kg
2. 4-5 months (b.wt. 100 kg)	1.5-2.0	Green fodder 5-10 kg + good quality hay 1.0 kg
3. 5-6 months (b.wt. 130 kg)	2.0	Green fodder 5 kg + good quality hay 1.0 kg + straw 0.5 kg
4. 6-9 months (b.wt. 130-160 kg)	2.0	Green fodder 10 kg + good quality hay 0.5 kg + straw 1.0 kg
5. 9-12 months (b.wt. 190 kg)	2.0	Green fodder 15kg + hay/straw/dry mixed grass 1.5 kg
6. 12 months to age of conception (b.wt. 200-300 kg)		
Cattle*	a) 1.5-2.5	Green maize/oat/jowar 20 kg + straw/dry mixed grass 1 kg
	b) 1.0-2.0	Green berseem 20 kg + hay/dry mixed grass 4 kg
	c) 2.0-3.0	Straw/dry mixed grass 4 kg + green fodder 5 kg
Buffalo	2.0-2.5	Green maize/oat/jowar 20 kg + straw/dry mixed grass 2 kg

*Crossbred cattle require more concentrate to sustain higher growth rate than indigenous ones

Concentrate Mixture

A livestock farmer desirous of producing concentrate mixture of his own should know the various types of feed ingredients required for making concentrate mixture ideal for animal feeding. If the farmer is not well conversant with the quality of raw feed ingredients and unconventional feedstuffs available in the region, he may not be able to formulate an ideal concentrate mixture for his animals economically. The various feed ingredients and their proportion of mixing in brief are as follows-

- (a) Primary source of energy (30-40%): Cereal grains like maize, barley, wheat, sorghum, oats etc.
- (b) Primary source of protein (25-30%): Oil seed cakes like groundnut cake, mustard cake, cotton seed cake, linseed cake, sesame cake and animal protein supplements like fish meal, meat meal, skim milk powder etc.
- (c) Diluents (5-25%): Cereal by-products like wheat bran, rice bran etc. and pulse chunies like mung chunni, arhar chunni, massoor chunni, gram chunni etc.

- (d) Common salt (1-2%)
- (e) Mineral supplements (1-2%)

Feeding of Milch Cows/ Buffaloes

For the development of practical feeding guides, the values on nutrient requirement (Table 3) are compiled on the assumption that fat content of cow milk varied between 4-5% and in buffalo milk between 6-8%. While the body weights ranged from 150 to 400 and 200 to 500 kg in cows and buffaloes, respectively.

Feeding of leguminous fodder like green berseem or lucerne and cowpea during winter and summer/ rainy seasons, respectively along with 1-2 kg of dry roughage to lactating cows and buffaloes sustained a milk yield up to 10 kg/ day (Table 4). But animals yielding more than 10 kg/ day required supplementation of energy rich concentrates @ 1 kg for every 2.5 - 3.0 kg of extra milk. Although, feeding of leguminous fodder exclusively resulted in wastage of protein, the most deficient nutrient in cereal fodder-based feeding regime. But a mixture of leguminous and cereal fodder at the ratio of 2:1 or 1:1 was found to be more promising. A balanced fodder mixture can be produced by growing legume fodder viz., cowpea, berseem, lucerne, stylo, dolichos, siratro etc. and cereal fodder viz., maize, oat, sorghum, hybrid Napier, guinea, paragrass etc. Cereals like maize/ sorghum can be cultivated along with legumes like cowpea during kharif, and berseem & oat during rabi season to supply a balanced fodder mixture. Cows consuming fodder mixture containing one part of berseem and oat each (fresh weight basis) with 1 kg concentrate (for letting down of milk) yielded 7-8 kg of milk/ head/ day. Similarly, hybrid Napier and lucerne (3:1) or maize and cowpea (1:1) mixture sustained up to 7 kg milk/ head/ day. Thus, the intake and utilization of nutrients from comparatively low-quality fodder were improved by judicious inclusion of legumes.

Cereal fodders including grasses are poor in quality, having low CP and high fibre contents coupled with low voluntary intake. Therefore, performance of lactating animals fed on such fodders like maize, sorghum, guinea and hybrid Napier grass etc. alone, were adversely affected which could meet only the maintenance with little production needs of animals. But supplementation of concentrates improved the level of milk production. However, oat at early stage of growth (up to 10% flowering) sustained 6-8 kg milk yield daily.

Table 4. Nutrient requirement of dairy animals

Body weight (kg)	Daily milk yield (kg)	Requirement			
		Cows		Buffaloes	
		CP (g)	TDN (kg)	CP (g)	TDN (kg)
150	2	311	1.95		
	3	388	2.29		
	4	464	2.63		
200	2	382	2.34	422	2.56

	3	458	2.68	518	3.01
	4	535	3.02	615	3.46
250	3	489	3.04	549	3.37
	4	566	3.38	646	3.82
	5	631	3.72	743	4.27
	6	708	4.06	843	4.72
300	4	610	3.72	691	4.16
	5	688	4.06	788	4.61
	6	765	4.40	891	5.06
	7	842	4.74	982	5.51
400	5	775	4.74	877	5.28
	6	852	5.08	974	5.73
	7	929	5.42	1077	6.18
	8	1006	5.76	1174	6.63
500	5			938	5.94
	6			1037	6.39
	7			1134	6.84
	8			1231	7.29
	9			13.28	8.74

Again, the surplus green forages available during the flush period of growth can be conserved as hay or silage to provide some quality forage to milch animals during the scarcity period of October-November or May-June. Berseem / Lucerne hay with 1 kg of concentrates sustained up to 10 kg daily milk yield during summer months of May-June, when there is complete scarcity of cultivated green forage. Although, milk yield was low (5 kg/ head/ day) in cows fed silages of jowar & cowpea (2:1) or oat & berseem (1:1) without any concentrate supplements. Hence, there is a need of supplementing quality concentrate also, in silage-based diets of milch animals to sustain their optimum milk yield under hot dry condition of summer months.

The complete ration of milch cows and buffaloes producing less than 10 kg milk daily should contain 12-14% CP and 60-62% TDN provided the minimum intake is 2% of the body weight. Important leguminous forages contain 18-20% CP and 58-60% TDN, and cereals contain 6-8% CP and 60-65% TDN in dry matter except the pre-flowering oat which contain 12-15% CP (Table 5). Thus, a mixture of equal number of cereals and leguminous forages contains the desired level of protein and energy for milch animals. However, all forage rations of milch animals should be supplemented with phosphorous rich complex mineral mixture. In a condition in which only one type of green forage (legume or non-legume) is available for the

feeding of milch animals, the leguminous forage can be balanced though the supplementation of small quantity of high energy grains like maize, barley, jowar etc., and protein deficiency on cereal forage feeding may be balanced through high protein oil cakes.

Table 5. Performance of milch cows/ buffaloes fed all forage/ forage-based rations

Kind of forage*	Level of supplementation (head/ d)	Milk yield sustained (kg/ d)
1. Berseem	1-2 kg dry roughage	8-10
2. Berseem	Concentrate @ 1 kg/ 2.5-3.0 kg extra milk	> 10
3. Cowpea	1-2 kg dry roughage	6-8
4. Cowpea	Concentrate	> 8
5. Hybrid napier + Lucerne (3:1)	1-2 kg dry roughage	6-7
6. Maize + Cowpea (1:1)	1-2 kg dry roughage	6-7
7. Berseem + oat (1:1)	1-2 kg dry roughage	7-8
8. Oat (10% flowering)	1-2 kg dry roughage	7-8
9. Guinea grass	1-2 kg dry roughage	> 5
10. Maize/ sorghum/ bajra/ hybrid napier	1 kg concentrate	4-6
11. Sorghum + Cowpea (2:1) silage	Nil	> 4
12. Oat + berseem (1:1) silage	Nil	5-6
13. Berseem/ Lucerne hay	1 kg concentrate (barley)	> 10
14. Cowpea hay (at 50% flowering)	1 kg concentrate (barley)	8-10

*Offered *ad libitum*

Feeding of High Producing Milch Animals on Mixed Rations

The genetically superior livestock needs balanced diets for superior feed efficiency to fully express their production traits. Cows with average daily milk yield up to 10 kg, may be fed a mixed ration of crop residues, green fodder and a concentrate mixture (of average quality containing 18% CP and 70% TDN), so as to meet the nutritional requirements. Otherwise, another approach could be to increase the quality of concentrate mixture if green fodder is not available only straw or stovers are the forage sources.

Table 6. Nutritional value (% dry matter basis) of some common forage for dairy animals

Forage	Species	DMI (kg/ 100 kg b.wt.)	CP (%)	TDN (%)
A. Greens				
1. Berseem	Buffalo	2.41	24.97	70.24
	Cattle	2.10	21.63	57.81
2. Cowpea	Cattle	2.90	20.46	61.05
3. Guar	Cattle	3.25	17.00	47.49

4. Lucerne	Cattle	2.25	19.58	53.14
5. Stylosanthes sp.	Cattle	2.42	15.10	55.75
6. Bajra/ pearl millet	Buffalo	-	8.84	63.81
7. Barley (pre-bloom)	-	-	12.56	60.47
8. Sorghum	Cattle	3.04	6.52	56.08
	Buffalo	-	4.57	63.33
9. Hybrid Napier (NB-21)	Cattle	2.20	4.69	57.99
	Buffalo	-	4.58	63.56
10. Maize	Cattle	2.43	9.32	62.99
Green stalk	Cattle	2.02	4.33	58.57
11. Oats	Cattle	2.57	9.47	62.42
	Buffalo	-	7.81	59.58
12. Sudan grass	Buffalo	3.22	6.35	52.74
13. Teosinate	Cattle	-	9.27	52.46
	Buffalo	1.90	9.23	57.90
14. Dinanath grass	Cattle	2.00	5.13	56.26
15. Dub grass	Cattle	2.50	8.46	55.00
16. Sain grass	Cattle	1.95	2.55	46.68
Hay				
1. Berseem	Cattle	-	15.84	65.80
2. Cowpea	Cattle	2.80	12.30	60.00
3. Lucerne	Buffalo	1.88	14.38	54.40
	Cattle	2.58	14.86	50.04
4. Oats	Buffalo	-	5.61	64.38
	Cattle	-	3.69	54.10
5. Sain grass hay	Cattle	1.95	1.96	48.85
Silages				
1. Hybrid napier (NB-21)	Cattle	1.91	4.18	54.11
2. Sorghum	Cattle	1.60	3.75	62.16
3. Maize	Cattle	-	5.12	61.33
4. Oats	Buffalo	-	5.43	63.40

But cows with 11 to 20 kg daily milk yield, are the improved ones and the farmers can expect a good economical return from them. They require a well-balanced diet for effective persistency, reproduction and feed efficiency. They may be given a ration (Table 6) comprising of little quantity of straws/ stovers, mixture of legume & non-legume (cereal) green forage and good quality concentrate mixture (20% CP and 72% TDN). While cows yielding >21kg milk per day, needs special attention to meet their nutritional requirement. Such high yielding cows will always be deficit in energy in first two trimesters of lactation on conventional diets. They should

be given a ration (Table 6) comprising of legume and nonlegume fodders, and a very good quality concentrate mixture (22% CP and 74% TDN). But they should not be fed poor quality crop residues like straws and stovers.

Table 7. Rationing (as such basis) of high yielding milch cows

Feedstuffs/ items	Quantity (kg/ head/ day)
A. Category-I (350-400 kg b.wt, 15 kg daily milk yield & 4-5% milk fat)	
1. Maize/ Sorghum/ Oat	20
2. Berseem/ Lucerne/ Cowpea	25
3. Wheat/ Rice straw	1
4. Concentrate mixture	5
B. Category-II (350-400 kg b.wt, 25 kg daily milk yield & 4-5% milk fat)	
1. Maize/ Sorghum/ Oat	20-25
2. Berseem/ Lucerne/ Cowpea	20-25
3. Concentrate mixture	8-9

Limitation of High Forage Rations

The major limitation on production in dairy animals fed high forage rations is voluntary intake and thereby limiting energy consumption. After the first meal, a milch cow can eat more forage only to the extent she can digest the forage already eaten. Therefore, the best indication of forage quality is the amount of forage she can eat in a 24 hours period per unit of body size. This takes into account per cent digestibility, rate of digestion, size of the animal and any influence palatability may have on voluntary intake. Another problem which may crop up in excessive forage feeding with limited grain supplementation; especially at early lactation, is ketosis. A lowering in the conception rate may be a problem if on excessive forage feeding, negative energy balance becomes prolonged. An investigation carried out in Louisiana (USA) showed that cows losing weight had considerably lower conception rate (of 43 per cent as compared to 65 per cent in cows gaining weight).

Conclusion

Feeding dairy animals is both an art and a science. It is a science influenced by years of research and it is an art developed by centuries of practical experience. Healthy animals fed balanced diets with abundant supplies of fresh water will be the most productive, the most profitable to the farmer and the most efficient users of nutrients.”

Forage Conservation through Silage Making: An Inevitable Technology for Sustainable Dairy Farming

Aparna and Satbir Singh

Krishi Vigyan Kendra Ropar, Punjab Agricultural University, Ludhiana

Corresponding author: aparnapau@gmail.com

Abstract

*Conservation of fodder means preservation of fodder when it is available in excess and at maximum nutrition stage. Its main purpose is to ensure fodder availability throughout the year. Silage is the green material produced by controlled anaerobic fermentation of the green fodder crop retaining its high moisture content (greater than 50 percent) and subsequently fermenting that crop in pit, tower, bunker, trench or plastic bags or drums. Fermentation takes place in five steps namely respiratory/ aerobic stage, anaerobic stage, lactic acid fermentation (beginning), Lactic acid fermentation and stabilisation stage. Homolactic fermentation allows lactic acid bacteria e.g. *Lactobacillus* to grow, which converts sugars into lactic acid, a strong organic acid. Lactic acid production declines the pH. As pH declines to 3-4, the degrading actions of plant enzymes and undesirable bacteria are inhibited and the growth of lactic acid bacteria is also inhibited and silage is stabilised. Moisture, dry matter, type of fodder and stage of harvesting are the important optimum conditions for silage making failing which undesirable changes like clostridial growth may take place that can spoil the silage. Once silo-pit is open, it should be finished within 45-60 days to avoid aerobic spoilage and fungal contamination. Non leguminous fodders are appropriate crops for making silage. Even leafy waste from fruits and vegetables can also be used for making silage. Apart from being reliable, flexible and resilient feed source silage also gives the advantage of increased feed efficiency, wastage reduction and being an environment friendly technology.*

Fodder Conservation

Conservation of fodder means preservation and careful maintenance of certain qualities of fodder and keep them unchanged during chemical reactions or physical transformations while conservation process; when it is excessively available. Purpose of conservation is to preserve fodder for future need.

Purpose of Forage Conservation

- To preserve fodders when it is available in excess and at maximum nutrition stage.
- To maintain optimum nutritional value of fodder.
- To ensure fodder availability throughout the year
- To shift available feed from the present to the future.
- To move feed from one location to another location.
- To assist pasture management

Methods of Conservation

Hay and silage are the main methods of conserving forage. Hay is preservation of forage by drying. It will keep up its nutritional value maintained till it is kept dry. Silage involves natural fermentation, which produces lactic and other acids, which ‘pickle’ or preserve the forage.

Silage

Fodder converted into succulent feed for livestock through processes of anaerobic bacterial fermentation (as in a silo). Silage is the green material produced by controlled fermentation of the green fodder crop retaining its high moisture content (greater than 50 percent) and subsequently fermenting that crop in pit, tower, bunker, trench or plastic bags or drums. Ideally, this process takes place in the total absence of oxygen. Silage contains 20-40% DM and 14-16% CP. The process of conservation of fodder is called ensiling and the pit/bag/drum used for packing of fodder for making silage is known as the silo.

Principle of Silage making- silage making is based on the principle of anaerobic fermentation.



Anaerobic condition is first and foremost requirement for silage making, as it allows lactic acid bacteria to grow, which converts sugars into lactic acid, a strong organic acid. Lactic acid production declines the pH. As pH declines, the degrading actions of plant enzymes and undesirable bacteria are inhibited and at pH 3-4, most degrading enzymes are inhibited and the growth of lactic acid bacteria is also inhibited and silage is stabilized.

Types of Fermentation in Silage Formation

Silage formation involves different types of desirable and undesirable fermentation process.

- I. **Homolactic fermentation:** This is the most desirable type of fermentation during the process of silage making. This type of fermentation is carried out by homofermentative organisms like *Lactobacillus*, *Pediococcus*, *Streptococcus* spp. and *Enterococcus*. These organisms ferment glucose to two moles of lactic acid which is the major end product during this process. Production of lactic acid reduces the pH to such an extent that nutrient loss is minimized.
- II. **Heterolactic fermentation:** Heterofermentative organisms like *Lactobacillus buchneri* and *Lactobacillus brevis* ferment hexoses to one molecule of lactate, CO_2 and acetate or ethanol as major end products. This is the less desirable and less efficient type of fermentation and takes place when limited quantity of sugars are available in fodder.
- III. **Secondary fermentation:** This type of fermentation takes place when moisture level of forage is high and sugar level is low. This occurs before the silo is opened i.e. in the absence of air and when a stable pH value is not achieved yet. At an unstable pH lactate gets attacked and degraded by clostridial bacteria to acetic & butyric acids which are weak acids eventually leading to rise in pH in silo. Furthermore, degradation of proteins to ammonia causes off smell due to production of putrescine and cadaverine. This is very undesirable type of fermentation.

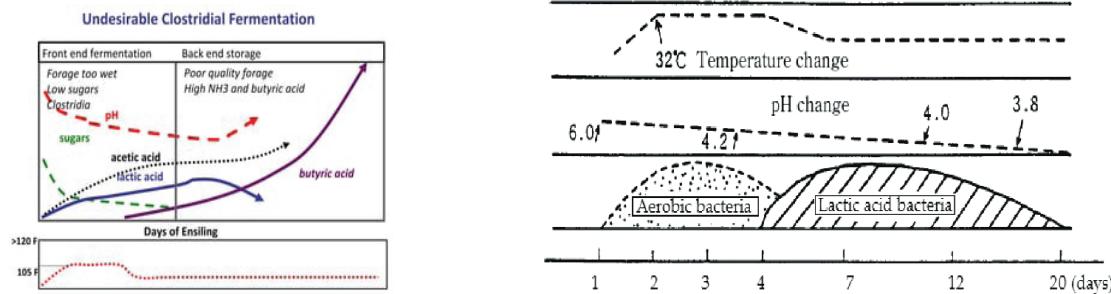
- IV. Aerobic spoilage during feed out:-** A good fermentation, high lactic acid and low pH content of a perfectly prepared silage doesn't ensure safe storage. Such reactions take place after the silage is ready. Faulty storage and erroneous feed out process facilitated by air exposure is its major cause. Erroneous feed out process exposes silage to oxygen. In the presence of oxygen yeasts breakdown sugars and lactic acids. This raises the pH value of silage and allows moulds to grow. Yeasts and moulds grow to generate carbon dioxide and heat and also cause severe DM losses. Good sealing, compaction and proper feed out techniques can avoid such spoilage.

Fermentation Process of Silage

Fermentation process of silage making is an interplay of aerobic and anaerobic fermentation process carried on for around 45 days. The whole process can be divided into five stages:

1. **Respiratory stage/ aerobic phase:** When the fodder has just been packed and the packed raw material is still respiring and consuming oxygen. This initial phase continues until either the oxygen supply or water-soluble carbohydrates have been depleted. The most notable feature of this phase is the increased temperature of the newly fermenting crop resulting from ongoing cell respiration where carbon dioxide, water and heat are produced. This will lead to rise of temperature to about 32°C in sealed pit around 4 days after packing

$$\text{Sugars} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} + \text{Heat}$$
2. **Early fermentation/ anaerobic fermentation:** Stage 2 begins when the trapped oxygen supply is depleted and generally lasts no longer than 24 to 72 hours. The primary bacteria during this phase are Enterobacteria. They can tolerate the heat produced during the aerobic phase and produce acetic acid, formic acid and other organic. These acids slowly reduce the pH from about 6.0 to 5.5.
3. **Lactic acid fermentation:** As and when oxygen gets exhausted and anaerobic conditions set in, lactic acid fermentation begins by lactic acid bacteria which are strictly anaerobic about 3 days after packing the chopped fodder and acetic acid production declines.
4. **Lactic acid fermentation:** Lactic acid production continues for about 2-3 weeks. The temperature goes down slowly to about the normal atmospheric temperature and pH gets maintained to 4.0 -3.8
5. **Stabilization phase:** The lactic acid fermentation completes in about 20 days, and the silage product is finished. This stage 5 lasts through the remainder of storage where the fermentation process is stable as long as oxygen does not penetrate silage, i.e. through silo walls with final temperature of well-preserved silage being 75 to 85° F. However, changes do occur in the digestibility of the nutrients found in these forages. First, studies show that with longer storage times, starches become more quickly degraded in the rumen. Secondly, changes also may occur in the digestibility of the neutral detergent fibre (NDF). Presence of lactic acid checks any further degradation due to which any bacterial and fungal growths are checked (Philips).



Da Silva et al , 2017

Important Conditions for Silage Making

Moisture: The optimum moisture content of fodder for making silage is about 65 percent. This degree of moisture will facilitate the fermentation process. Ensiling fodders at moisture contents greater than 70 percent may cause silage effluent to be produced and favour growth of clostridial bacteria. Such silage has high concentration of butyric acid and ammonia nitrogen and is less acidic. It may give off smell due to production of putrescine and cadaverine.

Absence of oxygen: anaerobic conditions help to timely stop the aerobic fermentation and minimize loss of nutrients due to respiration. Lack of oxygen facilitates the growth of lactobacilli and checks mould formation.

Optimum dry matter: 32-36% dry matter is required for optimum level of production of lactic acid. Fodder having >40% DM is tough to pack and gives poor aerobic stability. DM content of <28-30% level will lead to production of high content of acetic acid and chances of seepage are also high.

Stage of harvesting: Optimum stage of harvesting ensures optimum dry matter and starch content. Optimum stage of harvesting of different fodder crops is given below:

Crop	Stage of harvest
Sorghum and Maize	Flowering to milk stage
Bajra	Boot stage
Oats	Milk stage
Napier-bajra & Guinea grass	One meter tall

Site for construction of silo

Following points should be kept in mind while selecting the site for making silo:

- It should be elevated from other places.
- The place must be free from water clogging.
- The land should be free of dampness, cracks, rat burrows etc.
- It should be in proximity to animal shed.

Types of Silos

Depending upon the availability of land, fodder or requirement of silage, various types of silos can be opted

Bunker/trench type silo- built on the ground with 3-5% slope or a semi underground type, which is half below from the ground level and can be built by simply digging the ground, place plastic sheets inside to prevent loss. A trench silo whose interior is coated with concrete can be used for a long time

Tower type silo- In this type storage silos are cylindrical structures, typically 10 to 90 ft. (3 to 27 m) in diameter and 30 to 275 ft. (10 to 90 m) in height

Bag type silo- In this type plastic bags with thickness of 0.1 mm are taken and fill bags with chopped raw materials, compressed as much as possible to remove the internal air and then sealed completely. Different types of bags are available in the market that can be chosen as per requirement and convenience.

Drum type silo- plastic airtight barrels can also be used for preparing silage. Plastic drums of various sizes are easily available in the market.

Size of Silo

The size of silo pit/bag/drum is determined by following factors:

- herd size
- the amount of daily feed requirement
- the number of feeding days
- Quantity of fodder available
- 35.31 cuft/ 1cum can accommodate 5-6qtl fodder. E.g. 8x50x100ft can accommodate approx. 1000tons of silage.

Steps in Silage Making

- Selection of appropriate fodder
- Harvesting of fodder at appropriate stage
- Usually, the moisture content is too high at the time of harvesting hence let the crop wilt in the field for 1-2 days
- Spreading a polythene sheet at the base of silo
- Spreading straw in silo over the polythene sheet
- Spreading chopped fodder to make a bed of 2 feet height in silo
- Compact forage with help of tractor or any heavy object
- Again, spread another layer and compress again

- Repeat the steps until the silo is filled to its capacity
- Cover the compressed fodder with straw
- Seal the pit airtight with plastic cover.
- Plastic covers should be pressed with heavy objects like bricks or tyres.
- Maintain sealing for 45 days

Once silo-pit is open, it should be finished within 45-60 days to avoid fungal contamination.

Judging the Quality of Silage

Apart from proximate and cell wall composition of silage following physical parameters can give a first hand on farm view of quality of silage prepared:

- Color: In general, pale yellow indicates good quality. If the color is from dark brown to dark green, the silage underwent bad fermentation and is of bad quality.
- Smell: Acidic or a sweet-sour pleasant smell indicates good quality. On the other hand, if there is a manure smell or putrid smell and it is so repugnant that one cannot put the silage near one's nose, the quality is poor.
- Taste: If the silage tastes sour and there is no problem in putting it in one's mouth, the quality is good. On the other hand, if the silage tastes bitter and one cannot put it in one's mouth, the quality is poor.
- Touch: When squeezing the silage tightly in a hand and then opening the hand, if the silage breaks slowly into two, that silage is of good quality. If the silage breaks into small pieces separately, the silage is deficient in moisture content. If water is dripping, the moisture content of the silage is too high.

Rate of Feeding

The animals may not like its taste for first few feedings. Taste can be developed by mixing 5-10 kg silage per day with fresh green fodder for the first 5-6 days. Thereafter, 20-30 kg silage along with other fodders can be fed.

Silage Making from Fruits and Vegetables Waste

The green leafy wastes of fruits and vegetables like banana foliage, cabbage and cauliflower leaves with stem, baby corn husk or baby corn forage can be prepared in bunker- trench/ bag silo depending on the availability of raw material. (Wadhwa and Bakhshi 2013) One cubic meter can accommodate approximately 0.5 tonnes green waste; and accordingly keeping in view the availability of waste, the size can be adjusted. Method of making silage from fruit and vegetable waste is similar to green Fodders.

Method of Making Silage from Fruits and Vegetables Waste

Wilt the wastes like banana foliage, cabbage and cauliflower leaves with stem, baby corn husk or baby corn forage for 1–2 days in the open, then chaff to 3–5 cm. Mix the wilted, chaffed wastes with either chaffed wheat straw, rice straw or maize stovers in a 70:30 ratio.

Spread on the floor of the trench or pit or bag a 5–7 centimeter layer of any poor quality crop residue to absorb the effluents released during fermentation. Fill the silo with uniformly mixed waste and straw/stover layer after layer in batches of 40 to 60 kg by trampling. Ensure that no air is trapped in the chaffed waste, till the pit is filled. In case of large silos, the pit is filled directly with the help of chaff cutter cum blower followed by pressing or packing with a tractor. Seal the silo properly and allow it to ferment for 42 days.

Silage Additives

Silage additives are the preparations added to the forage or crop at ensiling and improve the nutritive value of silages and to reduce some of the risks during the ensiling process (Yitbarek and Tamir, 2014). A silage additive should be safe to handle, reduce DM losses,

Purpose of Silage Additives

- Increase DM (nutrient) recovery
- May improve the ensiling (fermentation) process
- Limit secondary fermentation and reduce aerobic deterioration at feedout
- Improve animal performance
- Decrease heating and molding during storage and feed out.

Silage additives can be grouped into four categories:

- (1) Bacterial inoculants: These additives inoculate the forage with desirable types of lactic acid-producing bacteria, thereby encouraging the fermentation process
- (2) Enzymes: these additives degrade plant cell walls and starch.
- (3) Substrate sources are primarily sugars, such as molasses, that also provide additional substrate for lactic acid-producing bacteria.
- 4) Inhibitors: Like formic, propionic, hydrochloric and sulfuric acids, are primarily organic acids that effectively sterilize the silage.

Importance of Silage Making

Reliable Feed Source

- o It is a reliable source of high-quality feed throughout the year for large and small herds.
- o Fodder can be harvested and stored at its peak nutritional value, ensuring that cows receive a balanced diet.
- o Control of anti-nutritional factors like nitrites, CN etc.

Increased Feed Efficiency

- o Silage making allows farmers to efficiently utilize forage crops by preserving them in a fermented form that is highly digestible for cows
- o cows are able to extract more nutrients from silage compared to other forms of forage
- o minimize the need for costly supplemental feeds

Waste Reduction

- o Silage making helps reduce waste by enabling farmers to harvest and store excess forage crops that might otherwise go unused or spoil in the field
- o minimize forage losses due to weather conditions, such as rain or frost, and reduces the need for additional land or resources to produce more forage.
- o Silage can be stored for extended periods, providing a consistent feed supply even during periods of forage scarcity

Environmental Benefits

- o The fermentation process during silage making preserves the nutrients in forage crops, reducing the need for synthetic fertilizers
- o Silage helps to sequester carbon by promoting healthy soil microflora and reducing tillage, which can contribute to greenhouse gas emissions.

Flexibility and resilience in managing feed supply

- o Silage can be made from various forage crops, providing farmers with options to choose the best feed sources based on their specific needs and local conditions.
- o Silage can be stored for long periods, providing a buffer during times of forage scarcity or unexpected disruptions, such as extreme weather events or changes in market conditions.
- o This allows farmers to better manage their feed supply, adapt to changing circumstances, and maintain the sustainability and resilience of their dairy operations

References

1. Da Silva T C, Da Silva L D, Santos E M and Oliveira J S (2017). Importance of the Fermentation to Produce High-Quality Silage. In book: Fermentation Processes Chapter:<http://www.intechopen.com/books/fermentation-processes/importance-of-the-fermentation-to-produce-high-quality-silage> Publisher: Intech
2. Phillips D A. Important Steps during the Silage Fermentation Process. Important steps during the silage fermentation process (uky.edu)
3. Wadhwa M and Bakhshi M. 2013. Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products Book ISBN 978-92-5-107631-6 (print) E-ISBN 978-92-5-107632-3 (PDF) © FAO 2013
4. Yitbarek M B and Tamir B. 2014. Silage Additives: Review. Open Journal of Applied Sciences 4, 258-274.

SCIENTIFIC CULTIVATION OF FODDER CROPS FOR SILAGE MAKING

Navjot Singh Brar¹, Simerjeet Kaur² and Balbir Singh Khadda¹

¹Krishi Vigyan Kendra, SAS Nagar, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana

²Department of Agronomy, Punjab Agricultural University, Ludhiana

Corresponding author: navjotbrar11@yahoo.co.in

Abstract

Green fodder is considered a cheap source of nutrients. During fodder scarcity period, green fodder with optimal nutritional contents is not adequate in supply and has been identified as one of the reasons for poor livestock productivity. Silage production is a technology which works under the present situations to meet this deficit of fodder. Silage is a technique where non-leguminous fodders like maize, sorghum, bajra, oats are cut fresh, chaffed and packed in silo/bunkers under anaerobic conditions. Green fodder is the raw material used for silage making and it is primary determinant of silage quality. Agronomic management of the parent crop is important in achieving high forage yields of high nutritive value. It is very important to adopt scientific cultivation practices of fodder crops to sustain the yield and quality of green fodder used for quality silage making. Cultivation of maize for silage making is preferred because of its relatively constant nutritive value, high yield and higher water-soluble carbohydrates for fermentation to lactic acid. In Northern India, spring maize is mainly cultivated for silage making instead of its high-water requirement and chemical fertilizer demand. Recently, more emphasis has been given to research to develop and promote technologies which help to decrease the stress on underground water resources. Due to these problems, there is need to encourage the dairy farmers for cultivation of other cereal crops (For example, oats, barley and wheat in rabi season; sorghum and bajra in kharif season) for silage making which enable them to fulfil their requirements and decrease their dependency on spring maize for silage making.

Introduction

Regular supply of fodder is essential to sustain the production potential of dairy animals and for better economic returns from the dairy farming. In India subcontinent, the nutritional requirements of ruminants are mainly met by feeding green fodder and dry roughages, as well as post-harvest crop residues. Contribution of forage in animal feed is more than 75% and is considered a cheap source of nutrients. At present there is 35.6% deficiency of green fodder in India. During fodder scarcity period, green fodder with optimal nutritional contents is not adequate in supply and has been identified as one of the reasons for poor livestock productivity. Poor supply of nutrients to livestock during scarcity of green fodder is a matter of concern. Farmers practice daily cutting and carrying of green fodders in conventional feeding system which not only lead to increase in lignin content (which is hard to digest) of fodder crop with maturity but is laborious as well. Further, land available for cultivation of green fodder

crops is getting limited and rising trend of cultivation of cash crops and cereals (food crops) will further restrict its growth. Thus, feed and fodder requirements for animals has remained below the recommended requirements that have restricted the utilization of the potential of animals by 26-51%.

Silage production is a technology which works under the present situations to meet this deficit of fodder. Silage is a technique where non-leguminous fodders like maize, sorghum, bajra, oats are cut fresh, chaffed and packed in silo/bunkers under anaerobic conditions. Here, fermentation is being conducted in an anaerobic environment, where the starch is changed to acids. The acidic environment kills most of the microorganisms and preserves the fodder. In Northern India, spring maize (February-sown crop) is cultivated primarily for silage making, and it is popularly known as "Makki Da Achar". Most of commercial dairy farmers are aware about the process of silage making. In this region, entire process of silage-making is strategically well-fitted to one season of year, which starts from 1st week of May and ends by 30th August. Approximately, 30% of farmers go for cultivation of maize after harvest of wheat (Summer maize) and ensiling is done in July. Summer maize always runs a risk of rain and machine scarcity.

Green fodder is the raw material used for silage making and it is primary determinant of silage quality. There is very important to adopt scientific cultivation practices of fodder crops to sustain the yield and quality of green fodder used for quality silage making.

Potential of different fodder crops for silage making

Crops like maize, sorghum, bajra, hybrid Napier bajra, oats etc. are most suitable for silage making. Legumes were less suited to silage-making than grass, because of their higher buffering capacity and lower water-soluble carbohydrate content. *Rabi* crops such as oats, wheat, barley can also be used for silage making. Wheat and barley possess dual-purpose characters for fodder and food availability. These crops also add flexibility to farming systems, as decisions to cut crops for hay or silage can be made mid-season in response to livestock prices or weather conditions.

Important points to be considered while selecting the crop for silage making are as under:

- Fodder crop must fit best into farmers' cropping system.
- Its yield potential and fodder quality must be optimum to meet the standards.
- Crop calendar is best suited to present silage system

There are desirable characteristics of fodder crops for quality silage such as

- Crop selected for silage making must have high level of fermentable sugars.
- It should have low buffering capacity.
- Must have optimum level of dry matter content at the time of harvest.

Table 1: Optimum stage of harvesting of crops for silage making

S. No	Crop	Stage of harvest	Days after sowing
1	Spring maize	Milk stage	85-100
2	Kharif maize	Milk stage	70-80
3	Sorghum	Boot to milk stage	80-90
4	Bajra	Flowering	50-60
5	Oats	Milk stage	90-105
6	Wheat	Milk to soft dough stage	125-130
7	Barley	Milk to soft dough stage	115-120

Scientific Cultivation of Fodder Crops for Silage Making

Agronomic management of the parent crop is important in achieving high forage yields of high nutritive value. Apply 6 tons of farmyard manure along with inorganic fertilizers. Organic fertilizers are very important for high yield and better quality of fodder crops. Poor quality forage will never become good quality silage. The brief cultivation practices to be followed in cultivation of different fodder crops grown for silage making are discussed below.

Maize

Maize is the best suitable and most common silage crop due to its high and easily digestible carbohydrate content and optimum buffering capacity in addition to high herbage yield. However, growing of corn is a difficult process in regions without irrigation facilities.

1. Time of sowing: First week of March to Mid-September
2. Seed rate: 75 kg ha⁻¹
3. Sowing method: 30 cm row spacing
4. Fertilizer: 137.5 kg DAP and 255 kg Ureaha⁻¹

Apply whole quantity of DAP and half dose of urea at the time of sowing and remaining half one month later.

5. Weed management: Application of Atrazine 2000 g ha⁻¹ within 10 days after sowing.

In northern India, spring maize is mainly grown for silage making in between window period of 80-120 days which is left between harvesting of *rabi* crop and sowing of next *kharif* crop. The brief package of practice for spring maize is discussed below.

1. Cropping system: Rice/Maize- Potato/Vegetable Pea-Spring maize
2. Time of sowing: 20th January to 15th February
3. Seed rate: 25 kg ha⁻¹
4. Sowing method: On ridges 60 cm apart with plant to plant spacing of 20 cm
5. Fertilizer: 125 kg DAP and 225 kg Urea ha⁻¹

Apply whole quantity of DAP and 1/3rd urea at the time of sowing and remaining in two equal splits at knee height stage and pre tussling stage.

6. Weed management: Application of Atrazine 2000 g ha⁻¹ within 10 days after sowing.

Sorghum

1. Time of sowing: From middle of March up to mid-July
2. Seed rate: 50 kg ha⁻¹
3. Sowing method: In rows 22 cm apart
4. Fertilizer: 125 kg SSP and 220 kg Urea ha⁻¹

Apply whole quantity of SSP and half dose of urea at the time of sowing and remaining half urea one month later.

Bajra

1. Time of sowing: March to August
2. Seed rate: 20 kg ha⁻¹
3. Sowing method: In rows 22 cm apart
4. Fertilizer: 110 kg Urea ha⁻¹

Apply half dose of urea at the time of sowing and remaining half three weeks later.

Oats

Silage of oats may also be supplied to dairy cows to meet the dry matter needs of the animals. Such silage crops may be an alternative silage source in cold and dry regions and may provide support to meet silage needs by plating ahead of corn

1. Time of sowing: 2nd week to last week of October
2. Seed rate: 62.5 kg ha⁻¹
3. Sowing method: In lines 20 cm apart
4. Fertilizer: 125 kg SSP and 165 kg Urea ha⁻¹

Apply whole quantity of SSP and half urea at the time of sowing and remaining half at 30-40 days after sowing.

Wheat

1. Time of sowing: Last week of October
2. Seed rate: 100 kg ha⁻¹
3. Sowing method: In lines 15-20 cm apart
4. Fertilizer: 387.5 kg SSP and 275 kg Urea ha⁻¹

Apply whole quantity of SSP and half urea at the time of sowing and remaining half at 30-40 days after sowing.

Barley

1. Time of sowing: 2nd week to last week of October
2. Seed rate: 87.5 kg ha⁻¹
3. Sowing method: In lines 20 cm apart
4. Fertilizer: 187.5 kg SSP and 137.5 kg Urea ha⁻¹

Apply whole quantity of SSP and half urea at the time of sowing and remaining half at 30-40 days after sowing.

Present Trend of Silage Making in Northern India

Cultivation of maize for silage making is preferred because of its relatively constant nutritive value, high yield and higher water-soluble carbohydrates for fermentation to lactic acid. Maize is the third most important cereal crop of the world and is a major forage source for ruminants around the world. In Northern India, spring maize is mainly cultivated for silage making instead of its high-water requirement and chemical fertilizer demand. Recently, more emphasis has been given to research to develop and promote technologies which help to decrease the stress on underground water resources. There are several challenges to increase area under spring maize cultivation in north-west India. The main concerns about the cultivation of spring maize are given below:

1. High evapotranspiration demand of atmosphere during the growing season of spring maize (February-June). This crop requires 12-14 irrigations during its growth period, which exerts huge stress on underground water resources.
2. The pesticide load on the spring maize is very high. It requires 2 sprays for control of weeds and two sprays for control of stem borer/fall army worm. This increased the chances of pesticide residue in fodder.
3. Increase in the lease rent of land also increased the cost of silage production.
4. Dairy farmers are required to buy spring maize fodder for silage making from market at higher price which result in increased cost of production.

Government is working on these issues and providing the subsidy for the installation of drip irrigation system in the fields to save irrigation water. Punjab Agricultural University, Ludhiana is also issuing regular advisories to the farmers for better control of pests in this crop by adopting proper time, method and dose of pesticide application and also to ensure the safety of environment. Due to these problems, there is need to encourage the dairy farmers for cultivation of other cereal crops (For example, oats, barley and wheat in rabi season; sorghum and bajra in *kharif* season) for silage making which enable them to fulfil their requirements and decrease their dependency on spring maize for silage making.

References

1. Anonymous (2022) *Package of Practices for Rabi Crops of Punjab*. Punjab Agricultural University, Ludhiana.
2. Anonymous (2023) *Package of Practices for Kharif Crops of Punjab*. Punjab Agricultural University, Ludhiana.
3. Brar N S, Kumar B ,Hundal J S, Singla A, Kumar A and Verma H K (2021) Maize (*Zea mays*) cultivars evaluation for herbage yield and silage quality. *Indian J Agric Sci* **91** (8): 1131–5
4. Brar N S, Kumar B, Kaur J, Kumar A, Verma H K, Singh R and Singh P (2019) Qualitative study of corn silage of cattle farms in subtropical conditions of Indo-Gangetic plains. *Range Mgmt & Agroforestry* **40**: 306-12.
5. Brar N S, Kumar B, Singh P, Kumar A and Singh P (2017) Qualitative assessment of silage prepared at farmer's field in Tarn Taran district of Punjab. *Indian J Anim Nutr* **34**: 357-360.
6. Kumar B, Brar N S, Verma H K, Kumar A and Singh R (2019). Nutritious feed for farm animals during lean period: silage and hay-a review. *Forage Research*. **45**:10-22.

Employment Opportunities through Dairy Based Enterprises

YS Jadoun¹, A.K. Thakur², Amandeep Singh³, Sarjeet Kaur¹ and R.K Nirala²

¹. SGIDT, Bihar Animal Sciences University, Patna-800014

²Bihar Animal Sciences University, Patna-800014

³GADVASU, Ludhiana, Punjab-141004

Corresponding author: ysvet1203@gmail.com

Abstract

Dairy sector in India plays an important role in the national economy and in the socio-economic development of the country. It has a significant role in supplementary family income and generating employment in the rural areas, particularly among the landless, small, marginal farmers and farm women. Recently, dairy sector is emerging as potential enterprise for rural masses. In order to meet the aspirations of today's rural youth with the opportunities available to them in dairy based enterprises can serve as a better option without disturbing their social and cultural ecosystems. Government of India started so many schemes, subsidies, services, and technological options for unemployed rural youth for start-up the dairy based enterprises and providing the technical know-how of dairy farming based enterprises through various capacity building programs running under the umbrella of Animal Husbandry Department (AHD), Dairy Development Department, Krishi Vigyan Kendras (KVKs), State Veterinary Universities (SVUs), State Agricultural Universities (SAUs), Agricultural Technology Management Agency (ATMA) etc., and connecting them to sources of financial credit for dairy based enterprises.

Introduction

Dairy farming is considered one of the most important farming systems practiced in the country since years ago. Dairy farming in India has been shaping the lives of rural masses as a major source of employment and income generation. Government organizations and policymakers of the country have emphasised the key role of dairy farming in terms of improving the socio-economic status of the rural people by reducing the longstanding problems of unemployment. Dairy based enterprises play a catalytic role in modeling the socio-economic status of the rural masses through the production of milk, meat and assisting the agricultural operations and recycling of dairy farm waste in many ways (Khan et al. 2009). Increasing demand for milk and milk products has created a huge market and an employment opportunity for the rural people to engage in dairy-based operations from different socio-economic sections. Dairy farming has also been recognized as a tool to bring socio-economic transformation in the rural sector (Mathur, B.N. 2000). Commercial and small-scale dairy farming in India is no doubt playing an important role in the total milk production and economy of our country. And almost all regions of India are suitable for setting up dairy farming business. Most of the dairy farmers in India are raising animals in small scale traditional methods. They are not aware about the modern farming methods, improved techniques for dairy farming and various employment opportunities in dairy value chain.

Dairy based enterprises: good opportunity for rural youth as they are;

- More educated than their elders
- More knowledgeable due to internet and electronic media
- Much more enterprising
- Looking for a change in lifestyle
- Willing to work hard
- Enthusiastic

Dairy based entrepreneurs and entrepreneurship: Entrepreneur associated to dairy farming/business, production of raw materials related to dairy farms and dairy related inputs and processing industries is considered as dairy entrepreneurs and process of starting the dairy-based enterprises is called dairy entrepreneurship.

Opportunities for Dairy-Entrepreneurship

- Mostly, marginal farmers and those who have quit farming are joining the livestock business.
- About 70 per cent of the livestock market in India is owned by 67.00 per cent of the small and marginal farmers and by the landless.
- Prosperity is now more dependent on per capita livestock ownership than on agricultural farms
- Global market for animal products is expanding fast, and there is an opportunity for India to improve its participation in global market.

Strategies to start a Dairy Enterprise: Sustainable and profitable livestock business involves the following aspects:

- Selecting the right enterprise/species/breed according to the area, weather and soil condition.
- Proper financial planning with cost and ROI (return on investment) calculations.
- Fixing the financial resources properly.
- Applying for the Government subsidy/grants.
- Ability in securing a loan.
- Relevant skill, knowledge, and expertise.
- Using proper equipment and upgraded technology.
- Risk management ability.
- Finally proper marketing planning

Entrepreneurial Opportunities in Dairy Sector

A. Dairy Sector Input Enterprises;

1. Commercial Feed and Fodder Manufacturer/Supplier

Feed and fodder account for the major cost of dairy production and are the major components of the livestock industry. By growing fodder crop round the year and supplying the feed and fodder to small, medium, and large dairy in cities can fetch good amount of money and act as a source of sustainable income. Progressive farmers can also take up the upcoming venture of silage making from green fodder through advanced technology machines of silage balers. The silage bales from green fodder could be easily wrapped and packed in bags, tubes and easily transported to small, landless farmers, urban dairies and green fodder deficient states. This would also provide new business and self-employment opportunities to the farmers of the as they could flourish this business by selling packed silage to the landless and needy dairy farmers across the country.

2. Hydroponic Fodder Production

Cultivation of fodder crop without soil or solid growing medium, but using water or nutrient-rich solution only, for a short duration. Advance technology to overcome the fodder scarcity especially farmers in urban areas and small land holders. Usually, maize, oats and barley seeds are used for growing inside hydroponic machines. Seeds are allowed to grow under controlled environments such as humidity and temperature. By this anyone can start their business enterprise.

3. Establishment of Area Specific Mineral Mixture Unit

It is a well-established fact that area specific mineral mixture is more profitable to our dairy farming community for increase in milk production, body weight in young animals and solving many productive and reproductive problems in dairy animals. Any one can take the training from animal nutrition department of any Veterinary University and can start the preparation of area specific mineral mixture and by packing it in different size bags as per the need and ease of the consumer. By selling mineral mixture he/she can earn good amount of money round the year.

4. Commercial Dry Fodder Enrichment Unit (Preparing Urea-Treated Straw)

The use of urea is relatively safe and has the distinct advantage of universal availability, less risk and low cost as compared to ammonia or alkali treatment. Urea treatment of straw leads to an increase in intake, digestibility and energy availability to the animal which otherwise would have been wasted. Urea treatment also enriches the straw for its protein content (up to 9-10%; 5-6 units). The urea treatment technology is simple and has great possibilities for adoption at farm-gate level for enhancing the utilization of poor-quality roughages.

The urea enriched dry fodder can be prepared on commercial level and can be sold to the dairy farmers at the time of shortage of green fodder which can fetch attractive prices.

5. Feed Manufacturer and Supplier

As farmer spend about 70% of its input cost on feed alone, so livestock feed manufacturing is a profitable business. Farmers can start their own feed mill units for various livestock species with proper planning and know-how about the right mixing formula. To save costs, most feed manufacturers like to take advantage of price fluctuations of feed ingredients by buying in bulk when prices are low; or by contracting for supplies months ahead. Identifying cheap raw material and seasonally modification in feed composition to remain price competitive while delivering good quality food is also necessary for better profitability. However, there are various factors restraining growth of the market which includes high import duties on feed ingredients, vague regulatory regime, volatility in raw material prices and frequent disease outbreak.

6. Commercial Breeding Units/Farms

For commercial livestock rearing one of the essential components is the availability of good quality breed of dairy animals viz., cattle, buffalo. Gap between demand and availability of good breed of dairy animal poses excellent opportunity in front of rural youth to establish dairy animal breeding farms in their areas and sell the young ones at good prices.

7. Providing Private Doorstep Artificial Insemination (AI) Services

Availability of good quality, progeny tested, sexed semen doses are the need of hour for all the category of dairy farmers having small, medium, and large herd size of dairy animals. Doorstep Artificial Insemination (AI) Services poses excellent opportunity for rural youth to provide door-step AI services in their areas and can earn good amount of money.

8. Fodder and Seed banks

Fodder scarcity main factor for low productivity of livestock. There is shrinkage of open land for animal grazing and less allocated cultivable land under fodder production. The availability of green fodder throughout the year has been a very important issue for the dairy farmers. Farmers especially women through group approach can establish fodder banks or fodder seed banks in the potential areas. They can purchase fertile land or uses community wasteland, uncultivable fallow land & common property land to raise fodder crops consisting of trees, grasses and legumes for green fodder supply to the nearby livestock farmers. They can take up seed production and supply good quality seed of fodders and can start their fodder and seed bank enterprise.

9. Production and Supply of Elite Germplasm to the dairy farmers

There is a huge scope for establishing breeding farms especially of male germplasm for supply of high-quality semen straw to the dairy farmers. Entrepreneurs interested in dairy farming often face the problem of shortage of good quality of germplasm. Farmers can rear best of bulls; cross breeds them, checks out the semen for both productivity and resistance to diseases, and then sells the semen to other farmers and start-up it as enterprise.

10. Male Buffalo Calf Rearing

Livestock farmers sees the male buffalo calf as a liability and cull the same for obvious reasons. It could be an income-generating source by utilizing them for meat production and recovery of hide for export market and domestic consumption. Under the schemes male buffalo calves are reared at farmer's field's up to the age of 22 months for economic meat production, recovery of hides to enlarge raw material base for leather industry and to generate employment opportunities in rural area with a free preventive health care and feed supply to them. The firm buy these buffalo calves at market rates set at the time of signing the contract with farmers. Similarly, GOI scheme "*Salvaging of Male Buffalo Calves*" is also running in the country to promote buffalo calf rearing among the farmers.

B. Dairy Sector Output Enterprises

1. Processing and Value Addition of milk and milk by-products-based enterprises

Demand of dairy products is increasing day-by-day and thereby provide excellent returns from various milk products. Processing of raw milk into products such as butter, ghee, cheese, yogurt flavoured milk, condensed milk, skimmed milk powder, ice cream etc have huge profit potential. Farmer or any rural youth can start their own milk parlour, where they can sell processed milk and milk products etc.

2. Processing and Value Addition of buffalo meat-based enterprises

Similarly, the demand for buffalo meat and meat products continuously rising in Arabian countries as well as in India and will be the key driver for livestock sector. Emerging consumption of convenience and value-added meat products will not only diversify the food production system, but also will provide huge employment opportunities to large number of micro, small and medium scale entrepreneurs.

3. Organic Dairy Farming

Dairy farming is becoming attractive and remunerative among educated youths especially in the production of organic products such as pure cow milk and organic milk. Rearing of desi cow provides several monetary benefits to farmers and health benefits to consumers. The desi cow milk or A2 milk are supposed to have medicinal benefits thus fetches higher rates to the rural economics. Similarly, desi cow ghee/A2 ghee, are also in great demand due to health consciousness. There is an also untapped employment opportunities for milk-based skin care products because they are natural, non-toxic when used on the skin.

4. Dairy waste-based enterprises

Dairy waste can be converted in to dairy wealth by various dairy farm waste management techniques such as; composting, vermicomposting, anaerobic digestion, biogas plant, black soldier fly processing and vermiwash etc., through 4R's of management; Reduce, Reuse, Recycle and Recover. The Jal Shakti Ministry launched the GOBAR (Galvanizing Organic Bio-Agro Resources)-Dhan Scheme - as a part of Swachh Bharat Mission (Grameen) for management of cattle and biodegradable waste. The main focus of GOBAR-Dhan Scheme is to keep villages clean, increase the income of rural households, and generate energy and organic manure from cattle waste. The scheme also aims at

creating new rural livelihood opportunities and enhancing income for farmers and other rural people (Ministry of Drinking Water and Sanitation, 2021).

Production of organic waste in rural areas of India will be increasing from 109.5 to 125.5 MT in the time period of 2018 to 2030 (Ministry of Drinking Water and Sanitation, 2015). Animal waste especially dairy animals waste is a valuable resource and can be utilized as biogas units for producing gas, manure and other value-added products made from cow dung. Dairy farming with biogas plant and urine distillation plant is very lucrative for new entrepreneurs. Cow urine/goumutra of native cows is used as manure for organic farming. Distilled cow urine when consumed also has medicinal values to increase the immunity and serves as detoxifier.

The earnings from cow dung have also opened new avenues for many unemployed rural youths. Government of India is also promoting Start-ups focused on “commercializing” cow by-products like dung and urine by providing subsidies and grants for dairy waste start-ups. Youths can be motivated, encouraged, and trained for cow waste-based enterprises like; Gobar pots, Dung cakes, Gobar gas plant, vermicompost, Dhoop and Agarbattis, Hawan samigri, fertilizers and Pest repellents, Panchagavya, Amruth Jal and Jeevamrutha etc.

Conclusion

Dairy sector plays an important role in providing regular and reasonable income throughout the year. By looking at the present scenario, the demand for dairy products, by-products, value-added products, and dairy farm waste products is increasing both quantitatively and qualitatively. There are plenty of job opportunities in the dairy value chain.

There is urgent need to provide adequate trainings on various dairy based enterprises to the rural youth and it is better to promote dairy-based enterprises in rural areas, as the local people/rural youth have the required skills. There is a need of establishment of proper *Research-Extension-Farmer- Market-Linkage* for the existing and emerging dairy-based enterprises. Therefore, given the importance of dairy sectors, for both farmers and consumers, there is a need for governments at various levels to establish a holistic framework for the overall growth and development of the dairy sector.

References

1. <https://www.vikaspedia.in/schemesall/schemes-for-farmers>
2. <https://epashupalan.com>
3. Jaiswal P, Chandravanshi H, Netam A. Contribution of dairy farming in employment and household nutrition in India. Int J Avian & Wildlife Biol. 2018;3(1):78–79. DOI: 10.15406/ijawb.2018.03.00059.
4. Khan, N. Khan, M.M. and Rehman, A. (2009). Livestock Husbandry, Rural Workforce and Employment Generation: A Case Study. The Geographer, 56(2), pp. 77-87.
5. Mathur, B.N. (2000), "Current Problems and Challenges Confronting the Dairy Industry in India" Asian-Aus. J. Anim. Sci. July, p.p. 447-452.
6. Ministry of Drinking Water and Sanitation (2015). Solid and liquid waste management in rural areas. Available at: <https://mdws.gov.in/sites/default/files/Primer%20SLWM.pdf> (accessed 22 June 2019).
7. Ministry of Drinking Water and Sanitation (2021). GOBAR-Dhan, framework for implementation.

Biotechnological Intervention in Animal Sciences

Niraj K. Singh

College of Animal Biotechnology, Guru Angad Dev Veterinary and Animal Sciences University,

Ludhiana, Punjab

Corresponding author: nirajvet57@gmail.com

Abstract

In order to meet the demand for animal products around the world, biotechnology is widely used in the production of animals. This includes increasing not only the population of livestock animals but also the population of endangered species to improve reproduction and maintain the genetic diversity and biodiversity order to improve reproduction and maintain the genetic diversity and biodiversity that are currently present. Biotechnologies can improve the identification of an animal's genetic values using genetic markers, candidate genes, and other related techniques. Biotechnologies can also artificially alter the genome at the DNA level through the use of genetic engineering, gene transfer, and related methods. These methods include artificial insemination, embryo transfer, sexing, and cloning.

Introduction

Biotechnology, in its broadest sense, is the application of scientific and engineering principles to the use of living organisms or substances derived from these organisms in order to produce or modify goods, improve plants or animals, or create microorganisms for particular human-beneficial purposes. It varies from traditional biotechnology, also referred to as conventional biotechnology, which applies biotechnology to a straightforward process like baking and using yeast to a complex one like recombinant DNA technology or the classical, which includes biofertilizers, biological nitrogen fixation, and fermentation to modern biotechnology, which includes plant tissue culture, cell culture, recombinant diagnostics, and genetic engineering. Today's biotechnology is mostly associated with uses in agriculture and medicine that are founded on our understanding of the genetic code of life. Increasing livestock productivity is one advantage of using biotechnology in animal husbandry.

In developing nations, where it accounts for more than a third of agricultural GDP, livestock production is one of the agricultural industries with the fastest rate of growth. In recent years, strong economic growth has really been achieved in many emerging and transitional nations. This is changing people's lifestyles and food product purchase habits, along with population growth, an increase in the number of people living in cities, and an increase in personal earnings. The need for protein in meals is shifting from plant to animal sources. By 2030, it is anticipated that demand for animal products would more than quadruple, with a large share of this growth coming from emerging nations and monogastric animals.

The "Livestock Revolution"—the rising demand for livestock products—offers a potential to improve the wellbeing of millions of impoverished people whose livelihoods depend on livestock and might play a significant role in eradicating poverty. According to reports, 29 g of animal protein were consumed daily by humans worldwide. Human intake of animal protein

was around 90 kg per capita, especially in developed nations. Yet, emerging nations (80% of the world's population) tend to have a higher per capita need for meals made from animals. The average annual meat consumption in Indonesia is 2.72 kg per person and is expected to rise to 3.36 kg per person by 2020, which is extremely low when compared to global consumption.

By enhancing animal growth, carcass quality, and reproduction, as well as nutrition and feed efficiency, food safety, animal health, and welfare, biotechnology has made it feasible to boost animal output while reducing waste due to more effective resource use. Because of this, the biotechnology used in cattle production is expanding more quickly than in any other industry. Livestock is anticipated to overtake crops as the most significant agricultural industry in terms of value-added commodities by 2020. This study covers the relevance of the most popular contemporary biotechnologies on animal production and some results that have been applied in Indonesia.

Biotechnological intervention in Animal Science

Reproductive Biotechnology

For controlling the reproduction of small and large ruminants, there are now several solutions available. The two major technologies that are utilised often are artificial insemination (AI) and semen storage. Other methods that can improve the effectiveness of reproduction and pregnancy rates include sexing sperm, synchronization and fixed-time insemination, superovulation, embryo transfer (ET), and in vitro embryo production (IVEP). Molecular DNA markers can be used to define and preserve an animal's genetic resources as well as for genetic improvement through marker-assisted selection (MAS).

Artificial Insemination (AI).

The most popular biotechnology used on livestock, especially in the production of cattle, is artificial insemination. One of the most significant assisted reproductive technologies is still it . Around 90% of the genetic advancement in a commercial herd is dependent on the genetic advancement in the AI. By using AI, the use of proven sire is considerably increased. Artificial insemination is easy, affordable, and effective. The vitality of sperm is crucial to AI's success [3]. The method used to keep the sperm alive for a longer period of time is called sperm cryopreservation. It refers to the long-term preservation and survival of biological material at extremely low temperatures, such as liquid nitrogen at -196°C.

Multiple Ovulation and Embryo Transfer (MOET)

A phase in assisted reproduction known as embryo transfer biotechnology involves inserting embryos into a female's uterus with the goal of starting a pregnancy. In the past, the method sparked a lot of attention among individuals. By using this biotechnology, it is feasible to produce more calves from chosen mothers than would be achievable by using conventional methods of animal production. By intensifying selection on the female and increasing the number of calves, MOET has the ability to improve the genetics of its animals. The three phases of the embryo transfer process include superovulation using follicle-stimulating hormones, surgical or non-surgical embryo collection, and transfer of the embryos to the recipients. The benefits

of embryo transfer include the protection of breeds and conservation, the development of disease-free herds, cost-effective livestock transportation, the quick multiplication of the best female breeding stock, and research applications.

Sperm Sexing

By employing AI with sexed sperm, hundreds of thousands of calves have been produced. Although this method has been employed for numerous animals, the great majority of pregnancies have occurred in cattle, virtually all as a consequence of sexed sperm and afterwards frozen.

Embryo Splitting

Embryo splitting is the artificial microsurgical division of an embryo that results in the development of twins or multiples. The genetically similar embryos can continue to grow after being divided. Before embryos are transferred to a surrogate mother, the morula or blastocyst stages can be divided into two equal halves using an inverted microscope attached to a micromanipulator and a microsurgical scalpel. By using this technique, genetically identical animals can be created. The creation of monozygotic twins appears to be duplicated in this procedure.

In Vitro Embryo Production

Bovine embryos may now be generated using in vitro fertilization. In order to speed up the maturation process, primary oocytes that were taken from the antral follicles of the ovaries might be stimulated. The in vitro maturation procedure must, however, guarantee that the produced oocyte can undergo typical fertilisation and generate a zygote capable of growing to term following embryo transfer. The high production costs and low overall efficiency of in vitro embryo production (IVEP) restrict its practical application in field settings. There have been reports of moderate to low blastocyst formation rates of 15% to 30% and calf production of 10.5%, as well as maturation rates of 70% to 90%, fertilisation rates of 60% to 70%, and cleavage rates of 40% to 50%. Compared to the 30% to 60% observed for cattle, the efficiency of blastocyst generation in buffaloes is significantly lower. Consequently, IVEP needs to be enhanced before it may be used extensively in underdeveloped nations on cattle and buffaloes.

Embryonic Stem Cell

Embryonic stem cells (ESCs) are stem cells that are derived from the embryo's inner, undifferentiated cell mass that is taken from the donor mother animal. ESCs are pluripotent stem cells which may self-replicate and develop into a variety of different types of cells. It is present in a variety of adult tissues and can be discovered at various stages of foetal development. The activity of stem cells may be altered by manipulating them in the lab such that they accept additional genes. The donor mother's ovaries are removed during this procedure, and she is then dosed with progesterone to alter her hormonal milieu and keep the embryos free to develop in the uterus. The embryos are taken from the uterus after 4-6 days of intrauterine culture and grown *in vitro*.

Utilization of Agricultural Residues for its Value Addition

Surya Tushir¹, Rajeev Kumar Kapoor² and Deep Narayan Yadav¹

¹ICAR-Central Institute of Post-harvest Engineering and Technology, Ludhiana 141004

²Department of Microbiology, Maharshi Dayanand University, Rohtak

Corresponding author: surya.kadian@gmail.com

Abstract

The agricultural industry generates vast quantities of residues from non-edible parts resulting from crop cultivation and processing, posing significant challenges for waste disposal. Encouragement has been given to the reuse and recycling of these agro-residues, with the implementation of environmentally friendly technologies playing a pivotal role in this regard. The by-products and food wastes derived from this industry offer tremendous potential as a source of nutraceuticals, bioactive, and other inherently functional components that are beneficial for human health. Consequently, recovering these by-products not only contributes to improving human health but also brings about economic benefits for labor, stakeholders, and the country as a whole. Effective techniques can be explored to separate and isolate proteins, oils, antioxidants, fragrances, colorants, biocides, and various other bioactive substances of natural origin. By subjecting these materials to additional and appropriate processing steps, they can be transformed from low-value residuals into high-value products. These high-value products find extensive applications in the food, cosmetic, pharmaceutical, and other industries, gaining recognition and acceptance from consumers due to their well-known and highly valued uses.

Introduction

Agricultural industry produces billions of tons of residues in non-edible portions derived from the cultivation and processing of a particular crop which may represent a major waste disposal problem. These residues can cause pollution, management, and economic problems worldwide. The reuse and recycling of agro-residues has been highly encouraged and new technologies applying environmentally clean processes have been playing a central role within this context. These strategies may boost both the environmental and economic profiles of the implied industries since they may create value in the entire chain-production pipeline. Typically, a sub comprise part of the agro-residues produced during the handling and processing of fruits, vegetables and forest resources still comprises important amounts of the original plant materials, such as fruit skins, fruit seeds, flowers, leaves, stems, barks, and roots. High-value natural compounds can be found in most of these vegetable residues, many of them having health-promoting characteristics.

The food industry generates large amounts of waste or by-products annually around the world from a variety of sources. In that food wastes or by-products are an excellent source of nutraceuticals, bioactives, inherently functional and possess many components that are

good for human health. Food wastes or by-products convert to functional food ingredients it is the healthy trends in the food industry. Waste management is one of the major parts of food industries. The large volume of the low-cost by-product gives economical advantage of its potentially valuable components and environmental benefits. Therefore, the recovery of by-products to health beneficial product and economic benefit to labour, stakeholder, and country. Efficient techniques can thus be explored for separation and isolation of oils, antioxidants, fragrances, colorants, biocides and other bioactive substances of natural origin. Therefore, with some additional and adequate processing steps, these materials can be easily transformed, from a residual low-value status into a very interesting high-value status, in terms of well-known and consumer high-value and accepted uses in the food, cosmetic and pharmaceutical industries, among others.

Conceptual framework

There are many misunderstandings concerning the technical and legal interpretations of waste concept. The current European Union waste law is very clear on this issue 'materials are simply termed as waste or not' (European Union 2006). However, many confusing and contradictory terminology including by-products, co-products, secondary products, intermediate products, and sub-products are often used in both business and scientific vocabulary. For these reasons, we will use the definitions from the Waste Framework Directive (European Union 2006):

Waste: a material which the holder discards or intended or is required to discard

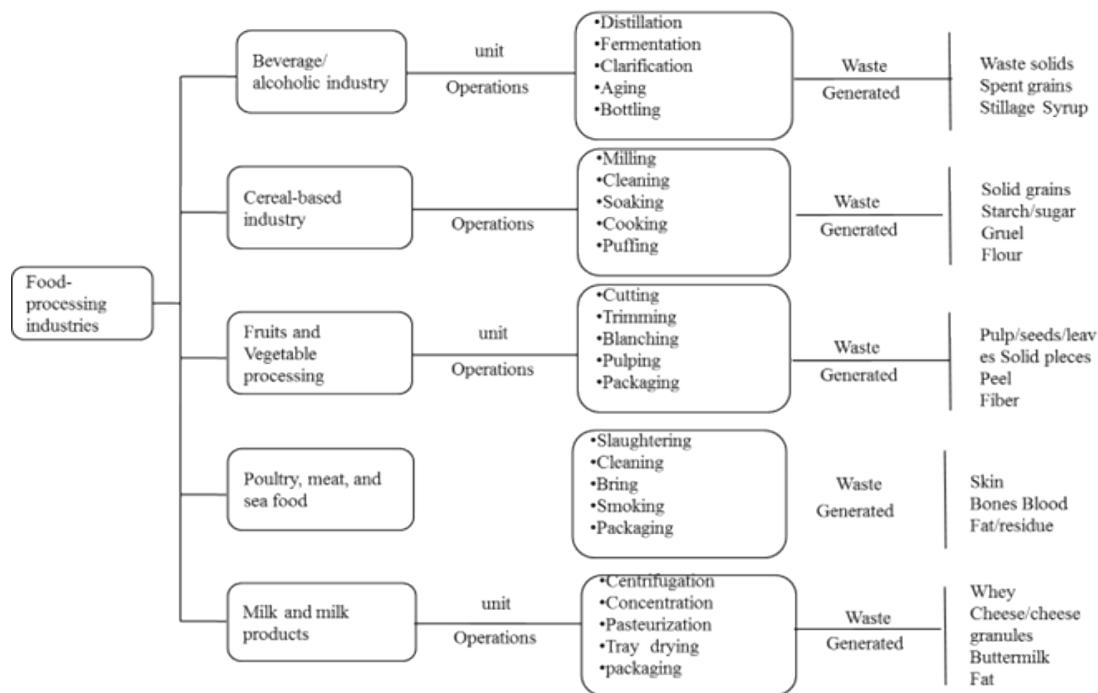
Production residue: a material that is not deliberately produced in a production process that may or may not be a waste.

By-product: a production residue that can be used directly without any further processing other than normal industrial practice.

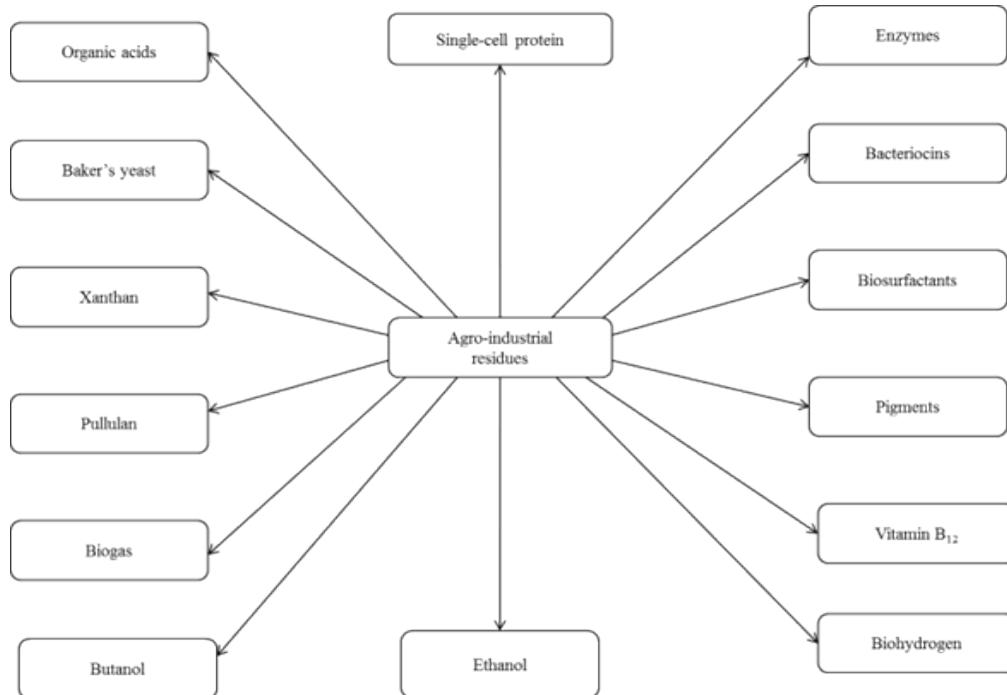
Types of wastes from different industries

Food waste or by-products most commonly refers to edible food products, which are intended for the purposes of human consumption, but have instead been discarded, lost degraded or consumed by pests, and does not include the inedible or undesirable portions of food stuffs. The various food industries disposed of their valuable waste and some food industries re-processed their waste and used as a functional food ingredient and developed their economy to survive in the neck cutting competition of the market. The food industries are categorized by the following.

- 1) Fruit and Vegetable Industry
- 2) Grain Processing Industry
- 3) Brewery and Winery Industry
- 4) Marine Industry
- 5) Meat Industry
- 6) Dairy Industry



Types of waste generated in food processing Industry

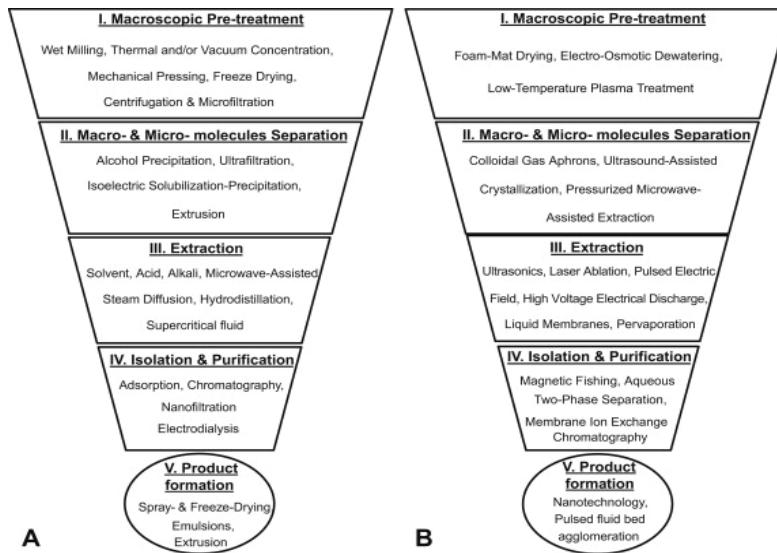


Value added products produced from agro-industrial residues through bio-processing

Recovery stages and conventional technologies

The extraction, fractionation, and isolation of high added-value compounds from food wastes usually follow the principles of analytical chemistry. Thereafter, modifications are accordingly introduced into the applied methodology with a goal of:

- (a) Maximizing the yield of the target compounds,
- (b) Suiting the demands of industrial processing,
- (c) Clarifying the high added-value ingredients from impurities and toxic compounds,
- (d) Avoiding deterioration and loss of functionality during processing and
- (e) Ensuring the food grade nature of the final product.



Recovery stages of high-added value components from food wastes:
(A) established and (B) emerging technologies.

Conclusion

Agri-industry by-products will also boost new markets in functional food industry as functional food ingredients. By using science and innovation to make valuable agri by-products and increase profitability. Most of these by-products are a good source of proteins, minerals, fatty acids, fibre, and bioactive compounds. The efficient utilization of the by-products from agro-industry can help in reducing the negative cost, reduce environmental pollution, demonstrating sustainability in food industry and that has direct impact on the economy of the country. The recovery of valuable compounds from food wastes is an important challenge, so researchers should manage to succeed scale up without affecting the functional properties of the target compound and develop a product that meet the consumers' high-quality standards for safety and organoleptic characteristics. These problems can only be solved in terms of proper management, but in practice this is not always feasible. Besides, scale up of compounds recovery and further valorization meets the same problems encountered in food formulations

production. Scale up is usually accompanied by a rapid development of complex interactions due to extensive handling, increased air incorporation and transition of batch to continuous processes. Thereby, recovered materials often receive a higher degree of scrutiny, which results in partial loss of product functionality. This is an important drawback to overcome, since industrially recovered compounds are used in foods constrainedly at higher concentrations compared to the predicted ones. Subsequently, the induced organoleptic character of the final product is altered, and process cost is increased. Limiting factors such as mixing and heating time can affect the quality, too.

Following all the above considerations, future investigations should target the development of safer and tailored-made processes. This could be accomplished by avoiding extreme processing conditions (i.e., using non-thermal technologies) and applying GRAS-status solvents and materials. However, what is needed more is the conduction of integral studies, which include not only recovery protocols, but also specific applications and preservation assays to secure industrial exploitation and sustainability of the final product, respectively.

References

1. Charis M. Galanakis (2012). Recovery of high added-value components from food wastes: Conventional, emerging technologies and commercialized applications. *Trends in Food Science & Technology* Volume 26, Issue 2, August 2012, Pages 68-87
2. European Union (2006) Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste. In: Official Journal of the European Union L114/9. Available in EUROPA, summaries of EU legislation. http://europa.eu/legislation_summaries/other/l21197_en.htm. Cited 09 June 2012
3. Helkar PB, Sahoo AK, Patil NJ (2016) Review: Food Industry By-Products used as a Functional Food Ingredients. *Int J Waste Resour* 6:248. doi:10.4172/2252-5211.1000248.
4. <https://estudogeral.sib.uc.pt>
5. https://www.researchgate.net/publication/257637906_Agricultural_residues_as_a_source_of_bioactive_natural_products
6. Omar Santana-Meridas, Azuela Gonzalez-Coloma, Raul Sanchez-Vioque. (2012). Agricultural residues as a source of bioactive natural products. *Phytochem Rev* (2012) 11:447–466 DOI 10.1007/s11101-012-9266-0.
7. Parmjit S. Panesar, Satwinder S. Marwaha. 2014. Biotechnology in Agriculture and Food Processing: Opportunities and Challenges. CRC Press.

Climate Resilient Agriculture: Field Experiences

Ashish Santosh Murai

ICAR-Agricultural Technology Application Research Institute, Ludhiana-141004

Corresponding author: muraiashish5@gmail.com

Abstract

Climate change is evident and it is happening at a must faster rate than ever. Earth's atmosphere is warmer by an average of 0.85°C over the period between 1880 and 2012 (IPCC, 2013). According to the estimates, global warming is likely to reach 1.5°C between 2030 and 2052, if it continues to increase at the current rate. Global warming, greater than the average, is being experienced in many land regions and seasons, including two to three times higher warming in the Arctic reason (IPCC 2018; IPCC 2013). There are many evidences of climate change being documented worldwide. According to reports (IPCC, 2013), the number of cold days and nights has decreased and the number of warm days and nights has increased globally. Similarly, the frequency of heat waves has increased in the large parts of Europe, Asia and Australian continents. The Greenland and Antarctic ice sheets have been losing mass over the years. Globally, the glaciers are continuously shrinking and the sea level rose by 0.19 m between 1901 and 2010. Likewise, increases have been observed in the frequency of extreme events since 1950. Negative impacts of climate change on crops are more common and coupled with rising population would pose large risks to food security globally.

Introduction

IMD (2013) report suggests that there has been an increase in maximum and minimum temperature during the monsoon season. Likewise, increase in the winter mean temperature in several parts of the country has been recorded. Besides, decrease in annual rainfall in several states, rise in the number of heavy rainfall events and flooding, expansion of arid regions in several parts and shortening of the growing season, retreating glaciers and increasing rainfall variability have also been witnessed across the country.

These weather aberrations have been affecting different sectors of agriculture due to events of drought, cyclones, floods, heat waves, sea water inundation and hail storms. Paddy and wheat yields are expected to reduce by 4 per cent to 6-23 per cent respectively in the coming years. The lack of sufficient chilling hours, extreme weather events and poor pollination is shifting apple cultivation from low to high altitude regions owing to nearly 30 per cent reduction in the yield. Alongside crops, it is estimated that heat stress may lead to milk yield loss of 1.8 mt in cattle and buffalo and the decline in availability of water is further expected to affect the animal productivity. Besides, the sea surface temperature has increased by 0.2 to 0.3°C along the Indian coast in the last 45 years, and is projected to increase by 2.0 to 3.5°C by 2099, which has serious implications for latitudinal extension of in abundance, spawning, and breeding activity of several marine fisheries.

Field Experiences in North India

During the second week of March 2022, minimum temperature in Ludhiana, Punjab reached up to 25°C and the maximum temperature crossed 35°C. This high temperature coincided with grain filling/ development stage of wheat and resulted in forced maturity. The crop was ready for harvesting 7-10 days earlier than the normal. Wheat yield in 2021-22 (42.9 q/ha) reduced by 16 per cent compared to that of 2020-21 (49.8 q/ha) under conventional system. Following adaptations have been adopted to counter this Heat Wave.

Time of Sowing: Sowing time of wheat is very crucial for realizing maximum yield. Looking at the case in Bathinda district, during 2021-22, about 10 per cent of the wheat crop was sown between 20-30 October 2021. The crop yield obtained was about 47 q/ha, which was about 12-15 per cent less than that of previous year. On the other hand, about 50 per cent of wheat was sown between 1-15 November 2021 with yield of 42.5 q/ha and about 35 per cent crop being sown between 15-20 November 2021 with yield of 39 q/ha. Thus, with the delay in sowing the yield loss went on increasing, due to the effect of rise in temperature during the maturity of the crop. The importance of sowing wheat crop at right time is a well-known fact, but its importance has increased even more due to the incidence of heat wave.

Happy Seeder Proves Smart and Sustainable Solution: Happy Seeder is a key innovative planter capable of direct drilling of wheat immediately after rice harvest in residual soil moisture with surface retention of residues. The direct seeding of wheat in standing paddy stubbles with Happy Seeder allows sowing of the crop without disturbing the soil structure. The compactness of the soil remains intact and the crop develops a robust root system upon germination. Moreover, the presence of mulch increases minimum and decreases maximum soil temperature, thereby providing a buffer during unusual fluctuations in the temperature. More importantly, the mulch keeps canopy temperature lower during the grain filling stage and results in production of equal or higher grain yield (2-6 percent) during normal weather condition. A study was conducted, in which the wheat sowing methods and their effects on yield during the normal and the heat wave year were ascertained at 400 farmers' fields across sixteen districts of Punjab. The study revealed that, during 2020-21 (a normal year), 2020-21, the average wheat yield was 49.8q/ha in conventionally sown and 52.46q/ha in Happy Seeder sown wheat. Whereas, during 2021-22 (a heat wave year), the average wheat yield was 42.92q/ha in conventionally sown crop and 47.14q/ha in Happy Seeder sown crop. The data indicate that the Happy Seeder sown wheat not only yielded better during the normal year but has proven to be even more effective during the heat wave year. Likewise, our previous observations show that the Happy Seeder wheat can relatively withstand the unseasonal rainfall and high velocity winds compared to conventionally sown wheat.

If we see the wheat economics in Punjab due to the impact of Heat Wave during 2021-22, the State Government estimated reduction of at least 8 q/ha in wheat yield. When we extrapolate the yield loss over 31.5 lakh ha (i.e. total wheat cultivation area), it reveals that the farmers of Punjab have incurred a loss of about Rs. 5000 crore. On the contrary, if we consider the yield advantage due to Happy Seeder and extrapolate the same over 3.5 lakh ha (i.e. Happy Seeder sown wheat area), it comes out to be Rs. 350 crore. Additionally, the saving of Rs.5000/ha in Happy Seeder sown wheat due to reduction in the cost of cultivation

in comparison to conventionally sown wheat, saving amounts to Rs. 175 crore. Thus, it is estimated that a saving of Rs. 525 crore is obtained from sowing wheat with Happy Seeder in Punjab only.

Rising Temperature in Hills

Impact of Rising Temperature on Apple in Lower Hills: In lower Himalayan region, a rise of 1.9 °C in average temperature has been observed between 1983 to 2015. The maximum mean winter temperature has gone up by 4.3 °C and the minimum mean winter temperature has increased by 0.5 °C. This rise in temperature has led to non-fulfilment of chilling requirement for apple crop. It has serious implications on apple, as the flowering has advanced by at least two weeks. Moreover, there will be large scale flower drop due to acute stress and heavy rainfall during second fortnight of April. Further, when it is accompanied by short fall in temperature, the common effect causes poor fruit set in apple. Nonetheless, the optimum temperature for fruit blossom and fruit set in apple is 24 °C, while the region experiences above 26 °C temperature. *In toto*, the temperature rise has reduced the apple yield in lower hills to 7-8 ton/ha, which is about 15-17 ton/ha in higher hills.

Efforts have been made to replace apple with more suitable fruit crops like pomegranate, persimmon, etc. Now, a significant area is under pomegranate which yields up to 15 ton/ha. The net return from apple is just Rs.280,000/ha; whereas, the net return in pomegranate is Rs.476,000/ha. Looking at the success of the intervention, the area under pomegranate has crossed 39.5ha in the study village and 32ha in the nearby villages. Moreover, its coverage in the district has gone up beyond 500ha. A simple study intervention reveals that cultivating pomegranate fetches additional income of Rs.77,42,000/- to the village and Rs. 10,35,20,000/- to the district.

Water Resource Development: The agriculture in Himalayan hills region faces severe drought due to low rainfall and quick runoff due to topography. Therefore, effective water management is the key to development of agriculture in the region. An attempt was made in Choyal –Gadauri village of Kullu to provide irrigation support to the farmers to revive agriculture. Under the project, four water harvesting structures with total storage capacity of 1.1 lakh litre were constructed in command area of 20 ha for the common use of farmers of the village. Using this irrigation water, the farmers started cultivating high value crops. Looking at the success of the intervention, the State Government officials constructed 31 small water harvesting structures of 6.40 lakh litre capacity under MGNREGA. The State Department of Agriculture came forward to further add eight such structures with 2.30 litre capacity, taking the total to 9.8 lakh litre. Now, the gross irrigated area in the village increased from just 15 per cent to 35 per cent of the total cultivated area. The crop diversification of the village led to a shift to vegetable cultivation (tomato, garlic) from traditional crops (wheat, maize) fetching a net return of Rs. 280,000/ha, which previously were only Rs. 150,000/ha. The story clearly depicts the importance of convergence of efforts and effective management by the end users.

Conclusion

There are many technologies available to be demonstrated in the farmers' fields for wider adoption. All technologies or interventions may not be successful in all the areas at the same

extent. However, efforts must be made to up-scale the proven technologies by involving line departments and other stakeholders for better convergence and steps must be taken to make these interventions sustainable. Similarly, a single method or process may not effective to address climate change in agriculture. Therefore, multi-intervention strategy to address specific issues need to be put in place. For an example, to address water scarcity or drought like situation different interventions like water saving through laser leveling, under-ground pipeline, Direct Seeded Rice, etc. need to be explored. Nevertheless, preventing wastage is as good obtaining higher yields; therefore, emphasis should be on minimizing losses than on maximizing yields. The time has come to emphasize Integrated Farming Systems for better utilization of resources and minimizing wastage. Concurrently, efforts must be made to harness less explored sources of energy like solar energy for farm operations. Value addition and processing have to be promoted to mitigate financial risks of a farm family. Looking at the health of a farm family, the concept of Nutritionally Smart villages has to be inculcated through interventions like nutri-gardens and back yard poultry. The villages must adopt community level interventions like community vegetable nursery (onion, cole crops, and cucurbits) and seed bank to encourage self-reliance. Likewise, subsidiary occupations like beekeeping, goat farming and piggery must be promoted to provide additional income as well as buffer from financial risks to a farm family. Moreover, looking at the labor situation, concepts like Community Machine Banks / Custom Hiring Centres should be promoted in the villages. Such efforts can only develop self-reliant villages and ensure climate resilient agriculture.

References:

- IMD (2013) State Level Climate Change in India. Indian Meteorological Department (IMD), Government of India.
- IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schröder, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24. <https://doi.org/10.1017/9781009157940.001>.

Carbon Credit in Agriculture Perspective

Rohit Gupta and Sanjeev Kumar Kataria

Krishi Vigyan Kendra, Jalandhar, Punjab Agricultural University, Ludhiana

Corresponding author: rohitgpt2009@gmail.com

Abstract

Climate change has become a hot topic and has prompted a market for carbon credits. Several scientific studies have provided evidence that increasing concentrations of greenhouse gases have increased the earth's average air temperature, resulting in the phenomenon termed global warming. Greenhouse gases have become newsworthy and carbon credits exist because of concerns about global warming. According to the National Energy Information Center, greenhouse gases have increased by about 25 percent since large-scale industrialization began around 150 years ago. Greenhouse gases are formed by both natural and man-made processes. Burning fossil fuels (e.g., automobiles, home heating, utility plants) is the major man-made source of greenhouse gases (CO₂). Carbon credits are a medium of exchange used to "offset" CO₂ emissions under the Cap and Trade guidelines set by the Paris Agreement. The idea is that companies responsible for emitting CO₂ have to reduce their emissions (cap) or pay for the efforts of farmers or others who can prove they are doing the work of removing CO₂ from the air (trade). In particular, carbon credits are created based on the amount of carbon you draw down into the soil. And so the GHG emissions you reduce above the soil. There are various opportunities to generate carbon credits in agriculture. Soil carbon capture or sequestration happens when plants capture and store, or "sequester," atmospheric CO₂ in the soil. On the other hand, agricultural practices like no-till farming and planting cover crops can slow the rate of soil carbon loss. They can even potentially increase soil carbon levels. There has been a lot of buzz in the agriculture sector about voluntary carbon markets. In this market, farmers can sell a carbon credit to investors for every metric ton of carbon that their land sequesters. The carbon market creates new revenue streams for farmers that were not there before. This incentivizes them to transition to sustainable farming practices and adopt regenerative agriculture. This publication briefly explains greenhouse gases and the relevance to agriculture production system, defines "carbon credit," and highlights ways agriculture producer can benefit from the growing market for carbon credits.

Introduction

The concept of Environmental Protection is an age-old idea imbibed in the Indian Cultural ethos since Vedic period. Our ancient Indian Civilization defined the norms and policies of environmental protection about 5,000 years ago. Sometime it's hard to believe what we can't see but that doesn't mean it isn't there. Carbon dioxide also known as Greenhouse gas is invisible but the impact of how carbon is affecting the earth is not. Each and every one of us is responsible for creating Carbon dioxide (CO₂). In actual fact, we are using 50% more resources than the earth can produce. It is difficult for people to grasp just how extreme our ecological crises really are.

According to the National Energy Information Center, greenhouse gases have increased by about 25 % since large-scale industrialization began around 150 years ago. Greenhouse gases are formed by both natural and man-made processes. Burning fossil fuels (e.g., automobiles, home heating, utility plants) is the major man-made source of greenhouse gases (CO_2). There is a long list of sources of carbon emissions, and agriculture is one that may be hard for many people to believe.

Agriculture as a whole is thought to contribute less than 10 percent to the projected total of greenhouse gases. The largest share of agricultural greenhouse gases are contributed by processes usually categorized as soil management. When soil organic matter (called *sequestered carbon*) is converted to carbon dioxide following tillage, erosion, and other soil disruptions, the CO_2 is released into the air.

Greenhouse Gases

Greenhouse gases have become newsworthy and carbon credits exist because of concerns about global warming. The phrase greenhouse gas comes from the way certain gases in the atmosphere — primarily carbon dioxide, methane, and nitrous oxide - mimic a greenhouse by trapping heat. Several scientific studies have provided evidence that increasing concentrations of greenhouse gases have increased the earth's average air temperature, resulting in the phenomenon termed global warming. Carbon dioxide (CO_2) is used as the reference greenhouse gas. All other greenhouse gases are compared using carbon dioxide equivalents (CO_2e). For example, methane (CH_4) has a heat trapping potential 21 times greater than that of carbon dioxide, so 1 metric ton of methane is equal to 21 metric tons of carbon dioxide ($21 \text{ CO}_2\text{e}$) when released into the atmosphere. The greenhouse gas effect of nitrous oxide is 298 times greater than that of carbon dioxide. So, even though methane and nitrous oxide gases are not as common in the atmosphere as carbon dioxide, they still have a large effect.

According to International Energy Agency (IEA), carbon dioxide emissions rose by 6% in 2021 to 36.3 billion tones, marking the highest peak point, as the world economy rebounded from the Covid-19 crisis? Countries worldwide have been discussing ways to combat climate change since the early 1990s. These discussions have led to the implementation of various important accords, including the Kyoto Protocol and the Paris Agreement. One of the major concerns faced by several countries, more specifically developing countries, while committing to sustainability goals is the impact it might have on their overall economy owing to the adoption of expensive cleaner technologies in every industry. To address this problem, both Kyoto Protocol and Paris Agreement developed and regulated the concept of carbon pricing.

Kyoto Protocol: The Kyoto Protocol was adopted in 1997 in Japan and entered into force in 2005. More than 170 countries adopted the Kyoto Protocol which set legally binding targets for some industrialized countries requiring them to reduce their emissions by an average of 5% below the levels emitted during the year 1990 over a period of five years i.e., 2008 to 2012 and established a system to monitor countries' progress. But the treaty did not compel developing countries, including major carbon emitters China and India. Under the Kyoto Protocol, countries were to meet their targets primarily through national measures. It also offered additional means to meet their targets by way of three market-based mechanisms:

- i. International Emissions Trading: Parties under the Kyoto Protocol that have set targets for limiting or reducing carbon emissions, were allowed emissions that were divided into assigned amount units ("AAUs"). Countries that had emission units to spare (emissions permitted to them but not 'used' were allowed to sell this excess capacity to other countries that were over their targets.
- ii. Clean Development Mechanism (CDM): CDM enables an industrialised country with a set target under Kyoto Protocol to set up an emission reduction programme in a developing country. The emissions reduced as a result of such programmes translates into carbon credits called as Certified Emission Reductions (CER). Emitters who have exceeded their emission allocations can purchase these CERs to make up the difference.
- iii. Joint Implementation: This mechanism allows an industrialised country to earn emission reduction units (ERU) from an emission-reduction or emission-removal project in another industrialised country.

Paris Agreement: In 2015, at the COP 21 Sustainable Development Summit held in Paris, all participants of United Nations Framework Convention on Climate Change (UNFCCC) signed a legally binding international treaty on climate change. While the Kyoto Protocol required only developed countries to reduce emissions, the Paris Agreement recognised that climate change is a shared problem and called on all countries to set emissions targets through 'nationally determined contributions (NDCs). Paris Agreement allows countries to voluntarily cooperate to achieve emission reduction targets set out in their NDCs. Paris Agreement is similar to the CDM and establishes a mechanism for trading GHG emission reductions between countries.

Kyoto Protocol was extended until December 2020 through Doha Amendment and has not been extended further. While Kyoto Protocol was never withdrawn, Paris Agreement in effect has superseded the Kyoto Protocol as the principal regulatory instrument.

Carbon Pricing

Carbon pricing is an increasingly popular mechanism that captures the external costs of emitting carbon. It effectively shifts the responsibility of paying for the destruction of the environment from the public to the GHG emitters. This gives emitters the option of either reducing their emissions or continue emitting by paying for their emissions. It creates a price signal that reduces or regulates GHG emissions and at the same time provides a strong financial case for shifting investments away from high-emission fossil-fuels based technology towards cleaner technology.

Carbon Credits

International treaties have set quotas on the amount of GHG countries can produce, which in turn set quotas for businesses. Instruments like carbon credits and carbon offset were introduced in order to improve the scenario by encouraging firms to be more environments friendly in conducting their business. The idea behind carbon credits is that many businesses may prefer to financially compensate other enterprises for reducing greenhouse gas emissions rather than make the changes necessary to reduce their own emissions. With a market in

place, a buyer can purchase carbon credits from a business (seller) that has verifiably reduced its emissions to offset (on paper) some or all of the greenhouse gases released by the buyer's operation. For example, if an environmentalist group plants enough trees to reduce emissions by one ton, the group will be awarded a credit. If a steel producer has an emissions quota of 10 tons, but is expecting to produce 11 tons, it could purchase this carbon credit from the environmental group.

One carbon credit allows one ton of carbon dioxide or a corresponding amount of other greenhouse gases to be discharged in the air. Businesses that are over their quotas must buy carbon credits for excess emissions, while those below can sell their remaining credits. This exchange of credits between businesses has encouraged carbon trading globally. These credits can be exchanged between businesses or bought and sold in international markets at prevailing market price at two exchanges, namely the Chicago Climate Exchange and the European Climate Exchange. The Multi - Commodity Exchange of India (MCX) may soon become the third exchange in the world to trade in carbon credits. The amount of global emissions can be controlled through the buying and selling of carbon credits in the carbon trading method. It is quite simple and convenient to purchase carbon credits from a number of firms, just like any other monetary instrument, as they are traded in an open market.

Agricultural Carbon Credits

Plants or crops form part of the entire carbon cycle. Growing almost any sort of plant is the same as practicing small scale carbon sequestration. That's because plants use carbon dioxide (CO_2) from the air during their photosynthesis. When the plants die, their carbon-based structure begins to decay. Some of that CO_2 is released into the air, and some of it is trapped underground. Grasses and other crops draw down CO_2 from the air quickly but they also tend to release it fast when they decompose. Yet, with proper soil carbon capture and farming practices like regenerative agriculture or carbon farming, they can sequester CO_2 very well. In carbon farming, carbon can be thought of as a crop similar to the other crops farmers produce on their farms or ranches. Agricultural practices give farmers the great potential to turn their farms' carbon sequestration into cash with carbon credits.

There has been a lot of buzz in the agricultural sector about voluntary carbon markets. In this market, farmers can sell a carbon credit to investors for every metric ton of carbon that their land sequesters. The carbon market creates new revenue streams for farmers that were not there before. This incentivizes them to transition to sustainable farming practices and adopt regenerative agriculture. *On the buyer side, companies, governments, and other entities buy carbon credits for around \$15–\$20/ton of carbon to offset their own emissions.* This can be done voluntarily (as offsets) to meet their emissions reduction goals. Or farmers can sell credits to entities in the regulatory market (cap-and-trade system) with reductions mandated by laws.

Mitigation of Green House Gasses

Agricultural lands occupy 37% of the earth's land surface. Agriculture accounts for 52 and 84% of global anthropogenic methane and nitrous oxide emissions. Agricultural soils may also act as a sink or source for CO_2 , but the net flux is small. Many agricultural practices can potentially

mitigate greenhouse gas (GHG) emissions, the most prominent of which are improved cropland and grazing land management and restoration of degraded lands and cultivated organic soils. The global technical mitigation potential from agriculture (excluding fossil fuel offsets from biomass) by 2030, considering all gases, is estimated to be approximately 5500 - 6000 Mt CO₂-eq.yr⁻¹. In addition, GHG emissions could be reduced by substitution of fossil fuels for energy production by agricultural feedstocks (e.g. crop residues, dung and dedicated energy crops).

Regenerative or Carbon Farming

Carbon farming describes a collection of eco-friendly techniques that have the ability to increase carbon sink into the soil i.e., carbon sequestration. Increasing the C sink in soil will help to reduce the amounts of CO₂, CH₄ and N₂O emission in environment. Carbon farming leads to reduction in greenhouse gas emissions referred to as abatement activities. It holds carbon in vegetation and soils, and reduces greenhouse gas emissions. Many regenerative farming methods follow the traditional ways of farming that were used for thousands of years. These include:

- Reducing soil disturbance due to tillage (no-till farming)
- Ending the use of synthetic pesticides and fertilizers
- Maximizing soil coverage through living roots and mulching.
- Promoting crop rotation by moving away from monocultures and growing cover crops

As farmers embrace regenerative farming, their land goes from being a net-emitter of GHG to sequestering carbon. In other words, becoming a carbon sink. The reduction or sequestration of CO₂ by regenerative farming methods can lead to the creation of carbon credits. These credits are created and brought to market by project developers. They then sold the credits to big companies seeking to offset their own emissions while supporting farmers. In return, farmers receive additional revenue for every ton of CO₂ reduced or sequestered by their farmlands. However, Farmers may claim to achieve certain carbon reductions or sequestration falsely. This is why a third-party body has to measure and verify the claim by the farmers to ensure there's indeed a reduction/sequestration that's happening. Soil tests, for instance, are one part of carbon credit programs. Validation of conservation practices is also done by way of federal crop records and field data.

Soil Carbon Capture

Soil act as a big carbon sink which give opportunity to sequester of carbon through farmland management. Soil carbon capture or sequestration happens when plants capture and store, or "sequester," atmospheric CO₂ in the soil. This increases the quantity of soil carbon stocks. Decaying plant matter, along with the carbon it contains, becomes part of the soil for a period of time before it is broken down by microbes. It's during decomposition when CO₂ sequestered goes back into the atmosphere. The length of time carbon stays in the soil before returning to the atmosphere varies. It depends on the climate, soil composition, and other factors. For instance, disrupting the soil structure like converting forests and grasslands to farmland, can

speed up the process of releasing much of the captured carbon and eventually it add up some heat in to environment.

On the other hand, agricultural practices like no-till farming and planting cover crops can slow the rate of soil carbon loss. They can even potentially increase soil carbon levels. Studies say that the past 200 years of agriculture released over 100 billion metric tons of CO₂ from the soil into the atmosphere. In particular, carbon credits are created based on the amount of carbon you draw down into the soil and so the GHG emissions you reduce above the soil. Applying the practices below can help increase soil health by improving soil structure, reducing losses of carbon and nitrogen from the soil, and building soil organic matter.

- Use conservation tillage techniques in cropping operations. If cultivation is absolutely necessary, do not till excessively wet or dry soils.
- Avoid burning crop residues and retain stubble where practical.
- Avoid periods of bare fallow and ensure continuous plant cover where possible.
- Manage irrigation and soil drainage to reduce water logging.
- Rotate crops and include rotations of perennial pastures and legumes.
- Add composted material where practical.
- Manage soil structure to maximize plant uptake and minimize nitrogen loss
- Manage livestock waste (dung and urine) to minimize nitrous oxide emissions.
- Manage soil nutrient levels by choosing nutrient targets, completing a nutrient budget to determine fertilizer requirements.

Carbon Sequestration through Cover Crops

Cover crops are different from the primary cash crop. They are planted without the intention of harvesting. That sounds not right but farmers can get plenty of benefits from doing that. They protect the soil from erosion and improve nutrient conditions. They are grown to help keep the soil intact which would otherwise be bare against winds, rains and water, and even tillage. Cover crops are becoming popular as the world fights climate change. Popular examples of cover crops are barley, oats, legume, radishes and rye. Some crops are converted into biofuel or fed to animals. But leaving them to break down in the soil is best for the environment because doing so can help the soil sequester carbon. And so, cover crops boost the capacity of agricultural lands to draw down carbon emissions.

It is estimated in USA that 20 million acres of cover crops can sequester over 66 million tons of CO₂ equivalent a year. This is equal to the emissions of about **13 million vehicles**. And this rate increases when cover cropping is used along with no-tillage farming. It is suggested that, one acre of cover crops land would sequestered about 3 - 4 tons of CO₂. So, *if one carbon credit (equals one ton of GHG removal) has the maximum price at the current rate (\$20), that's about \$60 – 80/acre market opportunity*. This is why growing cover crops qualify farmers for a carbon offset program. It means the crops can make carbon credits and give farmers additional revenue. (Jennifer L., 2022)

Carbon Mitigation through Fertilizer Management

Applying nitrogen fertilizers more efficiently reduces nitrous oxide emissions and nitrate runoff into waterways and has direct financial benefits. Farmers can save money, boost production and reduce emissions of nitrous oxide by using best management practices for the rates, sources, timings and placement of fertilizers. Match nitrogen supply to crop or pasture demand by soil and plant testing to assess nitrogen supply and using decision support tools and seasonal forecasts.

- Avoid high application rates of nitrogen in any single application.
- Avoid applying nitrogen fertilizers (especially nitrate) to waterlogged soils.
- Avoid tillage under wet conditions.
- Incorporate fertilizer at the top of raised beds or ridges to avoid wet areas.
- Choose the best source of nitrogen. In the wet season urea and DAP will lose less nitrate and nitrous oxide than nitrate-based fertilizers.
- Place fertilizer below the soil surface where possible.
- Use an inhibitor coated fertilizer where possible – in summer to reduce ammonia loss and in winter to reduce nitrous oxide and nitrate leaching losses.

Livestock Management for Mitigation of Carbon Emission

Methane is a major inefficiency in animal production systems. 6 - 10% of livestock gross energy intake is lost as methane which is the equivalent of up to 55 - 60 days grazing intake for ewes and 40 days for dairy cows. Nitrogen is another area of loss, between 70 - 95% of nitrogen consumed by ruminants is excreted. If used effectively, it can improve pasture or crop growth instead of being lost to the atmosphere. (Das et al, 2020). The following practices can reduce these losses:

- Optimize feed quality (Digestibility).
- Use and minimize nutrient excretion.
- Manage flock or herd performance through increased reproductive efficiencies.
- Selective culling and genetic optimization to enable faster finishing and other practices such as early joining and early weaning.
- Use a genetic improvement program to increase reproductive rates
- Manage livestock waste (dung and urine) to minimize nitrous oxide emissions.

Indian Initiatives for Environmental Management

Comparing the globally placed carbon trade, India seems nowhere nearby. However, in the recent years, compulsion to comply with Euro II emission norms is a very confident step towards controlling air pollution. It has now become essential for companies to make environmental considerations as a part of their business decision making. According to industry estimates,

Indian companies are expected to generate at least \$8.5 billion at the going rate of \$10 per tonne of CER (certified emission reduction). Tata Sponge Iron Ltd got a CDM (clean development mechanism) certificate from the UN for its waste heat recovery project in Orissa. Reliance Energy already has energy efficiency and process development CDM projects. This is a high time to call a revolution for reducing carbon footprint in order to preserve what's left of the ozone layer.

Indian Regulatory Framework

While there are various energy saving schemes like the “Perform Achieve Trade” scheme (PAT Scheme) and “Renewable Energy Saving Certificates” scheme (REC Scheme) that govern the trade of energy savings by some of the designated entities, there is no established regulatory framework for the domestic carbon market in India. Both PAT scheme and REC scheme work on similar principles of energy savings.

Under PAT scheme, designated consumers who over achieve the energy consumption norms and standards allocated to them are issued Energy Savings Certificates (ESCert) by the Bureau of Energy Efficiency (BEE). These designated consumers then trade these ESCerts on energy exchanges with other designated consumers who under achieve their consumption norms.

Under REC Scheme, the aim is to promote renewable energy and facilitate the compliance of renewable purchase obligations (RPO) (A mechanism under the Electricity Act, 2003 according to which the obligated entities have to purchase a certain percentage of electricity from renewable energy sources, as a percentage of the total consumption of electricity). The eligible entities as per these regulations are issued RECs which can be traded on energy exchanges or through electricity traders and purchased by obligated entities to meet their RPO compliance.

India is a party to both the Kyoto Protocol and the Paris Agreement. In pursuance of the Kyoto Protocol, it established the National CDM Authority (NCDMA) under the Ministry of Environment Forest, and Climate Change (“MoEFCC”) to provide a single window clearance for CDM projects in the country. Now, for implementing its commitment under the Paris Agreement, MoEFCC has constituted a high-level inter-ministerial Apex Committee for Implementation of the Paris Agreement (“AIPA”) under the chairmanship of the Secretary, MoEFCC. One of the key functions of AIPA would be to operate as a national authority to regulate carbon markets in India under Article 6 of the Paris Agreement, formulate guidelines for the consideration of projects or activities, issue guidelines on carbon pricing, market mechanism, etc.

The Indian government has recently taken the following steps towards the introduction of a domestic carbon market:

- i. In October 2021, India's Bureau of Energy Efficiency (BEE) presented a draft blueprint for the phased introduction of a national cap-and-trade system in India, providing for the introduction of a voluntary market in the first phase.
- ii. On 8 August 2022, the Lok Sabha passed an amendment (“Bill”) to the Energy Conservation Act 2001.8 Section 14 of the bill grants the Indian central government or

any authorized agency the power to issue “carbon credit certificates” for the reduction of carbon emissions to registered entities. These credits can then be sold in the market. (Chacko et. al. 2022)

How to Get Carbon Credits in Agricultural Operations

The carbon credit market has relatively few buyers and many sellers, as with many agricultural markets. Since each acre of land can sequester only a relatively small amount of carbon in any given year, it is impractical to attempt marketing individual acres or even hundreds of acres for credit trading. Similarly, it may not be feasible to directly trade carbon credits associated with covering a lagoon or building a digester. For that reason, aggregators play a critical role in organizing and delivering larger quantities of sequestered carbon for marketing as carbon credits. Aggregators are organizations (nonprofit or for-profit) that work with producers to determine:

- The qualifying amount of carbon credits,
- The practices necessary to achieve that potential,
- How to verify that carbon sequestration or offsetting is occurring
- How to aggregate carbon credits and market them to buyers.

Among many others, the Iowa Farm Bureau, North Dakota/National Farmers Union, Sun One Solutions, and Environmental Credit Corporation are aggregators for the CCX. Each charge a fee for aggregating the carbon credits. As part of the agreement to sell carbon credits, greenhouse gas reduction must be verified periodically by an approved verifier who reviews records, gas flow measurements, operational procedures, etc. Producers are required to maintain documentation and their operations may be inspected to ensure compliance. For methane capture projects, verifier costs usually run from \$3,000 to \$5,000 for the initial verification, and annual carbon audits cost \$700 - \$1,000. For agricultural soil credits, verification costs usually run at about 8 percent of total carbon credits. The price received for carbon credits will vary depending on the market and the trading fees agreed upon with your aggregator.

The agricultural carbon credits market consists of two largest players: **speculators and pilot-project developers**. Speculators expect a remarkable growth in carbon markets in the next few years. They're investors who try to contract as many acres as they can to trade as many carbon credits as possible. On the other hand, pilot-project developers are the ones who connect with growers or agribusiness partners. They act as intermediaries between producers and buyers of carbon credits with agriculture projects. Both of them share the common goal of using carbon credits to promote sustainable farming practices while reducing emissions.

Challenges

There's no doubt that agricultural soil carbon capture and sequestration can help address climate change. Many studies back this up and billions of investments have been made in this space. Yet, two major challenges remain that market players need to deal with: **measurement and verification**.

Carbon credits in agriculture and in other sectors are only as real or valuable as the science and evidence underlying them. Rigorous standards for quantifying, monitoring, and verifying carbon offsets must be in place for the creation of agricultural carbon credits. And so, international carbon certifiers exist to ensure highest standards when it comes to carbon credit measurement and accounting. Verra, Gold Standard and Climate Action Reserve are some popular examples. Their role is to set standards and guidelines on how to measure and verify carbon accurately and affordably. Doing so will shed light on how the sector can help tackle climate change and bring confidence in the market.

Conclusion

Indian Government initiatives may allow the land managers to earn carbon credits by reducing greenhouse gas emissions and storing carbon in vegetation and soil through carbon farming. Besides this, it may also allow landholders to generate offset credits from activities that reduce emissions or sequester carbon. The huge emitters will be able to utilize credits generated through the carbon farming to meet their emission reduction targets. Considering the urgent need to take action on climate change, it is recommended to include carbon farming in the portfolio of mitigation strategies. Thus, carbon farming may serve as a promising mitigation strategy deserving higher attention as many other geo engineering options.

References

- IPCC (*Intergovernmental Panel on Climate Change*). 2021. *Climate change 2021: The physical science basis. Working Group I contribution to the IPCC Sixth Assessment Report*. Cambridge, United Kingdom: Cambridge University Press.
Available at <https://uk.practicallaw.thomsonreuters.com/4-205-2962>
- Mathew Chacko, Praveen Raju and Janhavi Joshi. 2022. India: Carbon Credits: An Overview. Spice Route Legal.
- Shaon Kumar Das, Aniruddha Roy and N. U. Singh. 2020. Carbon sequestration through carbon farming to earn carbon credit technical report of ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok, Sikkim-737102
- Jennifer L. (2022). Agricultural Carbon Credits and Carbon Farming Guide

Scope and Importance of Nutri-Cereals in Current Agriculture Scenario

Gurupdesh Kaur¹, Preeti Mamgai² and Prerna Kapila³

¹*Krishi Vigyan Kendra, Patiala*

²*ICAR-ATARI, Zone-I, Ludhiana*

³*Krishi Vigyan Kendra, Ludhiana*

Abstract

Millet is a cereal grain that belongs to the Poaceae family, commonly known as the grass family. Millets are coarse grains and a repository of protein, fibre, vitamins and minerals. They include jowar (sorghum), ragi (finger millet), kangani (foxtail millet), arke (kodo millet), kutki (little millet), bajra (pearl millet), chena/barri (proso millet) and sanwa (barnyard millet). Since ages, these small crops are used for human consumption as well as a fodder for animals. Majority cultivated in the semi-arid tropical regions of Africa and Asia, around 97 percent of world's overall millet production happens in these regions.

Ministry of Agriculture and Farmer's Welfare has recognized the importance of Millets and declared Millets comprising of Sorghum (Jowar), Pearl Millet (Bajra), Finger Millet (Ragi/Mandua), Minor Millets i.e., Foxtail Millet (Kangan/kakun), Prosy Millet (Cheena), Kodo Millet (Kodra), Barnyard Millet (Sanwa/Jhangora), Little Millet (Kutki), Brown top millet and two pseudo millets i.e., Buck-wheat (Kuttu), Amaranth (Chaulai)) as "Nutri-Cereals" for production, consumption and trade point of view. India celebrated 2018 as 'The Year of Millets' and the Food and Agricultural Organization (FAO) has declared 2023 as "International Year of Millets". All these substantiate the importance of millets.

History of Millets

Millets have a long history of cultivation and consumption in India. Millets were widely grown and consumed in ancient India, especially in the Deccan plateau, which includes parts of present-day Maharashtra, Karnataka, and Andhra Pradesh. Millets were a staple food for many communities in ancient India, including farmers and pastoralists. They were preferred over other crops due to their high nutritional value, resilience to drought and other environmental stressors, and their ability to grow in poor soil conditions. Millets were also valued for their versatility, as they could be cooked in a variety of ways, including porridges, flatbreads, and savory dishes. Millets were widely consumed in ancient India up until the medieval period when rice and wheat became more popular. However, millets remained an important food source in many regions of India, especially in areas where rice and wheat did not grow well.

In recent years, there has been renewed interest in millets in India, due to their numerous health benefits and sustainability. The government of India has launched various initiatives to promote the cultivation and consumption of millets, including the Millets Mission, which aims to promote the cultivation of millets in 25 states across India. Overall, the historical significance of millets in India is a testament to their importance as a nutritious and versatile crop that has played a vital role in sustaining communities for thousands of years.

Nutritional composition of various types of Millets with their local name

Millets are high in nutrition and dietary fibre. They serve as good source of protein, micronutrients and phytochemicals. The millets contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fibre. The essential amino acid profile of the millet protein is better than various cereals such as maize. Millets are very good sources of micronutrients such as vitamins and minerals. Millets contain fewer cross-linked prolamine, which may be an additional factor contributing to higher digestibility of the millet proteins.

Similar to cereal proteins, the millet proteins are poor sources of lysine, but they complement well with lysine-rich vegetables (leguminous) and animal proteins which form nutritionally balanced composites of high biological value. Millets are more nutritious compared to fine cereals. Small millets are good source of phosphorous and iron. Millets contributes to antioxidant activity with phytates, polyphenols, tannins, anthocyanins, phytosterols and pinacosanols present in it having important role in aging and metabolic diseases. All millets possess high antioxidant activities.

Major Millets

Sorghum (Jowar)

1. Major portion of sorghum protein is prolamine which has a unique feature of lowering digestibility upon cooking which might be a health benefit for certain dietary groups.
2. Sorghum proteins upon cooking are significantly less digestible than other cereal proteins, which might be a health benefit for certain dietary groups.
3. It is rich in potassium, phosphorus and calcium with sufficient amounts of iron, zinc and sodium.
4. It is rich in protein, fibre, thiamine, riboflavin and folic acid

Pearl Millet (Bajra)

1. Pearl millet contains considerably high proportion of proteins (12-16%) as well as lipids (4-6%).
2. It contains 11.5% of dietary fiber. It increases transit time of food in the gut. Hence, reduce risk of inflammatory bowel disease.
3. The niacin content in pearl millet is higher than all other cereals.
4. It also contains foliate, magnesium, iron, copper, zinc and vitamins E and B-complex. It has high energy content compared to other millets.
5. It is also rich in calcium and unsaturated fats which are good for health.

Finger Millet (Ragi)

1. Finger millet is the richest source of calcium (300-350 mg/100 g)
2. Ragi has the highest mineral content.
3. It contains lower levels of protein (6-8%) and fat (1.5-2%).

4. Finger millet proteins are unique because of the sulphur rich amino acid contents.
5. The grains have excellent malting properties and are widely known for its use as weaning foods.
6. It has high antioxidant activity.

Minor Millets

Foxtail millet (Kakum)

1. It is high in carbohydrates.
2. It has double quantity of protein content compared to rice.
3. It contains minerals such as copper & iron.
4. It provides a host of nutrients, has a sweet nutty flavor and is considered to be one of the most digestible and non-allergic grains.

Kodo Millets

1. It has high protein content (11%), low fat (4.2%) and very high fibre content (14.3%)
2. Kodo millet is rich in B vitamins especially niacin, pyridoxin and folk acid as well as the minerals such as calcium, iron, potassium, magnesium and zinc.

Barnyard millet (Sanwa)

1. It is the richest source of crude fiber and iron.
2. Its grains possess other functional constituents i.e., Gamma amino butyric acid (ABA) and Beta – glucan, used as antioxidants and in reducing blood lipid levels.

Little millet (Kutki/Shaven)

1. It is smaller than other millets.
2. It is high in iron content.
3. It has high antioxidant activities.
4. It contains about 38% of dietary fiber.
5. Proso Millet (Chena/Barri)
6. It contains the highest amount of proteins (12.5%).
7. Health benefits of proso millet come from its unique properties. It has significant amounts of carbohydrate and fatty acids.
8. It is cheaper source of manganese as compared to other conventional sources like spices and nuts
9. It contains high amounts of calcium which is essential for bone growth and maintenance.
10. It reduces cholesterol levels and also reduces the risk of heart diseases.

Pseudo Millets

Amaranth (Ramdana/Rajgira)

1. High protein content (13-14%) and a carrier of lysine, an amino acid that's missing or negligible in many other grains.
2. Consists of 6 to 9% of oil which is higher than most other cereals. Amaranth oil contains approximately 77% unsaturated fatty acids and is high in linoleic acid.
3. It is high in dietary fibre.
4. High in iron, magnesium, phosphorus, potassium and appreciable amounts of calcium. A rich dietary source of phytosterols, with cholesterol-lowering properties.
5. Contains a lunasin-like peptide and other bioactive peptides which are thought to have cancer-preventive and antihypertensive properties.

Buckwheat (Kuttu)

1. It contains protein 13-15% protein and rich in the amino acid lysine.
2. Rich in carbohydrates (mainly starch)
3. Contains vitamins B I, C and E.
4. Rich in polyunsaturated essential fatty acids, such as linoleic acid.
5. Contains higher levels of zinc, copper, and manganese than other cereal grains, and the bioavailability of these minerals is also quite high.
6. High in soluble fibre.
7. A rich source of polyphenol compounds.
8. Contains rutin, a bioflavonoid thought to help control blood pressure and possess anti-inflammatory and anti-carcinogenic properties.

Comparison on Nutritional Composition of Rice and Wheat with Millets

Millets are rich in terms of their mineral content as compared to wheat and rice. Finger millet proteins are unique because they have abundant sulphur rich amino acids. Millets are extraordinarily superior to rice and wheat in their nutritional composition and therefore is the solution for the malnutrition that affects a vast majority of the Indian population. Millets are viable option to live healthy life and reduce the incidence of lifestyle diseases such as hypertension, cardiovascular disease and diabetes. Millets have many nutritional, nutraceutical and health promoting properties especially the high fibre content.

Millets and Sustainability

Millets are a group of highly nutritious, gluten-free, and hardy grains that have been cultivated for thousands of years in different parts of the world. Compared to other grains such as rice, wheat, and maize, millets have several environmental benefits that make them an excellent choice for sustainable food production and consumption.

One of the main environmental benefits of millets is their low carbon footprint. Millets are climate-smart crops, meaning they are highly adapted to low-input and rain-fed agriculture systems, which require minimal use of synthetic fertilizers, pesticides, and irrigation water. As a result, millet cultivation has a significantly lower carbon footprint than other grain crops. According to a study by the Indian Council of Agricultural Research, millet farming produces only 0.39 to 0.52 tons of CO₂ per hectare, which is much lower than rice or wheat farming.

Millets are also known for their ability to grow in low fertility soils and with minimal water resources. They are highly drought-tolerant crops that require up to 70% less water than rice and wheat. This makes millets an excellent crop for farmers in dryland regions who are often faced with water scarcity and unpredictable rainfall patterns.

Moreover, millets are naturally resistant to pests and diseases and require minimal use of synthetic pesticides. According to a study by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), millets require up to 90% less pesticides than rice and wheat crops. This makes millet cultivation a more environmentally friendly option as it reduces the amount of toxic chemicals that are released into the environment.

Overall, millets are a highly sustainable and environmentally friendly crop that can help address several environmental and nutritional challenges. They have a low carbon footprint, require minimal use of water and pesticides, and are highly nutritious. By promoting the cultivation and consumption of millets, we can contribute to a more sustainable and healthy food system.

Future of millets

Millets have the potential to become a mainstream crop in the future due to their high nutritional value, low water requirements, and adaptability to diverse agro-ecological conditions. Millets are also climate-resilient and can thrive in low-input farming systems, making them an ideal crop for small-scale farmers in developing countries. Millets can play a significant role in addressing food security challenges by providing a nutritious and affordable source of food for millions of people around the world. Millets are rich in micronutrients like iron, calcium, and zinc, and can contribute to reducing malnutrition and stunting in children.

To realize the potential of millets, there is a need for increased research, development, and promotion of millets as a mainstream crop. Governments, researchers, and private sector organizations can work together to improve millet varieties, develop appropriate technologies for millet cultivation and processing, and create market linkages for millet farmers.

Conclusion

In conclusion, millets have great potential to become a mainstream crop and can play a critical role in addressing food security, sustainability, and public health challenges in the future. Investing in millet research, development, and promotion can lead to significant benefits for farmers, consumers, and the environment.

Revival of Ancient Grain as Shree Ann for Sustainable Ecosystem

Pragya Bhaduria, Anjani Kumar, Atish Kumar and Amrendra Kumar

ICAR- Agricultural Technology Application Research Institute, Patna

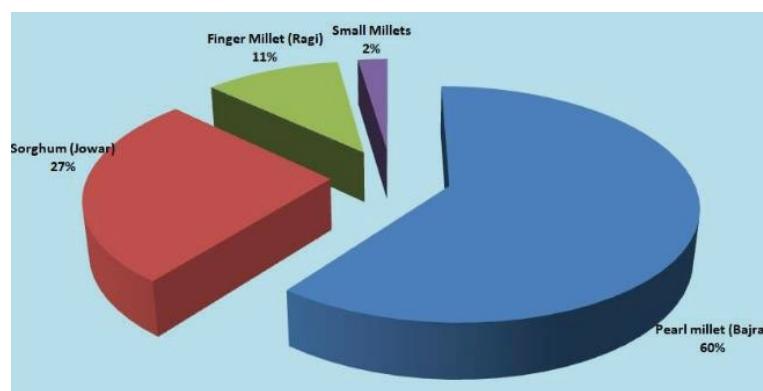
Corresponding author: pragya.bhaduria@icar.gov.in

Introduction

In India, millets were once traditional food grains commonly consumed. However, with the advent of the Green Revolution in the 1960s, there was a focus on food security, leading to a decline in the cultivation and consumption of millets. These millets, which were once a significant portion of all cultivated grains, saw a drop of around 20% over the years. The shift in agricultural practices favoured commercial crops that were more profitable and supported by government policies through subsidies and incentives. Despite this decline, the Government of India has now recognized the importance of millets in ensuring nutritional security for the country. Efforts have been made to promote millets, such as celebrating the National Year of Millets in 2018 and implementing small-scale policies to support their production.

India proposed to the United Nations to declare 2023 as the International Year of Millets (IYOM), and this proposal received support from 72 countries. Consequently, the United Nations General Assembly (UNGA) declared 2023 as the International Year of Millets on 5th March 2021. The Indian government is determined to make IYOM, 2023 a people's movement, aiming to promote Indian millets, recipes, and value-added products on a global scale.

Millets, including Bajra, Jowar, Ragi, and others, are some of the oldest known food grains to humanity. In India, they are referred to as "Shree Anna" due to their cultural and historical significance, which translates to "the honoured grain" or "the mother of all grains." There is substantial evidence that millet crops were domesticated during the Indus Valley civilization. Millets are categorized as small-seeded grasses and are often known as Nutri-cereals or Dryland-cereals. They include *Sorghum* (Jowar), *Pearl Millet* (Bajra), *Little Millet* (Kutki), *Foxtail Millet* (Kakun), *Proso Millet* (Cheena), *Finger Millet* (Ragi), *Barnyard Millet* (Sawa), *Kodo Millet* (Kodon), and others. These millets are well-adapted to dryland agro-ecologies of arid and semi-arid tropics, and they offer a more balanced amino acid profile and higher dietary fibre content compared to general food grains.



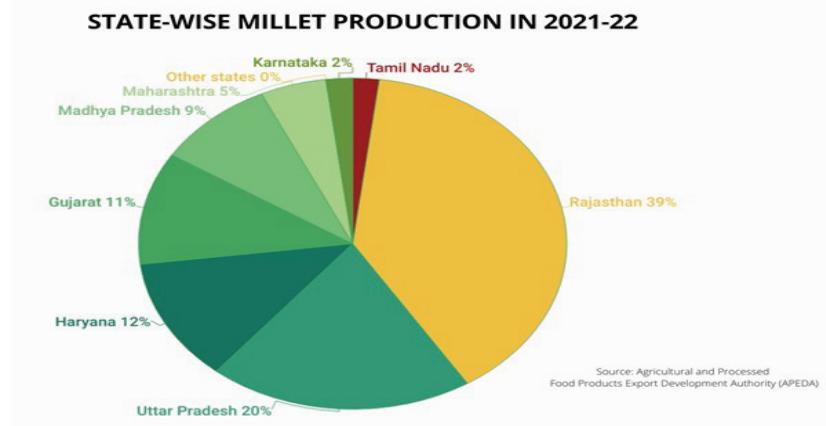
Millets: Significance and Benefits

1. **Nutritionally Rich:** Millets are nutritionally superior to other food grain like wheat and rice owing to their higher levels of protein with balanced amino acid profile. Similarly, the dietary fibre content of millet is also higher compared to some of the staple cereals. It also contains some phytochemicals which exert a kind of therapeutic properties owing to their anti-inflammatory and anti-oxidative properties.
2. **Health Benefits:** Millets are rich sources of nutrients like dietary fibre, carbohydrates, protein, and good-quality fat and higher amounts of minerals like calcium, potassium, magnesium, iron, manganese, zinc and B complex vitamins, making them a preferable choice over the cereal grains. Millets can also help in tackling health challenges such as obesity, diabetes and lifestyle problems as they are gluten-free, low glycaemic index, high in dietary fibre and antioxidants.
3. **Climate Resilient:** Millets are the backbone for dry land agriculture. They are hardy, resilient crops and have a low carbon and water footprint and withstand high temperature and can grow on poor soils, after combining all these qualities thus termed as the 'miracle grains' or 'crops of the future'. In times of climate change, they are the most secure crops to small farmers as they are adapted high temperature and water scarce condition.
4. **Soil Health:** Millets help improve soil health as they have deep root systems that help prevent soil erosion and increase soil fertility.
5. **Ecologically Sustainable:** production of millets is not so much dependent on chemical fertilizers. These crops do not attract pests, and a majority of the millets are not affected by storage pests.
6. **Biodiversity conservation:** Millet cultivation helps maintain biodiversity as it involves growing a variety of crops rather than monoculture farming practices
7. **Cultural Significance:** Millets have been a staple food for many rural communities in India for centuries and are an important part of the country's agricultural and cultural history.
8. **Economic Benefits:** The cultivation of millets provides livelihood opportunities for small farmers and rural communities, especially in areas where other sources of income are limited.

Millets in India: Facts and Figures

According to the 2023 Economic Survey, India takes the lead in millet production, contributing to 80% of Asia's millet output and 20% of the global millet production. The country's impressive millet yield of 1239 kg/ha surpasses the global average of 1229 kg/ha. India stands as the largest producer and currently it is the fifth largest exporter of millets in the world, according to 2020 data, with exports continuously increasing at around 3% CAGR in the last five years ending with 2020. In the year 2021-22, millet production witnessed a remarkable growth of around 27% compared to the previous year, reaching a total of 15.92 million metric tons (MMT).

Among the millet varieties produced in India, Pearl millet holds the major share at 60%, followed by Sorghum at 27%, Finger millet at 11%, and small millets at 2%. The states that significantly contribute to millet production in India are Rajasthan, Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, and Telangana.



Under National Food Security Mission (NFMS) programme, a programme NFSM-Nutri Cereals is being implemented in 212 districts of 14 states that made a significant impact on millets production and consumption. Indian Institute of Millets Research, Hyderabad has incubated 250 Start-ups under RKVY - RAFTAR. The export of millets also increases in last three financial year and the exported millets products worth of USD 34.32 million during 2021-22. In 2020- 21, India exported millets worth USD 26.97 million against USD 28.5 million in 2019-20. Through the support of Minimum support price (MSP), production of millets increases significantly in last three consecutive year. The government of Bihar also emphasise on production and consumption of millets and started several awareness programmes to popularise the crops.

Government Initiatives for Promotion of Millets

In 2018, under the guidance of the Government of India, the National Year of Millets was officially declared. As part of the National Food Security Mission (NFSM), the government launched a sub-mission called Nutri-cereals to raise awareness among farmers about the importance of millets such as ragi, sorghum, bajra, and others. Various research and development initiatives were undertaken by the government to popularize Nutri-cereals. Start-ups and entrepreneurs received support to develop value-added products and recipes that promote millet consumption.

An emphasis was also placed on millet export, and the Agricultural and Processed Food Products Export Development Authority (APEDA) prepared a comprehensive strategy to promote Indian millets globally. A Statement of Intent (SoI) was signed between NITI Aayog and the United Nations World Food Program (WFP) on December 20, 2021, with a focus on mainstreaming millets and supporting India's leadership in knowledge exchange during

the International Year of Millets in 2023. The Union Budget for 2022-23 allocated support for enhancing domestic consumption through post-harvest value addition and branding millet products both nationally and internationally.

To raise consumer awareness, the government collaborated with non-governmental organizations (NGOs) to launch campaigns and workshops highlighting the nutritional benefits of millets. These efforts aimed to dispel myths surrounding millets, such as considering them as food solely for the underprivileged or the elderly. Innovation in the food industry received encouragement, and several companies introduced millet-based products like ready-to-eat snacks, breakfast cereals, and baked goods to cater to health-conscious consumers. These initiatives not only contribute to the agricultural economy but also generate employment opportunities in rural areas. India shared knowledge and best practices related to millet cultivation with other countries facing similar challenges. Collaborating on research and technology exchange is helping to build a more sustainable and secure global food system.

Conclusion

The declaration of 2023 as the International Year of Millets by the United Nations has brought significant attention to these nutritionally rich grains. With the backing of the Indian government, efforts are being made to increase awareness and production of millets, recognizing their potential to play a crucial role in sustainable agriculture and address food security and nutrition challenges both in India and around the world. The future looks promising for this versatile grain, as it continues to receive support and recognition for its immense benefits.

References

- Saleh, A. S., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. *Comprehensive reviews in food science and food safety*, 12(3), 281-295.
- Jain, R. K., & Bal, S. (1997). Properties of pearl millet. *Journal of agricultural engineering research*, 66(2), 85-91.
- Singh, P., & Raghuvanshi, R. S. (2012). Finger millet for food and nutritional security. *African Journal of Food Science*, 6(4), 77-84.
- <https://www.nutricereals.dac.gov.in/IYoM2023/Data/M%20Mec%202.jpg>
- <https://www.nutricereals.dac.gov.in/IYoM2023/Data/M%20USP%20Millets.jpg>
- <https://www.nutricereals.dac.gov.in/IYoM2023/Data/M%20Health%20benefits.jpg>
- <https://pib.gov.in/PressReleasePage.aspx?PRID=1753108>
- <https://pib.gov.in/PressReleseDetail.aspx?PRID=1796559>
- <https://pib.gov.in/newsite/erelcontent.aspx?relid=106818>
- <https://pib.gov.in/PressReleasePage.aspx?PRID=1725612>

Assessment Approaches for Studying the Drudgery, Energy And Nutrition Requirements for Implementation of Sustainable Interventions

Nisha Verma¹, V P Chadhary¹, PC Jat¹, A K Prusty¹, Poonam Kashyap¹, Alka Verma², Suresh Malik¹, Chandra Bhanu¹, Amit Kumar³, Dinesh Kumar² N Ravisankar¹ and Sunil Kumar¹

¹*ICAR-Indian Institute of Farming Systems, Research, Modipuram, Meerut 250110*

²*G. B. Pant University of Agriculture and Technology, Pantnagar 263145*

³*ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora 263601*

Abstract

Agro-ecological approaches to agriculture looking at sustainability at farm/landscape level may be inefficient and requires a closer look at food system level working along with the workforce. The design of agricultural interventions needs to be cognizant towards food, energy and nutritional requirements at household level. Valuation towards identifying the disconnect between agriculture, farming practices, energy expenditure and human nutrition are pre-requisite condition for effective dissemination of sustainable agricultural interventions. Facilitating greater participation of women in productive activities in agricultural households and increasing their productivity should focus on mitigating the energy and time trade-offs. A clear scenario of time use, calorie/nutrient intake and energy expenditure in rural agricultural households can ultimately improve the design and targeting of nutrition-sensitive agricultural interventions.

Introduction

Agricultural interventions viz. rising agricultural productivity, through the adoption of modern technologies, diversification of crop production patterns, agricultural commercialization involves the adoption of new technology and practices for enhancing productivity offer the potential for enhancing productivity and household incomes in rural areas (FAO *et al.*, 2019, IFAD, 2016). Increased food production certainly improves food availability, but there is little assurance that poor and vulnerable people have access to the food produced neither does it provide information related to the quality and enrichment of the food that is produced. The increase in income does not necessarily ensure shift in diet preference (World Bank 2020). At the same time, many of these interventions call for greater participation of women in agricultural work, contributing to the observed trend of “feminization of agriculture”. An increase in time and energy devoted to “productive” agricultural activities by women can negatively impact household nutritional status through the impact on reproductive tasks – child-care, feeding practices, acquisition and preparation of food influencing dietary choice. Physical exertion, often in high temperatures, required by increased participation in productive activities can adversely affect women’s own health and nutrition, while impairing their ability to perform reproductive tasks (Headey and Masters, 2019, Srinivasan 2020).

The design of agricultural interventions needs to be aware of the energy and time demands that they impose on rural households. Facilitating greater participation of women in productive activities in agricultural households and increasing their productivity should focus on mitigating the energy and time trade-offs. Reducing women's daily workload through drudgery reducing interventions for example, by reducing the daily trek for collecting and carrying firewood, water and fodder could free up time and energy which could be more productively used in farming and childcare. Agricultural interventions are hardly ever evaluated in terms of their impact on women's agricultural productivity (Doss, 2018). These interventions should go alongside the provision of complementary services/drudgery reducing interventions that alleviate women's reproductive burden, such as childcare support and increasing women's available time to engage in formal and better paid economic activities (Johnston et al., 2018). Separate consideration of time and energy demands is a useful way to anticipate and plan for unintended negative nutritional and health consequences of productivity-enhancing agricultural interventions. A richer picture of time use, calorie/nutrient intake and energy expenditure in rural agricultural households can ultimately improve the design and targeting of nutrition-sensitive agricultural interventions.

The problem of under-nutrition therefore has to be dealt with by addressing factors that include nutrition-sensitive farming systems, increasing incomes, improving food accessibility, shifting dietary patterns, alleviating energy and time use patterns, nutrition education and health awareness.

How to proceed

- Production patterns – area, production, cropping patterns, livestock units, subsidiary enterprises, market surplus etc.
- Consumption patterns- farms, market, Public distribution system, dietary diversity, nutrient adequacy etc.
- Biochemical status: Haemoglobin level, blood vitamin A level etc.
- Body fat composition: skin fold thickness etc.
- Clinical signs and symptoms: Vitamin deficiencies.
- Shocks: Earthquake, storm, flood, drought, epidemic, pandemic
- Anthropometric status: BMI, BMI for age, Height for age, weight for age, weight for height etc.
- Time use pattern
- Energy expenditure pattern

Learnings through farmer participatory programmes

I) Tribal Sub Plan

The study area comprises of tribal farming systems of Tarai and Bhabhar zone, Uttarakhand of Western Himalayan Region, India which is located at (29°15'30 N to 29°16'0.07 N, 79°2'39E to 79°3'0 E) in Ramnagar block of Nainital District. It is characterized by the average altitudes

ranging from 195 to 268 m amsl. A total of 100 tribal farm families comprising of a cluster of three tribal villages having more than 40 per cent tribal population viz. Thari, Veerpur Tara and Mallapuri were selected using a clustered sampling frame. The survey instrument was organized into (i) general farm and household characteristics (ii) household dietary diversity, food consumption pattern and chronic energy deficiency status, (iii) farm input and labour use (iv) field crop and horticultural production technologies and practices (v) Dairy and other livestock production (vi) crop residue management including use as animal feed (vii) off farm income sources and expenditure.



Fig 1. Map of the selected tribal cluster from Tarai and Bhabhar Zone

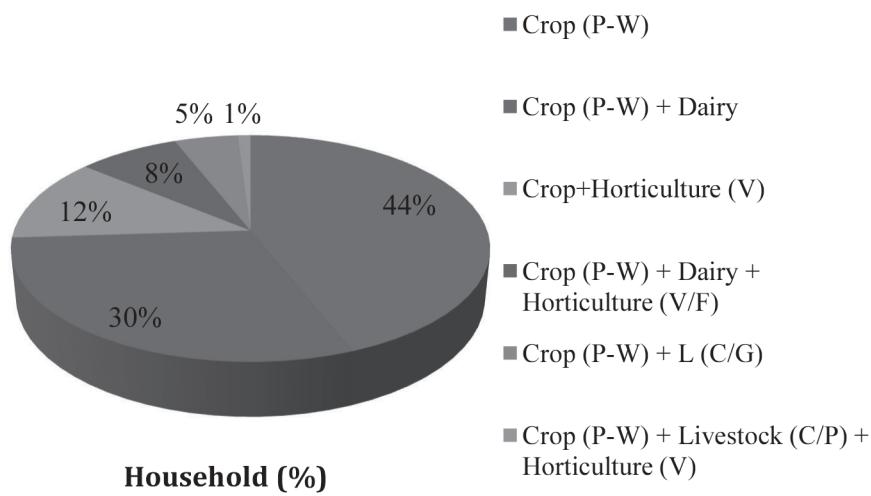


Fig 2. Farming System Characterization

Survey revealed that Crops (paddy-wheat) was the dominant farming system found in around 44 per cent of households followed by Crop (Paddy-Wheat) +Dairy farming system (30%). The survey on nutrition assessment depicted that the dietary diversity score was (DDS) found low (3.87 ± 1.45) amongst 5 food groups. Also, the diet availability was found inadequate in terms of pulses (27.12 ± 10.76), milk (99.46 ± 88.57 gm capita $^{-1}$ day $^{-1}$), green leafy vegetables (23.53 ± 13.59 gm capita $^{-1}$ day $^{-1}$), other vegetables (93.77 ± 41.94 gm capita $^{-1}$ day $^{-1}$), fruits (42.6 ± 39.23 gm capita $^{-1}$ day $^{-1}$) and animal foods (44.27 ± 39.69 gm capita $^{-1}$ day $^{-1}$) (ICAR-IIFSR Annual Report 2018, 2019). Around 3.4 per cent female population was severely undernourished and 20.9 per cent were mild to moderate undernourished. However, amongst males only 0.87 per cent was severely under nourished and 8.8 per cent were mild to moderate undernourished. A total of 2.13 per cent of adult population was found severely undernourished and 14.85 percent was found mild to moderate undernourished. Around 3.4 per cent female population and around 7.0 per cent male population was found overweight and 1.1 percent of female population was found under obese category. A total of 5.2 percent tribal population was found overweight and around 1.1 of tribal population was found obese. This was due to less food remaining for the females or having left over food by them. Therefore, only 70.9 percent of tribal female population and 83.1 per cent of tribal male population were found under normal category. A total of 77.0 per cent of tribal population were found normal. Around 85.71 per cent of pre-school male children of 0-5 years were found stunted ($<-2SD$) with a mean value of -3.25 ± 0.81 and about 60.00 per cent of pre-school female children of 0-5 years were found stunted with a mean value of -1.5 ± 1.91 whereas 80.00 per cent of pre-school female children of 0-5 years were found wasted ($<-2SD$) with a mean value of -2.38 ± 1.42 . Around 85.71 percent of pre-school male children of 0-5 years were found underweight ($<-2SD$) with a mean value of -2.74 ± 1.31 and around 60.00 per cent of pre-school female children of 0-5 years were found underweight ($<-2SD$) with a mean value of -2.54 ± 1.59 whereas, 80.00 per cent of pre-school female children of 0-5 years were found undernourished ($<-2SD$) with a mean value of -3.0 ± 1.09 . Amongst school age children of 11-19 years the stunting amongst males was found 48.27 per cent ($<-2SD$) with a mean value of -2.06 ± 1.23 and around 50.00 per cent of females were found stunted ($<-2SD$) with a mean value of -1.87 ± 1.06 . (ICAR-IIFSR Annual Report 2018).

Interventions Identified and implemented based on nutritional status

- Introduction of zinc (42.0 ppm) and iron (40.0 ppm) genetically bio fortified variety of wheat (WB2) to selected undernourished tribal farm families.
- Introduction of climate resilient with good nutritional quality wheat variety (DBW 173) and high yielding variety of wheat (HD 3086, HD 2967).
- Introduction of high yielding (PB1121, PB1728), short duration (PB1509), high value (PB 1637, PB 1718) varieties of basmati rice alongwith IPM (trichocards and

pheromone traps) practices.

- Diversification of rice-wheat system as well as for enrichment of household nutrition and income through improved varieties for the pulse crops (Lentil var. *PL 6*, *PL 8* and Blackgram var. *PU31*) and mustard (cv. RH 749).
- Integration of backyard poultry (CARI Nirbheek) for egg and meat production.
- Balanced nutrition in milch animals, poultry/goat through mineral mixture, Calcium & Vitamin mixture for enhancement of milk and egg yield.
- Promotion of nutritional kitchen gardening for getting better nutritional yields from vegetables.
- Brinjal (cv), (Pant Rituraj) and (Pant Samrat), cowpea (Pusa komal), okra (Kasi pragati), bottle gourd (Pant lauki 3) and ridgegourd (Pant torai 1) (Feb- May , July-Oct)
- Carrot (Pusa rudhira), Radish (Japanese white), Fenugreek (Pant ragini), Spinach (All green), Corriender (Pant haritima), Green podded and red podded French bean (Nov-Feb).
- Vitamin A bio fortified golden sweet potato's varieties VA 43, ST14, CIP440127 (July-December). Vitamin A, C and antioxidant rich seeds (red capsicum, yellow capsicum, broccoli) were demonstrated for nursery preparation using portrays.
- Promotion of fruit plants for getting better nutritional yields from fruits.
- Lemon (Pant lemon 1), Litchi (Rose cented), Guava (Pant prabhat) and mango plants alongwith IPM through pheromone traps in existing guava plants for the management of fruit fly.
- Year round mushroom production viz. button mushroom, oyester mushroom, milky mushroom, their scientific management and market linking for better family nutrition, income and resource integration.
- Introduction of vermicomposting for farm resource integration and organic consumption of crop, vegetables and fruits.
- Demonstration of package of improved tools and implements viz. improved sickle, *khurpi*, ring cutter, protective gloves seed cum fertilizer drill, single wheel weeder for line sown crops, and dibbler for efficient sowing of broad seeds for enhancing working efficiency and reducing drudgery.

Impact of interventions

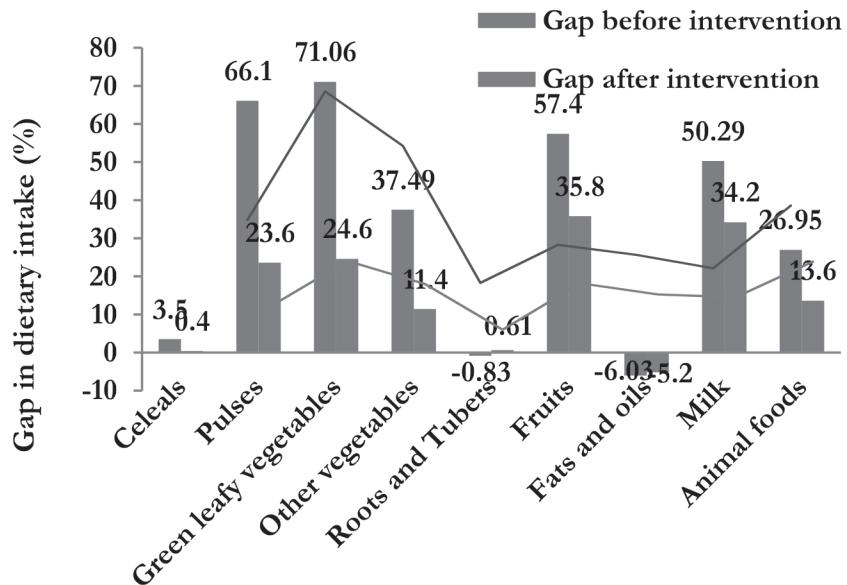


Fig 3. Change in percent gap for dietary intake of tribal farm households as RDA before and after intervention

Percent gap for dietary intake was changed significantly in terms pulses, green leafy vegetables, other vegetables, fruits, milk and animal foods in the adopted cluster. Significant change in terms of pulses, green leafy vegetables, other vegetables fruits and milk was noticed (64.29, 65.38, 69.59, 37.63, 32%) respectively (Fig 3) (ICAR-IIFSR Annual Report, 2020).

Mechanization level (3-46%), use efficiency (0.26 ha day^{-1} - 3.2 ha day^{-1}) have been increased whereas labour requirement have been reduced ($30 \text{ man hr ha}^{-1}$ - $4.99 \text{ man hr ha}^{-1}$) in different farm types by using improved tools and implements viz. tractor operated seed drill, manually operated seed drill, wheel hoe etc. through establishing custom hiring center (ICAR-IIFSR Annual Report 2021).

2) Farmer FIRST

The study area encompasses of farming systems of WPZ of Uttar Pradesh in Khatauli block of Muzaffarnagar district comprising a cluster of 3 villages viz. Satheri, Bhangela and Sonta including 1036 households. (Fig.4). The Farming System study locations were purposively selected on the basis of agro-climatic and socio-economic status, farming practices (cash crop based), and food consumption pattern under the ICAR funded Farmer FIRST project. The information on farming systems, production patterns, nutrient yields, food consumption patterns, dietary diversity, BMI values, stunting, wasting and underweight parameters was gathered through baseline survey for subsequent planning of nutrition sensitive integrated farming system interventions. The impact of the study was again measured through endline survey after three years of intervention period.

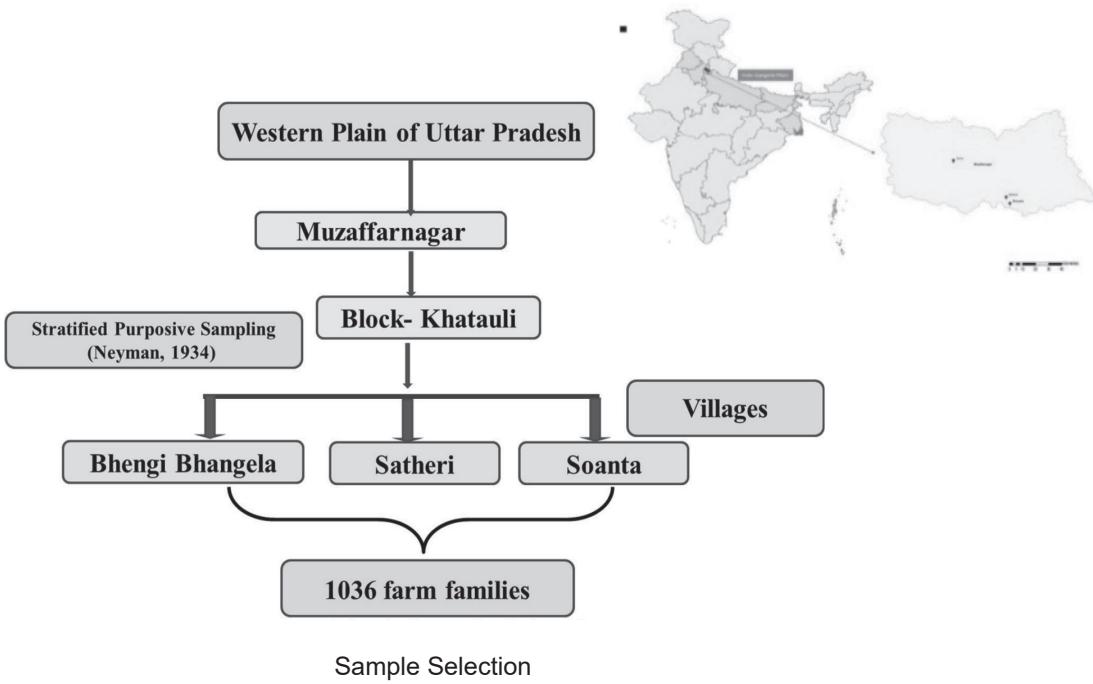


Fig 4. Farming System Characterization system

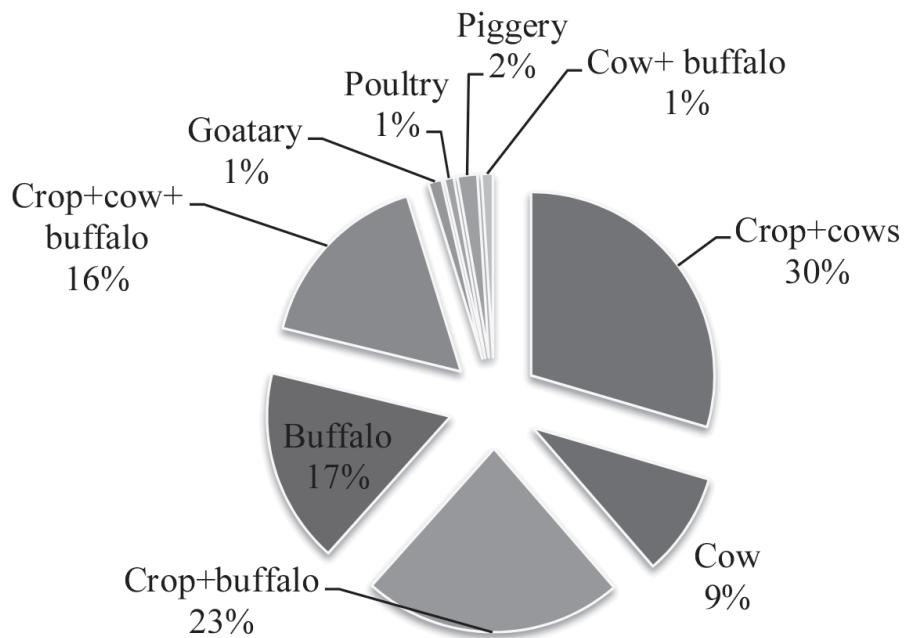


Fig 5. Farming System of Western Plain Zone of Uttar Pradesh

Crop + Dairy was the predominant farming system of Western Plain Zone of Uttar Pradesh consists of Crop+cows (30%) and Crop+ buffallows (23%).

Securing and balancing nutrition through implementing farming systems interventions

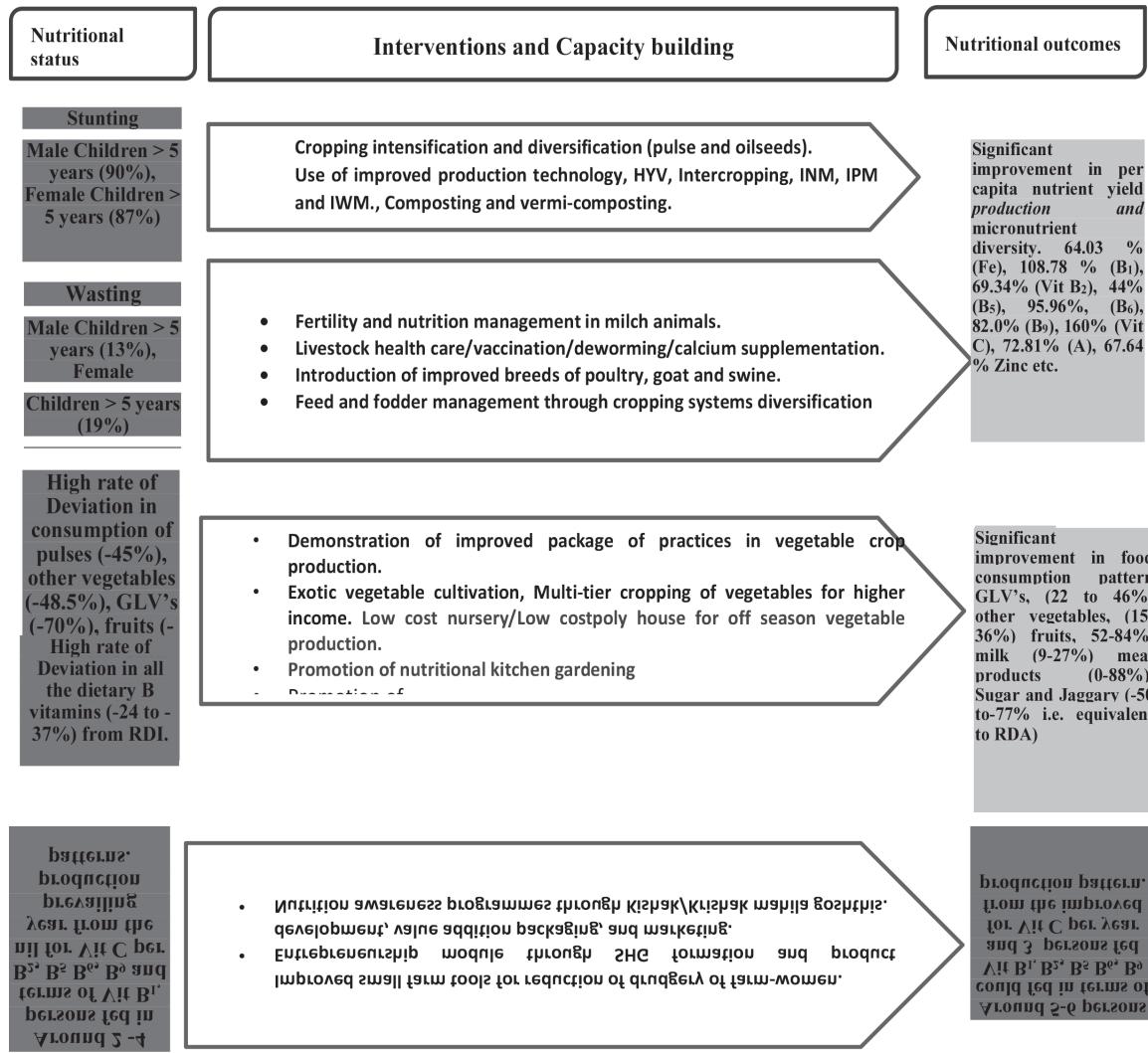


Fig 6. Nutritional Status, interventions planned and nutritional outcomes.

Adopted cluster's knowledge and capacity was expedited in terms of securing and balancing nutrition through implementing farming systems interventions viz. crop intensification through introduction of high yielding varieties alongwith IPM and INM practices in field crops, crop diversification through integration of pulses and oilseed crops, fertility and nutrition management in milch animals, round the year nutrition kitchen gardening through seasonal and exotic vegetables along with nutrition awareness programmes through *krishak melas/krishak, mahila krishak goshthis* etc. This leads to the improvement in per capita production in terms

of nutrient yield *viz a viz* micronutrient diversity. Further results revealed that around 64.03, 108.78 %, 69.34%, 44%, 95.96%, 82.0%, 72.81%, and in nutrient yield in terms of different micronutrients *viz.* iron, thiamine, riboflavin, niacin, Vitamin B6, Vitamin C , Vitamin A and Zinc respectively were observed. It indicates that farming system interventions are effective in terms of diversified supply of agricultural production thereby, contributing to nutrition security (Verma *et al* 2022)

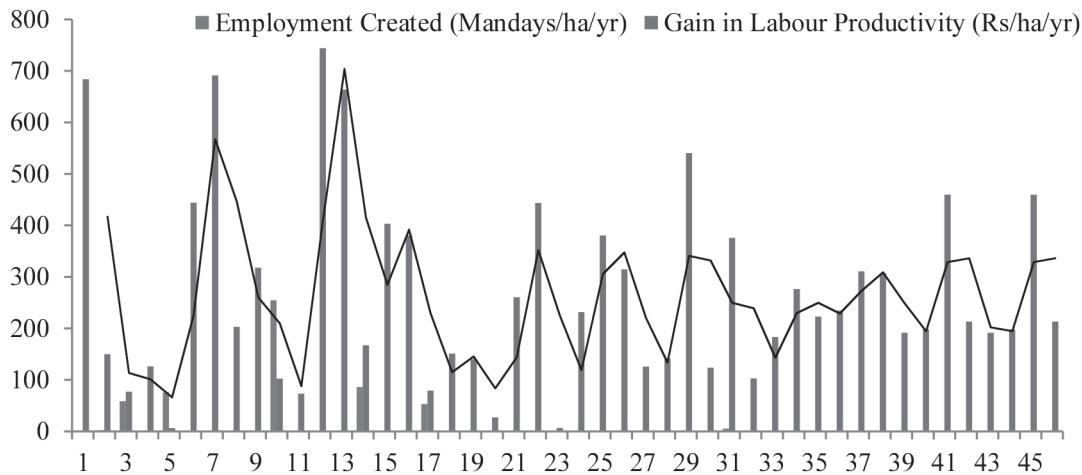


Fig 7 Status of Employment creation and labour productivity improvement related to crop production after intervention

Diversification of sugarcane-wheat production system through inclusion of pulse (backgram/ greengram)/oilseed (mustard) crops, intercropping of mustard/greengram/ backgram in sugarcane created employment opportunities amongst 15% farm households (5 -250 mandays $\text{ha}^{-1}\text{yr}^{-1}$), whereas the labour productivity has improved on an average (300 to 700 Rs $\text{ha}^{-1}\text{yr}^{-1}$) after intervention due to improved management practices (balanced fertilizer application, use of trichocards, improved varieties, line sowing, transplantation of sugarcane through trench paired row method, intercropping of oilseeds and pulses), use of labour and time saving improved hand tools (improved sickle, improved hoe etc).

Assessment of Drudgery: Experiences through ICAR's Extra Mural Fund Project

Drudgery is generally conceived as physical and mental strain, agony, fatigue, monotony and hardship experienced by human being, while all these result in decline in performance of men and women alike. A continuous manual work/use of traditional tools for long hours in awkward (inappropriate) working posture without rest-pause in leads to drudgery. Insufficient agricultural labour/time saving technology for women over men that takes into account the nature of their work, their time use, their physique, and the social and cultural context they live in.

Production system based in-depth workload assessment studies alongwith suitable ergonomic interventions supports reduction of work-related health problems. System based quantification of human drudgery (energy expenditure, postural discomfort, safety, occupational

health) and its optimization through ergonomically designed improved hand tools will lead to more efficient and productive farms.

Table 1. Physiological workload of the subjects for selected operations in farming systems

Physiological variables	Selected operations in sugarcane		
	De-topping of sugarcane leaves	De-trashing of sugarcane leaves	Loading of sugarcane
Working Heart rate (beats min^{-1})	104 ± 1.15	124.3 ± 1.45	130.33 ± 5.48
Energy Expenditure (kJ min^{-1})	7.81 ± 0.18	11.03 ± 0.22	12.0 ± 0.87

The results of the study shows that the mean heart rate of female farmers while working was 104 ± 1.15 , 124 ± 1.45 beats min^{-1} , whereas the energy expenditure was 7.81 ± 0.18 and 11.03 ± 0.22 for de-topping and de-trashing of sugarcane leaves respectively kJ min^{-1} . Similarly, the mean heart rate of male farmers for while working was 130.33 ± 5.48 beats min^{-1} for loading of sugarcane as headload. The energy expenditure was 12.0 ± 0.87 kJ min^{-1} (Table 1). De-topping of sugarcane leaves was found to be a moderately heavy type of work, whereas detrashing of sugarcane leaves and loading of sugarcane as head load was found to be heavy type of workload.

Table 2. Physiological workload in loading of vegetables on head

Physiological variables	Loading of vegetables on head
Working Heart rate (beats min^{-1})	107 ± 2.13
Energy Expenditure (kJ min^{-1})	8.2 ± 0.30
ΔHR (beats min^{-1})	19 ± 2.2
Type of workload	Moderately heavy



Fig 8 (a) Loading of sugarcane **Fig 8(b)** Loading of vegetables

The energy expenditure was $8.2 \pm 0.30 \text{ kJ min}^{-1}$ (Table 2). Loading of vegetables on head was found be moderately heavy.

Conclusion and way forward

Agro-ecological approaches to agriculture looking at sustainability at farm/landscape level may be inefficient and requires a closer look at food system level working alongwith the workforce. For improving food and nutrition security through establishing nutrition sensitive programs, it is foremost important to study food, energy and nutritional requirements at household level. The study is important to identify the disconnect between agriculture, farming practices, energy expenditure and human nutrition. The attention on future research planning should be on production-consumption-nutrition links to ensure healthy diets and food diversity. The energy expenditure dimension associated with changing patterns of activity in rural livelihoods may be an important factor explaining agriculture-nutrition linkages. Drudgery reduction can offer rural households an important route to improved nutritional status through substantial savings in energy expenditure, time use pattern that could offset the calorie deficits, reducing the burden and increasing the women's available time for adoption suitable interventions.

References

1. Cheryl Doss, Ruth Meinzen-Dick, Agnes Quisumbing, Sophie Theis, (2018). Women in agriculture: Four myths, *Global Food Security*, 16, 69-74, ISSN 2211-9124, <https://doi.org/10.1016/j.gfs.2017.10.001>.
2. FAO, IFAD, UNICEF, WFP, & WHO. (2019). The state of food security and nutrition in the World 2019. In Safeguarding against economic slowdowns and downturns. FAO, Rome.
3. ICAR-IIFSR Annual Report (2018) Cluster based on farm participatory research in farming systems under Tribal sub plan pp 68.
4. ICAR-IIFSR Annual Report (2019) Cluster based on farm participatory research in farming systems under Tribal sub plan pp 72.
5. ICAR-IIFSR Annual Report (2020) Cluster based on farm participatory research in farming systems under Tribal sub plan pp 71.
6. ICAR-IIFSR Annual Report (2021) Cluster based on farm participatory research in farming systems under Tribal sub plan pp 72.
7. Fondo Internacional de Desarrollo Agrícola. (2016). *Rural Development: Report 2016: Fostering Inclusive Rural Transformation*. IFAD.
8. Headey, D. and Masters, W. A. (2019) 'Agriculture for nutrition: direct and indirect effects.', CABI Books. CABI International. doi: 10.1079/9781786399311.0016.
9. Johnston, D., Stevano, S., Malapit, H. J., Hull, E., & Kadiyala, S. (2018). Review: Timeuse as an explanation for the agri-nutrition disconnect: Evidence from rural areas in low and middle-income countries. *Food Policy*, 76(2018), 8–18.
10. Srinivasan, C. S., Zanello, G., Nkegbe, P., Cherukuri, R., Picchioni, F., Gowdru, N., & Webb, P. (2020). Drudgery reduction, physical activity and energy requirements in rural livelihoods. *Economics & Human Biology*, 37, 100846.
11. Verma N, Panwar A S, Kashyap P, Prusty A K Shamim M and Jat P C (2022). The effect of integrated farming systems on securing and balancing nutrition in the farm households of Western Plains of Uttar Pradesh. In the abstract book of International Conference on AAFS. Pp 71.

An Outline of Inorganic Fertilizers, Herbicides, Pesticides and their Effects on Biodiversity in Jammu and Kashmir

Rayees Ahmad Shah

North Campus, University of Kashmir

Corresponding author: shahrayes@gmail.com

Abstract

Indiscriminate use of inorganic agrochemicals has led to environmental pollution and deterioration of biodiversity, integrated use of synthetic chemical and organic inputs can help in conservation of biodiversity and provide maximum crop yield with minimum input level. Government agencies are the party to conserve biodiversity and to manage agrochemicals. The higher-ups of Agriculture Production and Farmers Welfare Department are responsible to look after agrochemicals and their waste management in the UT and should give priority to integrated nutrient management, integrated pest management, integrated weed management, and integrated plant disease management to minimize damage to the biodiversity.

INTRODUCTION

Adaptation of Green Revolution Technologies (GRTs i.e., high yielding modern varieties, massive use of chemical fertilizers and expansion in irrigation areas), since mid- 1960's has resulted in significant expansion of the area under agriculture. Continuous growing of high yielding crop varieties in various sequences with NPK fertilizer application alone has no doubt remarkably increased food production but simultaneously put forth a lot of problems related to micronutrient deficiencies in soil. The capacity of soil to produce usable biomass depends upon the supply of adequate and balance amount of all the essential nutrients including the micronutrients. The common synthetic chemical fertilizers used in Jammu and Kashmir are given in Table 1.

Table1: Common chemical fertilizers used in Jammu and Kashmir

Nitrogenous fertilizers	
Source	Percentage of Nitrogen
Ammonium sulphate	20.5
Urea	44-46
Ammonium chloride	25
Ammonium nitrate	33.5
Ammonium sulphate nitrate	26
Calcium ammonium nitrate	25
Calcium nitrate	13-15
Sodium nitrate	16
Calcium cyanamide	21
Ammonium nitrate	32-35

Phosphatic fertilizers			
Source	Percentage of P₂O₅		
Single Superphosphate		18	
Double Superphosphate		35	
Triple Superphosphate		46	
Basic slag		30-80	
Rock phosphate (Mussori)		23-24	
Rock phosphate (Purulia)		23	
Potassic fertilizers			
Source	Percentage of K₂O		
Muriate of potash		50-60	
Potassium sulphate		48-52	
Potassium phosphate		30-50	
Compound fertilizers			
Source	% of N	% of P₂O₅	% of K₂O
Diammonium phosphate/D.A.P.	18	46	-
Urea ammonium phosphate (Gromor)	28	28	-
Monoammonium phosphate	11	48	-
Ammonium phosphate	20	20	-
Nitro-phosphate-potash	15	15	15
Gromor 14:35:14	14	35	14
IFFCO10:26:26	10	26	26

Insecticides and pesticides include chemically synthesized compounds that are routinely utilized in agriculture to manage, destroy, or repel insects, pests, pathogens and parasites. Certain insecticides and pesticides, which are more resistant to degradation by abiotic and biotic agencies, leach into the lower strata of the soil, are absorbed by plant roots, accumulate in the food chain and are ultimately biomagnified in the food web. Generally, pesticide usage in Jammu and Kashmir is against pests such as brown plant hopper, fruit flies and diseases like late blight of potato and tomato. Some synthetic chemicals are recommended by the Department of Horticulture (Govt. of Jammu and Kashmir) for the apple orchards of Kashmir valley, these are given in Table 2.

Table2: Common fungicides, insecticides, and spray oils recommended by the Department of Horticulture for Kashmir valley

Fungicides	
Chemical	Trade names
Bitertanol	Baycor (25WP), Captaf (50WP), Deltan (50WP), Kohicap (50WP), Jaicap (50WP), Hesacap (50WP), and Captan (50WP).
Dodine	Scabicide (65WP), Scabicide (50F), Superstar (65WP).

Difenaconazole	Score (25EC).
Dithionon	Tatashan (75WP).
Fenarimol	Rubigan (12EC).
Hexaconazole	Contaf (5EC), Anvil (5EC), and Control (5% EC).
Mancozeb	Indofil-M45 (75WP), Zinthane (75WP), Shield (75WP), Kohinoor-M45 (75WP), Jai-M45 (75WP), Manseb (75WP), Mancozeb flowable (35SL), and Flowin.
Myclobutanil	Grapple (10WP) and Boon (10EC).
Penconazole	Topas (10EC).
Propineb	Antracol (75WP).
Triadimefon	Bayleton (25WP).
Ziram	Ziride (80WP), Cuman-L (27W/V), Ziron (27W/V).
Zineb	Indofil Z-78
Insecticides	
Chemical	Trade names
Fenazaquin	Magister (10EC).
Methyl-o-Demeton	Metasystox (25EC).
Phosalone	Zolone (35EC).
Quinalphos	Ekalux (25EC).
Abamectin	Vertimec (1.8EC).
Chlorpyriphos	Coroban (20EC) and Kohiban (20EC).
Dicofol	Supernomite (18.5EC) and Colonial-S (18.5EC).
Dimethoate	Rogor (30EC).
Endosulfan	Thiodan (35EC) and Sholay (35EC).
Ethion	Tope (50EC) and Ethion (50EC).

Although the chemical method of weed control is very effective, quick and convenient but it leaves harmful residues in soil and in plant parts which may affect the succeeding crop and those who consume the produce. Sometimes herbicides are found to be carried over from one crop season to the next. Sensitive crops in rotation are found to be damaged and in some cases the stand of the succeeding crop are found to be low or it is completely lost. The common herbicides used in Jammu and Kashmir are tabulated below:

Table 3: Common herbicides used in Jammu and Kashmir

Crop	Herbicide used	Crop	Herbicide used
Rice	Butachlor: Pendimethalin: 2, 4-D Na salt: 2, 4-D ester: Benthiocarb.	Wheat	Isoproturon: 2, 4-D Na salt: Methabenzthiozuron: Oxyfluorfen: Terbutryn: 2, 4-D ester: 2, 4-D amine.

Maize	2, 4-D ester: Simazine: Atrazine.	Mustard	Isoproturon: Nitrofen (TOK-E-25).
Sunflower	Fluchloralin (Basalin): Alachlor (Lasso): Pendimthalin:	Lentil	Prometrynen: Fluchloralin (Basalin): Metribuzin.
Field Pea	Prometrynen: Fluchloralin (Basalin): Metribuzin.	Green gram	Fluchloralin (Basalin).
Black gram	Fluchloralin (Basalin).	Cowpea	Fluchloralin (Basalin).
Soybean	Metribuzin (Sencor): Alachlor (Lasso): Fluchloralin (Basalin).	Potato	Gramaxone: Metribuzin (Sencor): Alachlor (Lasso).

This research paper explores the use of inorganic fertilizers, herbicides, insecticides and pesticides and focuses Kupwara district of Jammu and Kashmir to assess the information on the use of synthetic factory made agrichemicals at a local level.

METHODOLOGY

The survey was conducted in Kupwara district of Jammu and Kashmir during the month of April to June, 2018. Stratified random sampling was performed for the selection of 180 individuals from the 11 blocks (Sogam, Tangdar, Teetwal, Ramhal, Drugmulla, Rajwar, Kralpora, Langate, Wavoora, Trehgam and Kalaroos) in three tehsils (Handwara, Kupwara, and Karnah) of the district. From each of the selected blocks, 1 panchayat and 2 municipalities (of Handwara and Kupwara) were covered. Meetings with numberdars, surpanjs, progressive farmers, and old age citizens of the community were held in which the objectives of the survey were clearly explained. Data collection was carried out by personal interview technique administering a structured schedule. The researcher revisits the households, to crosscheck the previously filled questionnaires.



Fig. 1: Map of Kupwara district

(Source: Kupwara.nic.in)

RESULTS

During the study it was observed that:

- 1) Residues of inorganic fertilizers, herbicides, insecticides and pesticides affect biodiversity. Since farmers serve as the main unit of agricultural production; their life and their daily activities are closely related to the biodiversity. Consequently, their irrational economic activities and unscientific ecological behavior directly and inevitably worsens the biodiversity.
- 2) The majority of the respondents had sufficient awareness about inorganic fertilizers, herbicides, insecticides and pesticides, in view of the fact that Kupwara is one of the major and well-known districts for the cultivation of agricultural crops in Jammu and Kashmir.
- 3) The farmers in Kupwara district of Jammu and Kashmir lack knowledge on synthetic chemical toxicity and do not follow specific guidelines. Rather, they utilize a random method when applying different kinds of chemicals on different kinds of agricultural products.
- 4) Farmers tend to apply synthetic chemicals excessively and irrationally because they do not understand the risks of chemical residues, the guidelines on how much chemical input to use or the standardized regulations in synthetic chemical application.
- 5) The significant factors that influence farmers' awareness of inorganic fertilizers, herbicides, insecticides, and pesticides and their residues include race, awareness of agricultural damage and awareness of health problems caused by pesticides, as well as whether they or their relatives have experienced damages caused by such chemical inputs.
- 6) Due to different agricultural practices and habits in different regions, weeds, plant diseases, insects, pests and status of soil fertility varies, accordingly levels of inorganic fertilizers, herbicides, insecticides and pesticides their sales, as well as economic levels, are all different.
- 7) In Jammu and Kashmir, women (especially in rural areas) do not have a strong notion of the dangers caused by synthetic chemical inputs because they have relatively lower education levels.
- 8) In rural areas of Kupwara, due to the lack of adequate education farmers rarely paid attention to the toxic side effects of chemicals on biodiversity.
- 9) Those farmers who cultivate crops to fulfill their own household needs tend to pay more attention to problems caused by residue of synthetic chemicals, while farmers who plant crops for commercial purposes pay more attention to the quantity of production.

Table 4: Sociodemographic characteristics of the respondents with Gender, Religion, Educational Status, Age, Occupation and Awareness about synthetic agrichemicals and their effect on biodiversity

Variables	Number	Percentage
Gender		
Male	115	63.88
Female	65	36.11
Religion		
Muslim	141	78.33
Sikh	30	16.66
Hindu	9	5.00
Buddhist	Nil	0
Educational Status		
Illiterate	79	43.88
Literate (up to 10 th)	13	7.22
Literate (10 th to 12 th)	22	12.22
Literate (12 th to Graduate)	44	24.44
Literate (Graduate to Post-graduate)	15	8.33
Literate (Post-graduate and above)	7	3.88
Age		
18-27 years	10	5.55
28-37 years	12	6.66
38-47 years	45	25.00
48-57 years	31	17.22
58-67 years	8	4.44
68-77 years	11	6.11
78 years and Above	7	3.88
Not available	56	31.11
Occupation		
Farmer	70	38.88
Business	55	30.55
Govt. employee (gazetted)	11	6.11
Govt. employee (non-gazetted)	30	16.66
Student	14	7.77
Awareness about synthetic chemical inputs		
Yes	166	92.22
No	14	7.77

Table 5: Perception of farmers towards agrichemicals and their effect on biodiversity

Variables	Number	Percentage
Type of synthetic chemical inputs they used		
Chemical fertilizers	50	27.77
Fungicides	64	35.55
Herbicides	7	3.88
Antibiotics	9	5.00
Nematicides	Nil	0.00
Fumigants against stored grains	22	12.22
Pesticides and insecticides	17	9.44
Not answered	11	6.11
Weed, pest and disease control measures		
Cultural methods and crop rotations	47	26.11
Biological methods	6	3.33
Synthetic chemicals	36	20.00
Cultural methods and toxic chemicals	84	46.66
Not answered	7	3.88
Idea of bioaccumulation		
Yes	108	60.00
No	70	38.88
Not answered	2	1.11
Adverse effects of synthetic chemical inputs		
Adverse effects on biodiversity	65	36.11
Killing of non-target species	47	26.11
Chemical resistance	68	37.77
Agrichemical storage practices		
Keep on the top of the house	42	23.33
Locked up in the safe store	66	36.66
Hanging inside the residential house	35	19.44
Keep them along with food stuffs	37	20.55
Solution for leftover synthetic agrichemicals		
Disposed on the soil	20	11.11
Apply even though it is not needed	5	2.77
Stored and used for another application	102	56.66
Sell it to other farmers (in cash)	Nil	0.00
Sell it to other farmers (barter system)	36	20.00
Pour into water bodies/bushes/wasteland	17	9.44

Disposal of empty containers of agrichemicals		
Sell them in cash	61	33.88
Sell them to other farmers (barter system)	32	17.77
Use them for household purpose	50	27.77
Burnt	9	5.00
Buried	13	7.22
Left into water bodies/farm/wasteland	15	8.33
Personal protective devices		
Yes	130	72.22
No	33	18.33
Not answered	17	9.44
Health impacts observed		
Fever	40	22.22
Headache	37	20.55
Abdominal pain	10	5.55
Allergy	51	28.33
Dermatitis	4	2.22
Conjunctivitis	1	0.55
Not answered	7	3.88
Dizziness	30	16.66
Whether you have received any training regarding the use of chemical inputs		
Yes	Nil	0.00
No	180	100.00
Idea of food materials they consume		
Food materials contain toxic residues	171	95.00
Food materials are safe	9	5.00
Idea of biodiversity		
Yes	28	15.55
No	152	84.44

CONCLUSIONS AND RECOMMENDATION

Presently indiscriminate inorganic fertilizers, herbicides, insecticides and pesticides has led to environmental pollution and deterioration of biodiversity, so optimum use of synthetic chemical inputs can help in conservation of biodiversity and provide maximum crop yield with minimum input level.

Government of Jammu and Kashmir is the party to conserve biodiversity and to manage agrichemicals. The Commissioner Secretary to Govt. Department of Agriculture Production and Farmers Welfare is responsible to look after agrichemicals and their waste management in the UT and should give priority to integrated nutrient management, integrated pest management,

integrated weed management, and integrated plant disease management to minimize damage to the biodiversity, as balanced use of agrichemicals is predicted to:

- i. Reduce reliance on toxic chemicals and encourage use of other alternatives.
- ii. Encourage use of low risk synthetic chemical inputs.
- iii. Prefer useful natural enemies and parasites to suppress crop pests and conserve biodiversity.
- iv. Raise farmer's knowledge about agro-ecosystem, surrounding environment and biodiversity.

Natural Farming for Sustainable Soil Health Management in Climate Change Scenario

Pragya Bhadauria, Anjani Kumar, Rohit Kumar and Amrendra Kumar

ICAR- Agricultural Technology Application Research Institute, Patna

Corresponding author: pragya.bhadauria@icar.gov.in

Abstract

Healthy soil is the foundation for pioneering the sustainable and eco-friendly agriculture. After independence feeding the population from available resources is not sufficient, so in the era of 1960's we adopted green revolution. Green revolution makes us sufficient in terms of feeding the population and food security for the nation, but along with this it also destroys the natural and inherent property of our soil. In last few years concept of Natural farming emerges as a good alternative option where the laws of nature are applied to agricultural practices. This method works along with the natural biodiversity of each farmed area, encouraging the complexity of living organisms, both plants and animals that shape each particular ecosystem to thrive along with food plants. Natural Farming is one such low-input, climate-resilient type of farming that encourages farmers to use low-cost locally-sourced inputs, eliminating the use of artificial fertilizers and industrial pesticides. There are four components of natural farming namely; Jeevamritha, Beejamritha, Whapsa and Mulching. The most important benefit of using natural farming is soil health rejuvenation, increase crop yield, minimized cost of production and eliminate the application of chemical input and thereby increase in farmers income. As per the directives of Government of India, the Krishi Vigyan Kendra of the countries are promoting natural farming through initiatives like Paramparagat Krishi Vikas Yojna (PKVY), Bhartiya Prakritik Krishi Padhati (BPKP) etc.

Key words: *Natural Farming, Jeevamritha, Beejamritha, Mulching, BPKY*

Introduction

India is the second largest country in terms of demography and feeding the population of around 139.34 (World Bank, United States Census Bureau ,2021) crores is a massive task. After independence feeding the population from available resources is not sufficient so in the era of 1960's we adopted green revolution. Green revolution makes us sufficient in terms of feeding and food security but along with this it destroys the natural and inherent property of our soil and that was signified by increase in demand and use of fertilizers and pesticides so that Indian farmers increasingly find themselves in a vicious cycle of debt, because of the high production costs. In last two decades our soil become less fertile and low productive so we have to look for an alternative option. According to NSSO data, agricultural households spend almost more than 70% what they earn and more than half of the farmers are in debt. Considering these issues, many alternatives are evaluated along with ancient farming practices for guidance but without scientific validation and understanding of both the strengths and weaknesses of traditional Indian farming. Meanwhile, particularly NITI Aayog (Government of India), realizing

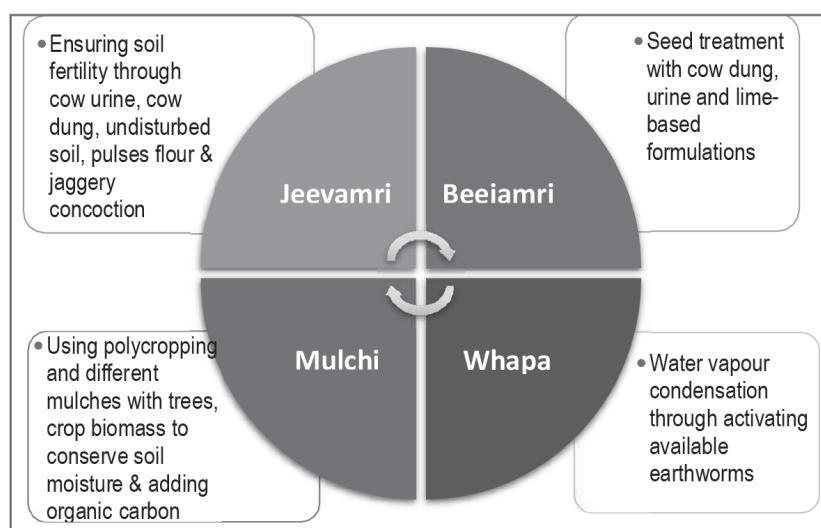
the declining productivity and profitability of the small and marginal farmers has been looking for alternative farming systems for low input and profitable farming techniques. Some of the alternative methods are *Agnihotra Farming*, *Amrutpani Farming*, *Vedic Farming*, *Homoeo Farming*, and *Zero Budget Natural* (Spiritual) Farming claiming exciting but not scientifically proven.

In last few years concept Natural farming emerges as a good alternative option. Natural farming is a system where the laws of nature are applied to agricultural practices. This method works along with the natural biodiversity of each farmed area, encouraging the complexity of living organisms, both plants, and animals that shape each particular ecosystem to thrive along with food plants. Natural Farming is one such low-input, climate-resilient type of farming that encourages farmers to use low-cost locally-sourced inputs, eliminating the use of artificial fertilizers, and industrial pesticides. Natural farming (NF) was first popularized by the Japanese scientist and philosopher, Masanobu Fukuoka in year 1975 in his book "*The one straw revolution*" who practiced it on his family farm in the island of Shikoku.

In India Natural Farming (NF), which is a set of farming methods, and also a grassroots peasant movement, has spread to various states. One of these farming standing aggressively in the states of Karnataka, Andhra Pradesh, and Maharashtra is the Zero Budget Natural Farming (ZBNF) even government of India also looking this farming technique. It has attained wide success in southern India, especially the southern Indian state of Karnataka where it first evolved. A rough estimation for just Karnataka puts the figure there at around 100,000 farmer families, while at the national level, NF leaders claim that numbers could run into millions. However, before conclusion regarding promoting or de-promoting of any of this farming technology, need to undertake their scientific evaluation, challenges, and opportunity and likely that impact on food security of the country

Components of natural farming

According to eminent agriculturist Sh. Subhash Palekar, the ZBNF/NF has following four essential components:



1. Jeevamritha

Jeevamritha is a fermented microbial culture. It provides nutrients along with acts as a catalytic agent that promotes the activity of microorganisms in the soil, and also increases population of earthworms.

Method of preparation of Jeevamritha?

1. Put 200 liters of water in a barrel
2. Add 10 Kg fresh local cow dung
3. Add 5 to 10 liters aged cow urine
4. Add 2 Kg of Jaggery (a local type of brown sugar)
5. Add 2 Kg of pulses flour and
6. Add a handful of soil from the bund of the farm

Stir the solution and let it ferment for 48-50 hrs. in shade. Jeevamritha is ready for its application. The 200 liters of Jeevamritha is sufficient for one acre of land and while the fermentation process, the aerobic and anaerobic bacteria present in the cow dung and urine multiply as they decompose organic ingredients (like pulse flour and jaggery). Sawant et al. (2007) have isolated many different bacterial genera such as *Citrobacter koseri*, *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella oxytoca*, *Klebsiella pneumoniae*, *Kluyvera spp.*, *Morgarella morganii*, *Pasteurella spp.*, *Providencia alcaligenes*, *Providencia stuartii* and *Pseudomonas spp.* from cow dung. Gupta et al. (2016) also found that many cow dung microorganisms have shown natural ability to increase soil fertility through phosphate solubilization. Lu et al. (2013) isolated 219 bacterial strains from cow dung, among which 59 isolates displayed nematicidal activity against a handful of undisturbed soil acts as inoculate of native species of microbes and organisms. Jeevamritha also helps to prevent fungal and bacterial plant diseases. Application of Jeevamritha: It should be applied to the crops twice a month with the irrigation water or as a 10% foliar spray. The preparation should not be stored more than 15 days and used in the field either through spray or mixed with irrigation water.

2. Beejamritha

It is used for seeds and planting material. Beejamritha is effective in protecting young roots of plants from fungus, soil and seed-borne diseases that commonly affect plants after the monsoon period.

Method of preparation of Beejamritha?

1. Take 5 kg of indigenous cow dung (preferably fresh or not more than 3 days old) in a cloth and bound it by tape and hang this in the 20 liters of water for 12 hours
2. Take one liter water and add 50 g lime in it, keep for a night.
3. Squeeze this bundle of the cow dung in water 3 times to extract material
4. Add the soil from undisturbed bunds or forest or under tree cover in the solution and stir it well
5. Add 5 liters of indigenous cow urine in the solution & add the lime water and stir it well

6. Beejamrit is ready for seed treatment

Application as a seed treatment: Mixed Beejamritha with the seeds of any crops (either coat or mixed by hand) after that, dry in shadow and use the prepared seed for sowing.

3. **Acchadana (Mulching)**

There are mainly 3 types of mulching practiced in Natural farming (also suggested by ZBNF) which includes:

- **Soil Mulch:** Its aim to protects topsoil during cultivation and it also helpful in aeration and water retention in the soil. Deep ploughing should be avoided as it also helpful in tilting.
- **Straw Mulch:** Straw material refers as the dried waste biomass of previous crops. After decomposition by soil microbes or added inoculum, it converts into humus that are being directly use in field.
- **Live Mulch:** It is essential to cultivate crops in multiple cropping patterns of monocotyledons and dicotyledons plants in same field, to supply all essential nutrient to the soil and crops. Dicot plants like pulses are good in nitrogen fixation while monocots plants such as rice and wheat supply elements like potash, phosphate and sulphur.

4. **Whapasa (Moisture)**

Whapasa is the condition when both air and water molecules present in the soil. Thus, irrigation should be done in noon, in alternate furrows, so that it can fulfil the moisture requirement of the crops (as seen in significant decline in need of irrigation in ZBNF). However, it is being rarely practiced followed by any farmer.

Benefit of Natural Farming

These are the following benefit of Natural Farming: -

- **Improve crop yield-** Its aims to improve the yields by optimizing production factors like soil, man-power, equipment and by avoiding the use of non-natural inputs like chemical fertilizers and pesticides.
- **Increased farmers income-** Its aims to make farming viable and profitable by cost reduction, risks reduction, increasing intercropping and crop intensity.

5. **Minimized cost of production-**

Its aims to cut down production costs by encouraging farmers to use more natural resources while preparing for essential nutrients and plant protection materials that ultimately end the dependency on inputs like fertilizers and other chemicals. The inputs like Jeevamritha and Beejamrita are significant in costs of cultivation.

- **Ensure better health –** Excessive use of Fertilizers and pesticides have adverse impacts on both farmers and consumers. Farmers may get exposed to contaminants

while applying hazardous chemical and by replacing such kind of inputs jeevamritha Beejamritha Whapsa Mulching. It can reduce the incidence of non-communicable diseases, chronic neurotoxicity, and respiratory diseases

- *Eliminate the application of chemical input*-The excessive use of chemical fertilizers and pesticides is hazardous for soil and environment. It also affect on crop response ratio and nutrients status of soil.
- *Environmental conservation* -Natural Farming reduce the risks that are associated with uncertainties of climate change by adopting an agroecological framework and it also helpful reducing impact of global warming because it encourages the use low-cost locally available inputs.
- *Rejuvenate Soil Heath*- it also helps in rejuvenating soil health by using natural product like cow dung, humus, jaggery, pulse floor etc. It also improves by adopting practices like crop rotation and it also helpful in enrichment of soil microorganism.

Government's Initiatives on Natural Farming

An announcement had been made on natural farming in Union Budget 2022-23 by honourable finance minister that government must focus towards promoting chemical-free natural farming. The Government of India will promote natural farming throughout the country and it will be more focused on farmer's lands in 5 km wide corridors along Ganga River. May other initiatives like States Agricultural Universities should also be encouraged to revise the syllabus so as to meet the needs of natural farming, zero-budget natural farming, organic farming, value addition and management and modern-day agriculture.

Bhartiya Prakritik Krishi Padhati (BPKP)

Natural farming is promoted as Bhartiya Prakritik Krishi Padhati (BPKP) under a centrally sponsored scheme- Paramparagat Krishi Vikas Yojana (PKVY). The scheme mainly emphasizes the exclusion of all synthetic chemical inputs and promotes on-farm biomass recycling. It stresses biomass mulching; use of cow dung-urine formulations; plant-based preparations and time to time working of soil for aeration. Under BPKP, financial assistance of Rs 12200/ha for 3 years is provided for activities like cluster formation, capacity building, and continuous handholding by trained personnel, certification, and residue analysis.

Paramparagat Krishi Vikas Yojana (PKVY)

Paramparagat Krishi Vikas Yojana is an elaborated component of Soil Health Management (SHM) of the major project National Mission of Sustainable Agriculture (NMSA). Under PKVY, organic farming is promoted through the adoption of the organic village by cluster approach and PGS certification. The scheme envisage:

- Promotion of commercial organic production through certified organic farming.
- It will raise farmer's income and create a potential market for traders.

Program implementation

- Fifty or more farmers will form a cluster having 50 acres of land to take up the organic farming under the scheme.
- In this way, during three years 10,000 clusters will be formed covering a 5.0 lakh acre area under organic farming.
- There will be no liability on the farmers for expenditure on certification.
- Every farmer will be provided Rs. 20,000 per acre in three years for the seed to harvesting crops and to transport produce to the market.
- Organic farming will be promoted by using traditional resources and organic products will be linked with the market.
- It will increase domestic production and certification of organic produce by involving farmers.

References

- Amit Khurana and Vineet Kumar,2020, The State of Organic and Natural Farming in India- Challenges and Possibilities, Centre for Science and Environment, New Delhi.
- Bharucha, Z. P., Mitjans, S. B., & Pretty, J. (2020). Towards redesign at scale through zero budget natural farming in Andhra Pradesh, India. International Journal of Agricultural Sustainability, 18(1), 1-20.
- Bishnoi, R., & Bhati, A. (2017). An Overview: Zero budget natural farming. Trends in Biosciences, 10(46), 9314-9316.
- Chakov, V. V., Berdnikov, N. V., & Kuzmenko, A. P. (2016). Possible Mechanism for the Natural Forming Process of Carbon Nanotubes from Plant Materials. Geosciences Research, 1(1), 1.
- Devarinti, S. R. (2016). Natural farming: eco-friendly and sustainable. Agrotechnology, 5, 147.
- Khadse, A. P.M. Rosset and B.G.Ferguson (2017) "Taking Agro Ecology to Scale: The Zero Budget Natural Farming movement in Karnataka, India', The Journal of Peasant.vol.45,pp.1-28.
- Khadse, A., Rosset, P. M., Morales, H., & Ferguson, B. G. (2018). Taking agroecology to scale: The zero-budget natural farming peasant movement in Karnataka, India. The Journal of Peasant Studies, 45(1), 192-219.
- Khadse, Ashlesha, and Peter M. Rosset. "Zero Budget Natural Farming in India—from inception to institutionalization." Agroecology and Sustainable Food Systems 43.7-8 (2019): 848-871.
- Palekar, S. (2005). The philosophy of spiritual farming I. 2nd ed. Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India.
- Palekar, S. (2006). The principles of spiritual farming II. 2nd ed. Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India.
- Smith, J., Yeluripati, J., Smith, P., & Nayak, D. R. (2020). Potential yield challenges to scale-up of zero budget natural farming. Nature sustainability, 3(3), 247-252.

DETAILS OF LECTURES AND THEIR RESOURCE PERSONS

The editors acknowledge the contribution of following experts/professionals in developing the book

S.NO	DATE	SESSION	SPEAKER
1.	05-04-2023	Scope and Importance of Nutri-cereals in Current Agricultural Scenario	Dr. Gupdesh Kaur Associate Professor, Krishi Vigyan Kendra, Patiala, Punjab
2.	06-04-2023	Method of Data Collection, Interpretation and Report Writing	Dr. Pushpendra Kr Singh Assistant Professor, BASU, Patna
3.	06-04-2023	Self-Reliance through Diversified Commercial Poultry Farming	Dr. Rokade Jaydip Jaywant, Scientist, PHM Section ICAR-Central Avian Research Institute, Izatnagar, Bareilly, U.P.
4.	07-04-2023	ICT Application in Extension Teaching and Technology Adoption	Dr. Amandeep Singh Assistant Professor Deptt. of Veterinary and Animal Husbandry Extension Education, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University,
5.	07-04-2023	The Emerging Role of Teacher in Higher Education Under NEP 2020: Opportunities and Challenges	Dr. Bilal A. Kaloo Coordinator, Department of Teacher Education, North Campus, Delina, Baramulla University of Kashmir (UT of J & K)
6.	08-04-2023	New Avenues for Marketing of Agricultural Produce	Dr. Shivraj Singh Associate Professor Department of Dairy Business Management SGIDT, BASU, Patna, Bihar
7.	08-04-2023	Statistical Methods for Biological and Social Sciences Data	Dr. Amit Jha Assistant Professor College of Veterinary Science and Animal Husbandry, Rewa, MP
8.	10-04-2023	Forage Based Balanced Ration for Sustainable Livestock Production"	Dr. Deepak Upadhyay Scientist, PAR Division, Indian Grassland and Fodder Research Institute, Jhansi, UP

9.	10-04-2023	Multimedia tools and Presentation Skills for effective communication	Dr. Girijesh Singh Mahra Scientist, ICAR-IARI, New Delhi
10.	11-04-2023	Planning Execution and Analysis of Agricultural Experiments	Dr. Arpan Bhaumik Senior Scientist ICAR- Indian Agricultural Research Institute, RRS, Dirpal Chapor, Gogamukh, Dhemaji, Assam
11.	11-04-2023	Testing and Demonstration of Technologies: Concept and Practices	Dr. Arvind Kumar Principal Scientist ICAR-ATARI, PAU Campus, Zone-1 Ludhiana, Punjab
12.	12-04-2023	Carbon Credit in Agriculture Perspective	Dr. Rohit Gupta Assistant Professor Krishi Vigyan Kendra, Nurmahal, Jalandhar, Punjab
13.	12-04-2023	For Personal and Professional Development Education needs to be more Innovative	Prof. Ranendra K Majumder Rtd. Head of the Department of Fish Processing Technology & Engineering College of Fisheries, CAU (I) Lembucherra, Tripura
14.	13-04-2023	Backyard Poultry Farming System for Rural Livelihood Enhancement	Dr. Reena Kumari Kamal, Scientist Division of Livestock & Fisheries Management ICAR-Research Complex for Eastern Region FSRCHPR, Palandu, Ranchi-Jharkhand
15.	13-04-2023	Importance of Evaluating Extension Programmes at Field Level	Ms. Sarjeet Kaur Assistant Professor SGIDT, BASU Patna
16.	14-04-2023	Utilization of Agricultural Residue for Value Addition as Protein	Ms. Surya Scientist, ICAR-Central Institute of Post-Harvest Engineering and Technology, Ludhiana-141004, Punjab
17.	14-04-2023	Methods and Challenges for Impact Assessment of Frontline Extension Programme	Dr. R.K Rana Principal Scientist, ICAR - Agricultural Technology Application Research Institute (ATARI), Zone-1, Ludhiana Punjab

18.	15-04-2023	Role of IOT in Agriculture and Dairy Sector	Er. Prateek Bhadauria Assistant Professor, Department of Electronics & Communications RJIT BSF Academy Takenpur, Gwalior, MP
19.	15-04-2023	Extension Tools for Dissemination of Research Technologies to the Farmers	Dr. Suniti Kumar Jha, Principal Scientist, Agricultural Extension Section ICAR-Central Research Institute for Jute and Allied Fibers, Barrackpore, WB
20.	17-04-2023	Climate Resilient Agriculture: Field Experiences	Dr. Ashish Murai Scientist, ICAR -Agricultural Technology Application Research Institute (ATARI), Zone-1, Ludhiana, Punjab
21.	17-04-2023	Role of Farmer Producer Organization in Enhancing Farmer's Income	Dr. Preeti Mamgai Principal Scientist (HM), ICAR -Agricultural Technology Application Research Institute (ATARI), Zone-1, Ludhiana, Punjab
22.	18-04-2023	Forage Conservation through Silage Making: An Inevitable Technology for Sustainable Dairy Farming	Dr. Aprana Assistant Professor Krishi Vigyan Kendra, Rupnagar, Punjab
23.	18-04-2023	Scientific Cultivation of Fodder for Silage Making	Dr. Navjot Brar Assistant Professor, Krishi Vigyan Kendra, Majra, Sahibzada Ajit Singh Nagar, Mohali, Punjab
24.	19-04-2023	Nutritional Management for Profitable Dairy Farming	Dr. Madhu Suman Assistant Professor, Department of animal Nutrition, DGCN, COVAS, Palampur, Himachal Pradesh
25.	19-04-2023	Biotechnological Intervention in Animal Sciences	Dr. Neeraj Kumar Assistant Professor, College of Animal Biotechnology Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab

26.	20-04-2023	Role of Food Safety and Quality Assurance in Food System”	Dr. Anuradha Kumari Assistant Professor, Department of Dairy Chemistry, College of Dairy Science & Technology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab
27.	20-04-2023	Harnessing Social Media for Teaching and Learning purposes	Er. Komal SRF, ICAR-Central Institute of Post-Harvest Engineering and Technology, Ludhiana-141004, Punjab
28.	21-04-2023	Employment Opportunities through Dairy Based Enterprises	Dr. Y.S Jadoun Associate Professor, Department of Dairy Extension Education SGIDT, BASU, Patna, Bihar
29.	21-04-2023	Assessment Approaches for Studying the Drudgery, Energy and Nutrition Requirements for Implementation of Sustainable Interventions	Dr. Nisha Verma Scientist ICAR- IIFSR, Modipuram. Meerut, UP
30.	22-04-2023	Communication Skills as an Effective Tool for Information Dissemination	Dr. S.K Jha, Principal Scientist ICAR- Agricultural Extension Division, KAB-1, Pusa, New Delhi
31.	22-04-2023	Adult Teaching & Learning in a Nonformal Environment: An Andragogical Exploration	Dr. Samrat Sikdar, Teaching Assistant, School of Human Sciences, College of Agriculture & Life Sciences, Mississippi State University, (Starkville, Mississippi State, MS 39759, United States)
32.	24-04-2023	Good Management Practices for Profitable Livestock Farming	Dr. R.K Nirala Assistant Professor, Department of BASU Patna
33.	24-04-2023	Planning Monitoring and Evaluation of Capacity Development Programmes	Dr. Keshava Principal Scientist ICAR- Agricultural Extension Division, KAB-1,Pusa, New Delhi

34.	25-04-2023	Mindset: A Powerful Tool for Stress Management	Dr. Pragya Bhadauria Senior Scientist ICAR-ATARI, Zone-IV, Patna, Bihar
35.	25-04-2023	An Outline of Inorganic Fertilizers, Herbicides, and Pesticides and their Effects on Biodiversity in UT of Jammu And Kashmir	Dr. Rayees Ahmad Shah North Campus, University of Kashmir