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EDITORIAL

Indian Agriculture has witnessed a lot of changes and advancement in the diverse cultivating techniques in last two decades. The modern agricultural practices are mostly dependent on the use of synthetic inputs and growth regulators which have raised the agricultural production manifold but it has resulted in environmental deterioration and loss of crop diversity. Therefore, the concept of sustainable agriculture emerged which not only emphasizes on the conservation of natural resources but also maintains the quality of the environment. Sustainable agriculture is in fact the successful management of resources for agriculture to satisfy the changing human needs, while maintaining or enhancing the quality of environment and conserving the natural resources.

Natural farming is a step in the direction of regeneration of agriculture with a diversified farming system which integrates crops, trees, livestock and allows the optimum use of functional biodiversity for saving the planet. Natural Farming is defined as 'chemical-free and livestock based farming' and considered a form of regenerative agriculture. Natural farming is a way of seeing ourselves as a part of nature, rather than separate from nature. It is also referred as 'the Fukuoka Method' or 'the natural way of farming'.

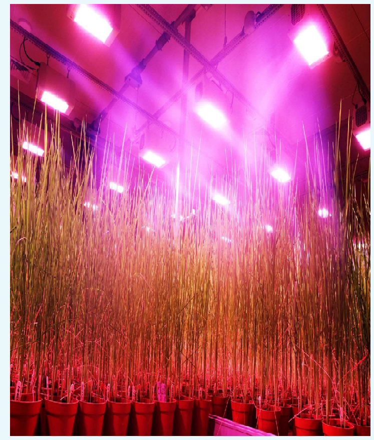
Government of India is promoting Natural Farming as 'Bharatiya Prakritik Krishi Paddhati' (BPKP) under the centrally sponsored scheme Paramparagat Krishi Vikas Yojana (PKVY). BPKP aims at promoting traditional indigenous practices which are largely based on on-farm biomass recycling with an emphasis on mulching and use of cow dung and urine formulations. It excludes all synthetic chemical inputs. Natural Farming focuses on promoting traditional indigenous cow based agricultural practices which gives freedom to farmers from externally purchased inputs. The vision is to implement sustainable natural farming systems with the aim to cut down on cost of cultivation, enhance farmers income, ensure resource conservation and safe & healthy soils, water, environment and food. Currently several states are undertaking Natural farming through central programmes like RKVY, PKVY, BPKP and others state specific programmes.

Natural farming has five components viz. (i) stimulation of microbial activity to make nutrients available to crop and protection against pathogens using a microbial inoculum, 'jiwamrita'; (ii) protection of young roots from fungal and soil-borne diseases using another microbial culture, 'beejamrita'; (iii) production of stabilized soil organic matter and conservation of top-soil by crop residue mulching, (acchadana), (iv) soil aeration (whapahasa) by improving soil structure and reducing tillage and (v) multiple cropping for round the year production and pest control.

Natural farming is gaining traction in India as it aligns with sustainable development goals and offers an alternative to conventional farming practices that can be costly and hazardous to the environment. Natural farming leads to the sustainability of the system, natural resource conservation, soil health rejuvenation, harnessing the potential of so-far unexplored desi cow and move towards a regime which gradually helps in reduction of chemical fertilizers and making agriculture sustainable in the long run.

Dr. Sanjay Kumar Joshi

Rapid Crop Improvement: The Benefits of Speed Breeding in Maximizing Genetic Gain



Satyam Singh, Hitesh Kumar*, Mitendra Kumar, Mukul Kumar

Speed breeding is a technique in crop improvement that accelerates the breeding cycle of plants, allowing for quicker development of new crop varieties. Several benefits of speed breeding are Accelerated Breeding Cycles, Rapid Response to Environmental Challenges, Increased Genetic Diversity, Efficient Trait Selection, Reduced Costs, Improvement of Underutilized Crops, Facilitation of Genomic Approaches and Adaptation to Local Conditions. Speed breeding offers significant advantages in terms of efficiency, flexibility and adaptability in crop improvement programs. It contributes to the development of more resilient, productive, and sustainable crop varieties by accelerating the breeding cycle and enhancing trait selection.

Sustaining human life in a healthy state requires adequate food and nutrition. With a projected global population of 10 billion by 2050, meeting the escalating demand for food represents a significant challenge for agriculture-based economies. To ensure nutritional security for this burgeoning population, a 60% increase in agricultural production is required by 2050. Furthermore, the agriculture sector must address the complex challenges posed by climate change, including aberrant temperature fluctuations, inadequate precipitation, and prevalence of pests and diseases as well as degradation of natural resources. In order to address the challenges of climatic variability and meet the food demands of a burgeoning population, novel crop varieties must be developed with targeted breeding objectives for enhanced yield, superior nutritional quality, and heightened resistance to diverse stress conditions. Conventional breeding or classical breeding has yielded numerous potential cultivars utilizing traditional techniques without the aid of advanced tools such as molecular plant breeding or genetic engineering. Nonetheless, conventional breeding remains a time-consuming process, posing a significant obstacle in crop plant breeding. Thus, the

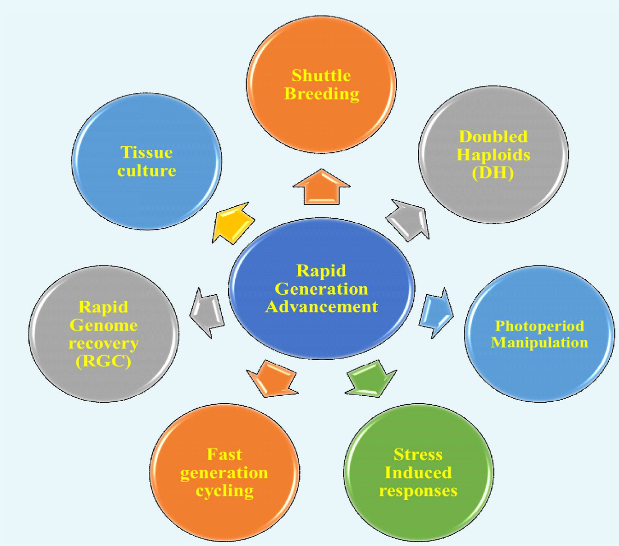


Figure 1 Current approaches utilized to decrease the breeding cycle.

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integration of modern technologies is crucial for expediting breeding programs, promoting the rapid genetic advancement of crops and achieving desired breeding objectives.

The development of new cultivars necessitates genetic fixation, followed by evaluation and assessment of multiple generations, with each generation taking a year. Typically, it takes approximately 12-14 years for a newly developed variety to be ready for commercial cultivation by farmers. To overcome this prolonged process and meet the exponentially increasing demand for major food crops, innovative technologies such as shuttle breeding, off-season nurseries, haploid breeding, tissue culture, and manipulation of ambient temperature photoperiods have been employed to reduce the crop life cycle and increase the number of generations per year (Figure 1). However, to meet the pressing need for rapid crop development, the concept of "Speed Breeding" has been successfully adopted, which utilizes a suite of technologies that manipulate environmental conditions to accelerate early flowering and seed set in different lines. Speed Breeding is a cutting-edge technique for rapidly advancing the breeding cycle of crops. It involves manipulating environmental conditions such as light intensity, photoperiod, and temperature to promote early flowering and seed set in different crop lines. By utilizing this approach, it is possible to achieve up to six generations per year, dramatically accelerating the breeding cycle and enabling the development of new cultivars in a shorter period of time. Speed Breeding is a promising technology that has the potential to revolutionize the field of crop improvement, facilitating the production of crops with desirable traits such as improved yield, better nutritional quality, and heightened resistance to environmental stressors.

Concept of Speed Breeding Evolution

Approximately 150 years ago, the basic principle of speed breeding began to emerge when it was discovered that plants could grow under artificial light. In the mid-1980s, a collaborative effort between NASA and Utah State University was undertaken to develop a plant that could thrive under continuous light at the space station, which resulted in the development of USU-Apogee', a full-dwarf hard red spring wheat (Figure 2). The term "Speed Breeding" (SB) was first used in 2003 by Queensland University, inspired by the work of NASA. The SB approach involves artificial manipulation of plant growth conditions, such as the regulation of light intensity and temperature, to accelerate the breeding cycle. Additionally, other crucial factors, including the density of plants, photoperiod, and light intensity, are also manipulated to facilitate rapid generation advancement.

Essential Requirements for Speed Breeding

The growth and development of plants in SB conditions require all essential factors under natural field conditions. However, the light, temperature, photoperiod and humidity are four main pillars of speed breeding. Regulation over the intensity of light, photoperiod and manual change in temperature enhances the plant's physiological efficiency. The principle factors of speed breeding along with their suitable range of requirements are mentioned below:

Light: The intensity and quality of light are the prime requirements in SB. Manipulation in light intensity changes the rate of photosynthesis. Light ranges from 400-700 nm are pertinent for light quality which can be achieved using halogen, lamps, LEDs or Sodium vapour lamps (SVLs). Along with it the intensity of light should be about

Figure 2. Wheat plant in NASA space station under controlled conditions

450–500 μmol/m²/s PPFD (Photosynthetic Photon Flux Density).

Photoperiod: Enhanced photoperiod is another key factor of SB. In a 24-h diurnal cycle, the 22h of photoperiod with a night period of 2h is suggested. The 18-h of photoperiod is enough to get rapid generation cycles in crop species of oat, wheat, triticale and barley.

Temperature: Temperature, being another component of SB is maintained according to light and dark periods. The temperature should be higher at the time of the photoperiod while it should be lowered during darkened period. Temperature is not fixed for any crop species but it is subjected to the breeding method adopted and requirement of the plant.

Humidity: A humidity level between 60-70% is optimum for most of the crops but the crops in water-stressed conditions require a lower level of humidity.

Table 1: Increased generation turnover in major food crops under speed breeding

S.No.	Crops	No. of Generations/Year
1	Barley (*Hordeum vulgare*)	6
2	Chickpea (*Cicer arietinum*)	6
3	Groundnut (*Arachis hypogaea*)	4
4	Lentil (*Lens culinaris*)	8
5	Oat (*Avena sativa*)	7
6	Pea (*Pisum sativum*)	5
7	Pigeonpea (*Cajanus cajan*)	4
8	Rapeseed (*Brassica napus*)	5
9	Rice (*Oryza sativa*)	4-5
10	Sorghum (*Sorghum bicolor*)	4
11	Soybean (*Glycine max*)	5
12	Wheat (*Triticum aestivum*)	4-6

(Source: Samantara *et al.,* 2022)

Generation Turnover in Crop

Increased number of generations per year of a crop is the basic principle of speed breeding. With the continuous hard work and successful efforts of the plant breeders, the number of generations per year of many crops has increased. In long-day crops such as Lentils, the number of generations per year increased up to 8 generations, 4-6 generations in Wheat, 6 generations in Barley, 7 generations in oats, and up to 5-6 generations in peas. Successful attempts for increasing number of generations per year are not only done in long-day plants but also in short-day plants such as up to 4 generations in Sorghum and Groundnut, 5 generations in soybean and 4-5 generations in Rice (Table 1)

Speed Breeding 2.0

The techniques of speed breeding are focused on manipulating key factors such as light duration and intensity, temperature and humidity, which play crucial roles in rapid generation advancement. In addition, various other factors can also be employed to increase the number of generations per year, including (i) breaking seed dormancy through techniques such as cold treatment and vernalization, (ii) early seed harvest followed by artificial drying and cold treatment, (iii) optimization of day length and light quality by adjusting the ratio of different light colors and durations, (iv) elevating CO2 concentration to increase the rate of photosynthesis, (v) inducing high temperatures and water stress

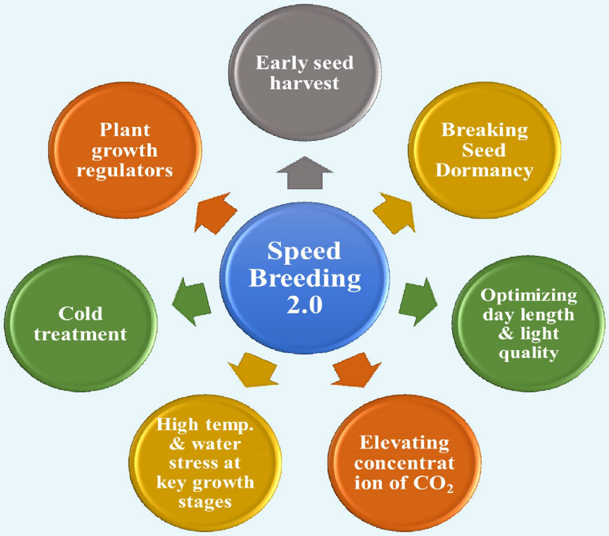

Figure 3: Different methods under Speed Breeding 2.0

during key growth stages to trigger vegetative and reproductive growth, and (vi) application of plant growth regulators to enhance vegetative growth and promote early seed harvest. The application of these factors, individually and collectively, can greatly enhance breeding programs.

Methods of Speed Breeding

The implementation of SB necessitates adherence to a comprehensive protocol that outlines the procedures involved in the breeding program. This protocol provides detailed guidelines for the manipulation of light, temperature, photoperiod and humidity within a controlled environment to enhance the rate of physiological processes. Although there is no standardized SB protocol that applies to all crops, the methods employed vary across different crop species. Multiple scientists have developed distinct protocols for crops such as wheat and barley, rice, peanuts, chickpea, soybeans and lentils.

Watson *et al.* (2018) developed three different methods of speed breeding as below:

i. Speed Breeding I- Controlled-environment chamber: This method was developed for wheat, barley and seeds of *Brachypodium.*

♦ Photoperiod: 22-hour; Temperature 22 °C

♦ Dark period: 2-hour; Temperature 17°C

♦ Humidity: 70%.

♦ Light intensity: 360–380 µmol/m2/s at bench height,

♦ Light intensity: 490–500 µmol/m2/s at adult plant height

ii. Speed Breeding II- Glasshouse speed breeding conditions: This method was developed for the seeds of chickpeas, canola barley, and wheat.

♦ Photoperiod: 22-hour; Temperature 17/22 °C

♦ Dark period: 2-hour; Temperature 17°C

♦ Light intensity: 440–650 µmol/m2/s at adult plant height

iii. Speed Breeding III-Homemade growth room design for low-cost speed breeding: The homemade method of SB was developed for barley, wheat and canola. It requires a completely shielded room of $3m^3$**.**

♦ Photoperiod: 12-hour; Temperature 21 °C (For first 4 weeks)

♦ Dark period: 12-hour; Temperature 18°C (For first 4 weeks)

♦ Photoperiod: 18-hour; Temperature 21 °C

♦ Dark period: 06-hour; Temperature 18°C

♦ Light intensity: 210–260 µmol/m2/s at bench height,

♦ Light intensity: 340–590 µmol/m2/s at adult plant height

Protocols of different crops are mentioned in table 2:

Applications and Achievements

Speed Breeding is a valuable tool for plant breeders, as it allows for rapid generation advancement and the evaluation of physiological traits in crops. The technique can increase breeding cycles by 2-3 generations per year for photo-sensitive crops, and up to 6 generations per year for photo-insensitive crops. Additionally, Speed Breeding is used to accelerate genomic selection methods, gene

Table 2: Protocols of Speed Breeding in different crops

S. No.	Crops	Protocols
1	Barley (*Hordeum vulgare*)	Light: 22h, Temp: Day: 22°C, Night: 17°C, Light Intensity: High PAR, Early seed harvest
2	Groundnut (*Arachis hypogaea*)	Light: Continuous, Temp: Day: 28°C, Night: 17°C, Light Intensity: High PAR
3	Pearl Millet (*Pennisetum glaucum*)	Better growth was observed at 38°C than 31 °C
4	Rapeseed (*Brassica napus*)	Light: 22h, Temp: Day: 22°C, Night: 17°C, Light Intensity: High PAR, Early seed harvest
5	Rice (*Oryza sativa*)	Light:10h, Temperature: Day: 27°C, Night: 25°C Soil requirement/plant: 260 cm^3, CO2 Supplementation: 560–800ppm
6	Soybean (*Glycine max*)	Light: 14h; Temp: Day: 30°C, Night: 25°C; CO2 Supplementation: 400–600ppm:
7	Wheat (*Triticum aestivum*)	Light: 22h; Temp: 22°C, Night: 17°C; Light Intensity: High PAR, Early seed harvest

(Source: Hickey *et al.,* 2019)

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Agronomic management of Indian mustard *Brassica juncea* (L.)

Diksha* and Dr. Aastha Khatri

Agronomic management practices for Indian mustard (Brassica juncea), a significant oilseed crop in India and other regions, are crucial for maximizing yield and quality. Key agronomic practices recommended for the cultivation of Indian mustard include Seed Selection, Land Preparation, Sowing Time, Sowing Method, Fertilizer Application, Irrigation, Weed Management, Disease and Pest Management, Harvesting and Post-Harvest Management. Implementing these agronomic management practices can help in optimizing Indian mustard production, improve yield and quality, and mitigate risks from pests, diseases, and environmental stress. Adjustments may be necessary based on local specific conditions and agronomic practices.

Indian mustard (*Brassica juncea* L.), a member of the Cruciferae family, also known as Indian mustard, brown mustard, Chinese mustard, and oriental mustard, is one of the major *Rabi* season oilseed crops in the world. India ranks third among the major rapeseed mustard growing countries of the world with 9.98% of the world's area under Rapeseed mustard cultivation. Domestic production of edible oil meets only 50% of the total requirement, while most of the requirement is met by importing from other countries.Despite leading producer of vegetable oil in the world, India is the largest importer of edible oil in the world. The attainment of self-sufficiency in edible oil is possible if the production potential of annual edible oilseed crops is harnessed through improved technologies for managing nutrients and weeds. Nepal, Russia, and Canada are currently the largest producers of mustard, globally. However, it is also cultivated in India, China, Pakistan, Poland, Bangladesh, Sweden and France. In India, mustard is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat. It is also cultivated in the plains of some northeastern states, which comprise Bihar, Chhattisgarh, Jharkhand, Odisha, Eastern Uttar Pradesh, Sikkim and West Bengal. The area, production and productivity of rapeseed mustard in India was 10.74 million hectares, 13.54 million tonnes and 1261 kgha^{-1} respectively (Indiastat, 2023).

Importance of rapeseed-mustard

Mustard seeds contain high levels of copper, calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, manganese and selenium. Mustard seeds are also a great source of several B vitamins like thiamin, riboflavin and vitamin B_6. Mustard oil has about 60% monounsaturated fatty acids (42% erucic acid and 12% oleic acid), 21% polyunsaturated fats (6% omega-3 alpha-linolenic acid and 15% omega-6 linoleic acid), and about 12% saturated fats. Mustard seeds offer a wide range of

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health benefits. Incorporating these flavourful seeds in a diet can reduce headaches, improve digestion, support heart health, strengthen bones and teeth, benefit the skin and hair, delay aging, provide antioxidant protection, control blood sugar etc. including mustard greens in the diet can boost the immune system, improve digestion, enhance skin health, maintain eyesight, promote bone density, improve heart health and prevent cancer potentially. Moreover, mustard greens are known to be packed with antioxidants which may help in the management of diabetes and obesity.

1. Seedbed preparation :

To achieve optimal growth and yield for mustard plants, it's crucial to maintain a firm, moist and uniform seedbed. This ensures proper seed-to-soil contact, even planting depth, and efficient moisture absorption, leading to uniform germination. Tillage plays a significant role in both crop growth and grain yield. There are different types of tillage systems, such as:

i. Conventional Tillage: This method involves use of a moldboard plough followed by disc harrowing. It is an extensive form of soil disturbance, which can lead to better soil aeration and improved drainage. However, it may also result in higher fuel consumption and soil erosion.

ii. Reduced Tillage: In this approach, disc plowing is followed by disc harrowing. It is a more moderate form of soil disturbance, which helps in maintaining soil moisture and reducing soil erosion. This method also helps in conserving energy, as it requires less fuel consumption compared to conventional tillage.

iii. Zero Tillage: This method involves sowing crops directly under uncultivated soil. It is the least invasive form of tillage and helps in maintaining soil structure, improving water retention, and reducing soil erosion. Moreover, zero tillage can lead to higher organic matter content in the soil, which can contribute to better crop growth and yield.When choosing a tillage system for mustard cultivation, it is essential to consider factors such as soil type, climate and specific requirements of the mustard variety being grown. The right tillage method can significantly impact the overall success of the crop, leading to higher yields and better-quality produce.

2. Sowing :

Seed and sowing play a crucial role in the successful cultivation of mustard, as they influence various factors such as growth, yield and resistance to pests and diseases. An overview of some key aspects related to seed priming, sowing time and planting techniques in mustard cultivation are as follows:

i. Seed priming is a technique that enhances early germination and growth of mustard seeds, even in unfavorable conditions. Soaking seeds in specific solutions can improve germination rates and overall crop performance. The rate of imbibition varies among different mustard varieties, which can be useful for identifying suitable options for abiotic stress conditions.

ii. Sowing time is another critical factor that affects mustard production. Optimal sowing dates allow for suitable environmental conditions throughout the growth stages, leading to higher yields. Different varieties respond differently to planting dates, so it's essential to consider this when planning sowing schedules. Delayed sowing can result in poor growth, low yield and reduced oil content.

iii. Sowing techniques such as broadcast, line sowing, ridge and furrow, and broad bed and furrow methods, can also impact mustard cultivation. The choice of technique depends on factors like land resources, soil conditions and management practices. Broadcasting is often successful in higher soil moisture regimes, while line sowing is beneficial under normal and conserved moisture conditions. Paira or utera sowing, where the next crop is sown in the standing previous crop without tillage, has shown promising results in eastern India. Ridge and furrow sowing has also demonstrated improved growth parameters and yield in *Brassica juncea*.

In summary, understanding and optimizing seed priming, sowing time and planting techniques can significantly contribute to mustard crop success under low temperature and radiation regimes. These factors should be carefully considered and tailored to specific local condi-

tions and varieties to achieve maximum yield and quality.

3. Crop Geometry :

In rapeseed-mustard plants, the competitive ability and yield are influenced by factors such as plant density, row spacing, soil fertility and environmental conditions. The optimal plant population density and row spacing can vary depending on these factors. A uniform distribution of plants allows for efficient use of resources and suppresses weed growth, leading to higher yields. Narrower row spacing generally promotes vegetative growth, but wider row spacing can result in taller plants with increased seed yield. As row spacing increases, crop maturity days may also increase, and plants may grow taller with more branches, pods, and seeds per plant. However, wider rows can lead to some lower leaves receiving less light, which may negatively impact yield. The recommended spacing for mustard is 30 × 10 cm, while for hybrids, it is 45 × 10 cm. In specific locations, such as Kumher and Pantnagar, different plant spacings may result in higher seed yields, but overall, the 45 × 10 cm and 30 × 15 cm spacings have shown promising results. To achieve the best yield for rapeseed-mustard plants, it is essential to consider the specific environmental conditions, genotype, and other factors when determining the optimal plant population density and row spacing.

4. Plant population and shading effect :

In summary, the study on *Brassica juncea* (Var. laxmi) found that dense plant populations can reduce yield due to mutual shading, impacting the photosynthetically active leaf area. This effect was more pronounced at the 91-110 DAS stage compared to the 71-90 DAS stage. Specific leaf weight, crop growth rate, and net assimilation rate were negatively influenced by 50% shading at the 71-90 DAS stage, while net assimilation ratio remained unaffected by 25% shading. However, a 50% shading at the 91-110 DAS stage had a more significant impact on these factors, indicating that higher shading levels can be more detrimental to plant growth and yield at later development stages.

5. Cropping system :

Physiography, soils, geological formations, climate, cropping patterns, and the development of irrigation and mineral resources play a significant role in determining the choice of crop varieties and cropping systems. In major mustard-growing areas, fallow mustard is a popular sequence. However, recent studies have revealed that certain crops can lead to better resource utilization and higher returns when incorporated into mustard-based cropping systems. By exploring and adopting these alternative crops, farmers can improve their yields and overall profitability.

6. Fertilizer management :

In summary, adequate nutrient supply, particularly nitrogen and phosphorus, plays a crucial role in increasing seed and oil yields in mustard crops. The recommended dose of fertilizers varies depending on factors such as climate, soil type, time, and cropping system. Nitrogen application efficiency is influenced by the rate, source, and method of fertilizer application. Optimal nitrogen levels (60-90 kg/ha) have been found to improve yield attributes and seed yield, while phosphorus levels (up to 80 kg/ha) enhance seed yield due to increased secondary branches and siliquae per plant. Split application of nitrogen in three equal doses has shown better results compared to two split doses. It is essential to apply nitrogen with pre-sowing irrigation and adjust the application method according to local conditions and practices.

Rapeseed-mustard, as an oilseed crop, has a high requirement for sulfur, which plays a crucial role in promoting oil synthesis, seed protein, amino acids, enzymes, glucosinolate formation, and chlorophyll production. This essential nutrient significantly contributes to mustard yield. In terms of agronomic efficiency, each kilogram of sulfur applied can increase mustard yield by 7.7 kilograms. The oil content in Canola-4 and Hyola-401 is 3% higher than the hybrid “PGSH-51” due to the combined effect of varying nitrogen and sulfur doses. Additionally, the oleic acid content in these hybrids is

double that of "PGSH-51."In "PGSH-51," erucic acid levels ranged from 23.2% to 29.4%. Higher sulfur levels led to a 2-3% reduction in erucic acid content, while lower nitrogen levels resulted in a 3% decrease in erucic acid with a corresponding increase in oleic acid. This suggests that higher doses of sulfur combined with low doses of nitrogen can affect the chain elongation enzyme system, leading to reduced erucic acid synthesis.

Mustard, being a sensitive crop, is highly susceptible to micronutrient deficiencies, particularly zinc and boron. These deficiencies can significantly impact its growth and productivity. In a study, it was observed that by applying 12.5 kg of ZnSO4 per hectare, the seed yield increased by 8.5%. This demonstrates the importance of adequate zinc supply for mustard cultivation. However, it is also noteworthy that the seed yield showed diminishing returns with an increase in the ZnSO4 dose. This indicates that there might be an optimal level of zinc application for mustard plants, beyond which the additional zinc may not contribute significantly to the seed yield. Moreover, the harvest index (HI), which is the ratio of grain yield to the total biomass, was also significantly affected by the zinc application. This suggests that zinc plays a crucial role in the partitioning of assimilates towards the seeds, leading to higher yields.

In conclusion, ensuring proper zinc and boron nutrition for mustard plants is essential for optimizing their growth and productivity. However, it is also crucial to maintain an optimal balance of these micronutrients to avoid wastage and environmental concerns.

7. Water management :

Rapeseed-mustard crops are sensitive to water scarcity, and regions like Rajasthan, Gujarat, Haryana, and Punjab have implemented irrigation systems to support their growth. Irrigation at critical stages positively impacts the crop's water use efficiency and yield. Two irrigations, one at the flowering stage and another at the siliqua formation stage, have been observed to increase seed yield by 28% compared to rainfed plots. Increased water supply enhances various factors like leaf water potential, stomatal conductance, light absorption, leaf area index, seed yield, and evapotranspiration while reducing canopy temperature. Studies have shown that the water use efficiency is highest with one irrigation at 45 days after sowing and that crops receiving two irrigations at pre-flowering and pod-filling stages produce about 33% more seeds than unirrigated crops. Single irrigation at the vegetative stage and two irrigations at the vegetative and pod formation stages are most beneficial for yield. Overall, proper irrigation management significantly affects rapeseed-mustard crop yield and water use efficiency. This practice can help maintain the optimal nutrient supply to the mustard crop while minimizing the negative impacts of saline water. Additionally, proper drainage systems should be in place to manage excess salts and prevent their accumulation in the root zone. It is essential to monitor the soil's electrical conductivity (EC) and adjust the irrigation water's EC accordingly. The ideal EC for mustard cultivation is typically between 2 and 4 dS/m. If the irrigation water's EC is higher than this range, it may be necessary to dilute it with freshwater or use other water management techniques like partial root zone drying or deficit irrigation. Furthermore, the use of saline-tolerant mustard varieties can help mitigate the effects of poor irrigation water quality. Breeding programs and selection of genotypes with higher salt tolerance can contribute to improve the overall productivity of mustard crops under such conditions.

In conclusion, ensuring the quality of irrigation water is crucial for optimal mustard production. Proper management, treatment, and selection of suitable water sources, along with appropriate agricultural practices, can help in minimizing the negative impacts of poor irrigation water quality on mustard crops. This will ultimately contribute to increased crop yields and better agricultural sustainability.

8. Weed management :

Weeds significantly impact crop production in various ways, such as competing for resources

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Millets for food and nutritional security

Gulab Choudhary*, Suresh Chand Kantwa, Kanchan Shilla, Akshay Ginthala, Sunil Kumar Yadav, Vikramjit Singh and Ashok Choudhary

Millets are cereals from the Poaceae grass family and are considered one of the oldest cultivated crops. They are a group of small-seeded grasses and have been staple food in many parts of the world for thousands of years, particularly in arid and semi-arid regions of Africa, Asia, and Latin America. They are low maintenance and drought-resistant grains. Millets are highly nutritious, providing essential vitamins, minerals, and amino acids. They are gluten-free and easy to digest, making them a suitable alternative for people with gluten sensitivities.

Millets have been an integral part of our diet for centuries. In addition to a surplus of health benefits, millets are also good for the environment with low water & input requirement. With the aim to create awareness and increase production & consumption of millets, the year 2023 was declared by United Nations as the International Year of Millets.

Millets are highly varied group of small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Most species generally referred to as millets belong to the tribe Paniceae, but some millets also belong to various other taxa.

Nutrient content

Millets are high in their nutrition content. Each millet is three to five times superior nutritionally to rice & wheat in terms of proteins, fiber, minerals, iron, and calcium. Millets are rich in B vitamins and gluten-free thus millets are suitable for people with allergies to wheat. Also for curing diabetes and obesity, millets are very excellent.

Millets are important crops in the semi-arid tropics of Asia and Africa (especially in India, Mali, Nigeria and Niger) with 97% of millet production in developing countries. In India, millets are mainly cultivated in Uttar Pradesh, Punjab, Andhra Pradesh, Tamil Nadu, Rajasthan, Karnataka, Maharashtra, and Gujarat. This crop is favoured due to its productivity and short growing season under dry, high-temperature conditions. Millets are indigenous to many parts of the world. The most widely grown millets are Sorghum and Pearl millets which are important crops in India and parts of Africa. Finger millet, Proso millet and Foxtail millet are also important crop species.

Climate requirement

Millets require warm temperatures for germination and development & are sensitive to frost. For these reasons, they are normally planted from mid-June to mid-July month. Optimum soil temperatures for seed germination are between 68°F and 86°F. Proso and foxtail millet is efficient users of water & grow well in areas of low moisture, partly because they are early and thereby avoid periods of drought. Millets are often grown as catch crops where other crops have failed due to

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Nutrient content of various raw millets with comparison to rice and wheat

S. No	Crop	Protein (g)	Fibre (g)	Minerals (g)	Iron (mg)	Calcium (mg)
1.	Sorghum	10	4	1.6	2.6	54
2.	Pearl Millet	10.6	1.3	2.3	16.9	38
3.	Finger millet	7.3	3.6	2.7	3.9	344
4.	Foxtail millet	12.3	8	3.3	2.8	31
5.	Proso millet	12.5	2.2	1.9	0.8	14
6.	Kodo millet	8.3	9	2.6	0.5	27
7.	Little millet	7.7	7.6	1.5	9.3	17
8.	Barnyard millet	11.2	10.1	4.4	15.2	11
9.	Browntop millet	11.5	12.5	4.2	0.65	0.01
10.	Rice	6.8	0.2	0.6	0.7	10
11.	Wheat	11.8	1.2	1.5	5.3	41

unfavourable weather.

Soil requirements

Millets produce well on well-drained loamy soils. They will not stand water-logged soils or extreme drought. Proso millet does not make good on coarse, sandy soils.

Seed treatment

Seeds treated with fungicide will give protection against head smut (*Sphacelothaca destruens*) and may increase seedling survival.

Seedbed Preparation

Seedbed preparation for millet is related to that for spring-seeded small grains. Weeds must be controlled prior to planting and the seedbed should be firm and well-worked. Since millets are planted late in the season, spring ploughing for weed control is practical.

Method of Seeding

Millets are generally seeded with a grain drill at a depth of one inch. Even though the seed is small, it can develop extreme elongation of the first internodes & even deeper unless a hard crust forms. Press wheels on the drill will increase seedbed firmness & aid in stand establishment. Millets compete poorly with weeds; therefore, high seeding rates are essential to establish a dense stand.

Fertility and Lime Requirements

Nitrogen is usually the most limiting nutrient in millet production. Rates of nitrogen must be based on yield goals & cropping history. Excess nitrogen, whether applied or residual, may affect in lodging. Phosphorus & potassium should be applied as needed based on soil recommendations. Drill row applications of fertilizer (except straight phosphorus fertilizers) may cause seedling injury & are not recommended. A pH level of 5.6 or higher is recommended for millet cultivation.

Important millets cultivated in India

Sorghum (*Sorghum bicolor*)

Sorghum or Jowar has high nutritional value, with high levels of unsaturated fats, protein, fiber and minerals like phosphorus, potassium and iron. Sorghum helps to develop metabolism. It is a strong grass & usually grows to a height of 0.6 to 2.4 meters, sometimes reaching as high as 4.6 meters.

Sorghum is normally known as Jowar in India. Traditionally, it was used as a grain to make flatbreads or Rot's. Enriched with the goodness of iron, protein & fiber, Jowar can help in reducing cholesterol levels as it has a component called policosanols. Sorghum is also called great millet, Indian millet, milo, durra.

Sorghum requires an average temperature of at least 25°C to generate maximum grain yields in a given year. Maximum photosynthesis is attaining at daytime temperatures of at least 30°C. It cannot be planted until soil temperatures have reached 17°C. The long growing season, generally 90 to 120 days, causes yields to be severely decreased if the plants are not in the ground early enough. Grain sorghum is generally planted with a commercial corn seeder at a depth of 2 to 5 centi-

meter, depending on the density of the soil. Yield can be boosted by ten to fifteen percent when optimum use of moisture & sunlight are obtained by planting in 25-centimeter rows instead of the conventional one-meter rows. Sorghum, in common is a very competitive crop and does well in competition with weeds in narrow rows, however, herbicides are also used to control the weeds.

Pearl millet (*Pennisetum glaucum*)

Pearl millet (known as Bajra in Hindi, also known as sajjey in Kannada and 'Kambu' in Tamil). Pearl millet is the most widely grown type of millet & India is the largest producer of pearl millet. Pearl millet is the second important millet of India. Pearl millet is a rich source of phosphorus, which plays an important element in the structure of body cells. It is also called Bulrush millet, Babala, Bajra, Dukhn, Gero, Sajjalu, or Souna. Sowing takes place between May and September, and harvesting between September & February. Soil temperatures should be at least 65°F and rather warmer before pearl millet is planted. In optimum planting time is early June, with a range of mid-May to mid-June being suitable. The seeding rate is recommended at 1.8 kg per acre. An exact seeding rate is not critical, because pearl millet can moderately compensate for a poor stand by increasing the number of tillers.

Ragi (*Eleusine coracana*)

Ragi is the best millet for weight loss because; it has the highest content of calcium. And also have a high fiber content that makes it an excellent food option to manage body weight. It is also known as African finger millet, red millet and very popular millet especially in Southern India. It is rich in calcium and protein and has a good amount of iron and other minerals.

Finger millet tops in antioxidant activity among common Indian foods, Ragi has a good number of Essential Amino Acids (EAA) which are necessary for the human body. It is used as a healthy substitute for rice & wheat. Finger millet is undoubtedly a powerhouse of nutrition loaded with protein and amino acids. This gluten-free millet is very good for brain development in growing kids.

Finger millet may be grown as a hot weather crop, from May to September, using long-duration varieties and as a cold season crop, from November and December, using early types. An application of farmyard manures at eight to ten tons/ha is recommended in order to develop the soil organic matter content, moisture retention ability & soil structure. Phosphorous must be applied in the form of rock phosphate. Weeding must be done twice; 2 to 3 weeks after emergence and about two weeks later. Early land training is recommended. A fine seedbed suitable for small grains is required to ensure good germination, plant population density & effective weed control. Most soils except coarse sand are appropriate for its farming.

Kodo Millet (*Paspalum scrobiculatum*)

Kodo millet contain high amounts of polyphenols, an antioxidant compound, they have high fiber, low on fat. Kodo millet inhibited glycation & cross-linking of collagen. Kodo millets are very good for diabetes, easy to digest and contains a high amount of lecithin & is very excellent for strengthening the nervous system. Kodo millets are rich in B vitamins, mainly niacin, B6, and folic

acid, as well as the minerals such as calcium, iron, potassium, magnesium & zinc. Regular consumption of Kodo millet is very beneficial for treating high blood pressure and high cholesterol levels.

Generally, the Kodo millets are grown in tropical as well as sub-tropical areas up to an altitude of 2,100m. It is a heat-loving plant. Kodo millet is propagated from seed, preferably in row planting instead of broadcast sowing. Kodo millet is better suited to conditions which require about 800 to 1200 mm of water annually and is well suitable to sub-humid arid conditions.

Foxtail Millet or Korralu (*Setaria italica*)

Foxtail millet are high in Iron content & these millets are pest-free. Foxtail millet does not need any fumigants but acts as an anti-pest agent to store delicate pulses such as green gram. They control blood sugar and cholesterol levels & increase HDL cholesterol. Foxtail millet has healthy blood sugar balancing carbohydrates, and it is popularly available in the form of semolina & rice flour. The presence of iron & calcium in this millet helps in strengthening immunity.

In India, foxtail millet is still an important crop in arid & semi-arid regions. In South India, foxtail millet has been a staple diet among people for a long time from the Sangam period. In China, foxtail millet is the most common millet & one of the main food crops, especially among the poor in the dry northern part of that country. In Southeast Asia, foxtail millet is generally cultivated in its dry, upland regions.

In Europe and North America it is planted at a moderate scale for hay & silage, and to a more limited extent for birdseed. In the northern Philippines, foxtail millet was once the main staple crop, until its later replacement of wet-rice and sweet potato farming.

Little Millet

Panicum sumatrense, known as little millet, is a species of millet in the family Poaceae. Little Millet is also rich in tannins, flavonoids which helps against diseases like diabetes, cardiovascular diseases, cataract, cancer, inflammation, gastrointestinal problems and delay ageing too. Its largest cultivation is in central India. The green plant can also be used as cattle feed. The straw can be mixed with clay or cement and used in construction.

Browntop millet (*Urochloa ramose*)

Browntop millet known as palapul (Tamil), Korale (Kannada) and Andakorra (Telugu) is an all climate grass grown mostly in Andhra Pradesh and Karnataka. Browntop millet is one of rarest millets now. It is gluten-free having low GI, so its consumption reduces cholesterol. It is rich in fibre, iron, calcium, magnesium and many minerals.

Barnyard millet

Barnyard millet (*Echinochloa* sp.) has become one of the most important minor millet crops in Asia, showing a firm upsurge in world production. The genus *Echinochloa* has two major species, *Echinochloa esculenta* and *Echinochloa frumentacea*, which are predominantly cultivated for human consumption and livestock feed. They

are less susceptible to biotic and abiotic stresses. Barnyard millet grain is a good source of protein, carbohydrate, fiber and most notably, contains more iron & zinc than other major cereals. Despite its nutritional and agronomic

benefits, barnyard millet has remained an underutilized crop. Barnyard millet is grown throughout India, particularly in Uttarakhand, Madhya Pradesh, Andhra Pradesh, Gujarat, Maharashtra and Tamil Nadu.

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editing using Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technology and for development of transgenics.

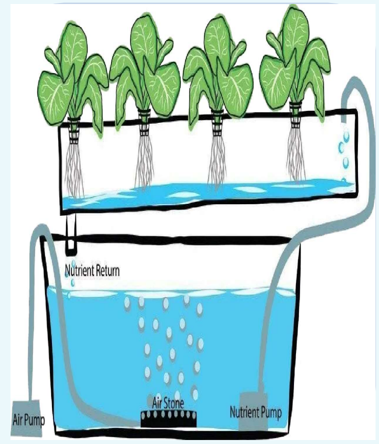
Several successful cultivars have been developed using Speed Breeding techniques. For example, 'DS Faraday', the first wheat cultivar developed using SB techniques, was created to improve tolerance against pre-harvest sprouting and increased protein and milling quality. Another cultivar, 'Scarlett', was developed in just two years using modified backcrossing methods and is resistant to various plant diseases, making it a popular choice for large-scale cultivation in Argentina.

Another example is 'YNU31-2-4', a rice cultivar developed using SB and molecular breeding techniques. This cultivar is tolerant to saline conditions and was developed by adding the hst1 (OsRR22) gene, a salt-tolerant gene from "Kaijin", to the high-yielding "Yukinko-mai" using single-nucleotide polymorphism (SNP) markers. The breeding cycle was then enhanced using SB protocols, which provided 14 hours of light and 10 hours of dark for vegetative growth and 10 hours of light and 14 hours of dark for the reproductive growth of the plant.

Challenges and Limitation

Although Speed Breeding has its benefits in the breeding program but on the other side of the coin, it also has its limitations and challenges. As we know SB requires controlled environments but to get success a lot of effort is needed. Prolonged photoperiod affects the response of plant species due to which universal protocol is still undeveloped which is one of the major limitations of speed breeding. In developing countries, continuous use of SB techniques for varietal development is a major challenge due to a lack of infrastructure, skills and international support. Further, the collaboration of speed breeding with other modern techniques of molecular biology makes it much costlier. Low cost and efficient cooling and lightning systems are the major factor that reduces cost and further widely uses this potential technique in new varieties development. In future, the involvement of new technologies with some of the modifications may be helpful to make this technique cost effective. The policy intervention for research, training and financial support at both national and international level are needed to widely use the SB technique in sustainable manner. Indian research institutions and various agricultural universities have been exploring and implementing speed breeding techniques. These institutions are focused on developing high-yielding and resilient crop varieties through accelerated breeding processes. There is a growing emphasis on collaboration between Indian researchers and international institutions to exchange knowledge and expertise in speed breeding. Training programs and workshops are also being organized to build capacity among Indian scientists. Speed breeding is an emerging field in India, with ongoing efforts to integrate it into mainstream agricultural practices to boost productivity and address food security challenges.

Hydroponic Farming: Challenges and Future



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Hydroponic farming, a method of growing plants without soil by using nutrient-rich water solutions holds promising potential for the future of agriculture. However, hydroponic farming faces challenges related to initial costs, technical complexity and energy consumption; its future appears promising due to its potential for resource efficiency, year-round production, high yields, and sustainability. Continued research, technological innovation and investment are essential to unlock the full potential of hydroponics and integrate it effectively into global agricultural systems.

Hydroponic farming is a method of growing plants without soil. Instead, plants are grown in a nutrient-rich water solution that is carefully controlled and monitored to provide the plants with everything they need to grow and thrive. The roots of the plants are suspended in the solution, which is typically circulated through the growing medium using a pump.

Hydroponic farming can be done indoors or outdoors and can be used to grow a wide range of plants, including vegetables, herbs, and even some fruits. The benefits of hydroponic farming include faster growth rates, higher yields, and more efficient use of water and nutrients compared to traditional soil-based farming methods. Additionally, hydroponic farming can be used in areas where traditional farming methods may not be possible due to soil conditions, climate, or other factors.

However, here are some countries that are known to have significant hydroponic farming industries. The Netherlands is often considered a leader in hydroponic farming technology and is home to many innovative hydroponic farms. Dutch companies are major suppliers of hydroponic technology and equipment to other countries. Canada is another country that has a thriving hydroponic farming industry. The climate in Canada is often

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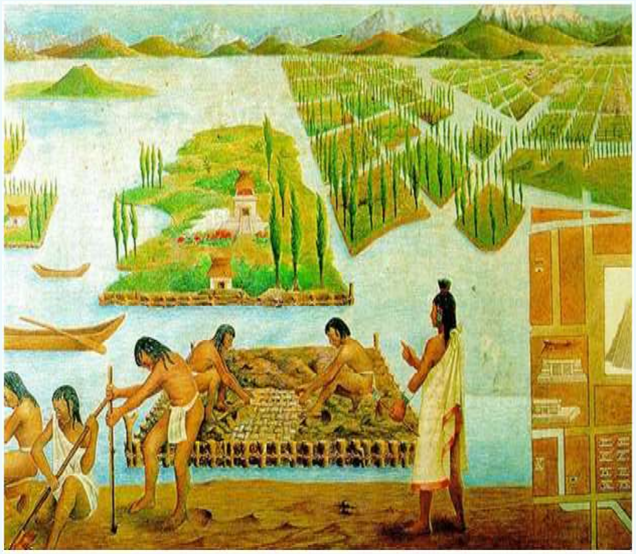
too cold for traditional outdoor farming, making hydroponics an attractive alternative.

Australia has a large and growing hydroponic farming industry, particularly for the production of high-value crops like tomatoes and lettuce.The United States has a significant hydroponic farming industry, with many farms located in urban areas where land is expensive and limited.China has been investing heavily in hydroponic farming technology in recent years to address food security concerns and to meet the growing demand for fresh produce in urban areas.

History of hydroponic farming

Hydroponic cultivation, or the practice of growing plants without soil, has been around for thousands of years in various forms. The Hanging Gardens of Babylon, one of the Seven Wonders of the Ancient World, were thought to have been created using hydroponic methods.Similarly, ancient Egyptian hieroglyphics dating back to several hundred years BC depict the growing of plants along the Nile River without soil, as do the floating gardens.

In the 17th century, English scientist John Woodward conducted experiments with plants grown in water, marking the beginning of modern hydroponic farming. In the 18th and 19th centuries, several other scientists conducted research on hydroponics, including Johann van Helmont, who grew plants in water to demonstrate that they obtain their nourishment from the air as well as the soil.



In the early 20th century, researchers developed the nutrient film technique (NFT), which involves a thin film of nutrient-rich water flowing over plant roots, allowing for efficient nutrient uptake. This technique paved the way for the modern hydroponic farming industry.

During World War II, hydroponics gained more attention as a way to grow fresh produce for troops stationed in remote locations. In the 1960s, NASA also began researching hydroponic farming as a way to provide food for astronauts on space missions.

The future of hydroponic farming

Since then, hydroponic farming has become increasingly popular as a way to grow fresh produce in urban areas, where land is scarce and soil quality is poor. Today, hydroponic farming is used to grow a wide range of crops, from lettuce and tomatoes to herbs and flowers.

The future of hydroponic farming looks bright, with several trends indicating that this agricultural method will continue to grow in popularity and importance. Here are some factors that could shape the future of hydroponic farming:

1. **Increasing demand for fresh produce -** As consumers become more health-conscious and demand fresh, locally grown produce, hydroponic farming can provide a year-round supply of fresh fruits and vegetables. Hydroponic farms can be set up in urban areas, reducing transportation costs and emissions associated with traditional farming.
2. **Advances in technology -** As hydroponic farming technology continues to improve, farmers will have access to more efficient, cost-effective systems. Innovations in lighting, climate control, and nutrient management could improve crop yields and reduce operating costs.
3. **Climate change -** Climate change is expected to increase the frequency and severity of extreme weather events, such as droughts and floods that can disrupt traditional agriculture. Hydroponic farming can provide a more resilient and flexible food production system that is less vulnerable to climate-related shocks.
4. **Sustainability -** Hydroponic farming uses

less water and fertilizer than traditional farming methods and produces less waste. As environmental concerns grow, consumers and policymakers may place greater emphasis on sustainable farming practices, including hydroponics.

5. **Vertical farming -** Vertical farming, which involves stacking hydroponic growing trays on top of each other in a controlled environment, is gaining popularity in urban areas where space is limited. This approach can increase food production per square foot and reduce transportation costs.

Steps of Hydroponic farming

Choose a location - Hydroponic farms can be set up indoors or outdoors, but the location should have access to electricity, water, and adequate space for the system.

Choose a growing system - There are several types of hydroponic systems available, including deep water culture, nutrient film technique, drip irrigation, and more. Choose a system based on your needs, budget, and available space.

Choose the plants to grow - Hydroponic farms can grow a wide range of crops, from herbs and lettuce to fruits and vegetables. Choose plants that are suitable for hydroponic growing and meet the demand of the market.

Install the system - Install the chosen hydroponic system according to the manufacturer's instructions. This typically involves setting up the water reservoir, pumps, tubing, and grow trays.

Mix nutrients - Hydroponic plants require specific nutrient solutions to thrive. Mix the appropriate nutrient solution for your plants according to the instructions provided with the system. The mixture preparation for hydroponic farming varies depending on the type of hydroponic system being used, the plants being grown, and the nutrient solutions available. However, here is a general recipe/Ingredients for preparing a basic nutrient solution for hydroponic farming:

- Calcium nitrate
- Magnesium sulfate (Epsom salt)
- Potassium nitrate
- Monopotassium phosphate
- Trace mineral solution

Instructions:

- Dissolve 1.13 kg of calcium nitrate in 189 ltrs of water.
- Dissolve 0.45 kg of magnesium sulfate (Epsom salt) in the same 189 ltrs of water.
- Dissolve 0.45 kg of potassium nitrate in the same 189 ltrs of water.
- Dissolve 0.23 kg of monopotassium phosphate in the same 189 ltrs of water.
- Add the trace mineral solution according to the manufacturer's instructions. This will provide micronutrients such as iron, copper, and zinc.

This basic nutrient solution can be adjusted depending on the specific needs of plants. It is important to regularly test and adjust the pH levels of your nutrient solution to ensure optimal plant growth. Additionally, some plants may require additional nutrients that are not included in this recipe.

Plant the seedlings - Once the system is set up, plant the seedlings into the grow trays, taking care not to damage the roots.

Monitor and adjust the environment - Monitor the pH level of the nutrient solution, temperature, humidity, and lighting levels regularly to ensure optimal growing conditions for the plants. Adjust the environment as needed.

Harvesting of crops - Harvest the plants once they have reached maturity. Clean the system and replant new seedlings to continue the cycle.

Challenges of hydroponic farming

While hydroponic farming has many advantages, it also faces several challenges, including:

1. **High start-up costs -** Hydroponic systems can be expensive to set up, particularly for larger operations. The cost of equipment, lighting, and nutrient solutions can be a significant barrier to entry for new farmers.
2. **Ongoing Maintenance Costs**: Hydroponic farming requires ongoing maintenance, including regular monitoring of nutrient levels, pH balance, and lighting. This can be costly and time-consuming.

3. Technical expertise required - Hydroponic farming requires specialized knowledge of plant biology, nutrient chemistry, and system engineering. Farmers may require training or experience to operate and maintain a hydroponic farm effectively.

4. Energy consumption - Hydroponic systems require electricity to power pumps, lighting, and climate control systems. The energy consumption of hydroponic farms can be high, leading to increased operating costs and environmental concerns.

5. Water quality and availability - Hydroponic farms require high-quality water that is free of contaminants and has the right balance of nutrients. Access to clean water can be a challenge in some areas, particularly in arid regions where water is scarce.

6. Pest and disease management - Hydroponic plants are vulnerable to pests and diseases, just like any other crop. Farmers must take appropriate measures to prevent and control outbreaks, which can be more challenging in a closed, controlled environment.

7. Market competition - As hydroponic farming becomes more popular, farmers may face increased competition from other growers. This competition can drive down prices and make it more challenging to sell produce profitably.

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like water, light, space and nutrients. This competition can lead to a decline in crop yield, ranging from 15-30% to total failure in some cases. To address this issue, farmers have adopted various methods for weed control, with herbicides being a popular choice due to their efficiency, increased profit, and reduced labor requirements. Some effective weed control methods for mustard include hand weeding, fluchloralin pre-plant incorporation, wooden hand ploughing, polythene mulch, and a combination of these techniques. These methods help in maintaining a weed-free environment, which results in higher seed yields. Broomrape (*Orobanche*) is a major parasitic weed that causes significant damage to mustard crops, reducing both yield and quality. To combat this issue, farmers can consider using preceding crops that help reduce *Orobanche* infestation in mustard, such as cowpea, black gram, moth bean, sunn hemp, cluster bean and sesame. Additionally, cultural practices like mulching and hoeing can be beneficial in controlling weeds and improving mustard yield.

In conclusion, managing weeds is crucial for maintaining high crop yields and overall productivity in mustard farming. Employing effective weed control methods, such as herbicides, hand weeding, mulching, and hoeing, can significantly improve mustard yield and ensure better nutrient use efficiency.

Conclusion

The growth in oilseed production, particularly mustard, can be enhanced through various strategies. Firstly, exploiting genetic resources and employing breeding and biotechnological techniques can help break yield barriers. Secondly, focusing on horizontal growth in rapeseed-mustard production areas with lower yields than the national average can, contribute to overall growth. Developing production technologies for different agroecological cropping systems and utilizing unutilized farm situations can also help expand mustard cultivation. Adopting such cropping systems could potentially bring an additional 1 million hectares under cultivation. Improving existing practices like proper land preparation, timely sowing and using better quality seeds can significantly impact productivity. Implementing site-specific nutrient management and adopting an integrated approach to plant-water, nutrient, and pest management are crucial for achieving higher yield targets. Further, extending rapeseed-mustard cultivation to new areas under different cropping systems will play a vital role in increasing and stabilizing productivity.

Rugda: A prized edible mushroom of Jharkhand

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Rugda mushroom is a highly prized edible fungus found in the forests of Jharkhand. It is known for its unique flavor and texture. Rugda mushrooms are sought after in culinary dishes, especially in local cuisines. In addition to being delicious, rugda mushrooms are also noted for their nutritional value, being rich in vitamins and minerals. These mushrooms typically grow in the wild during the rainy season, often near specific types of trees. Foraging for rugda is a traditional practice in many local communities, and it plays an important role in their economy and culture

Jharkhand is situated in Chota Nagpur Plateau which is blessed with various kind of mushrooms with different texture and flavor. These mushrooms are integral part of the life of tribal population. They collect it, either for consumption or sale in monsoon season. *Lycoperdon* (Putka or Putto), *Lentinula spp.* (Bansh Khukhri), *Geastrum, Ganoderma* (Medicinal mushroom) *Volvariella spp.* (Pagla Khukhri), *Boletus edulis* (Jamun Khukri), *Macrolepiota procera* (Bada Khukri), *Calocybe* (Milky mushroom) *Termitomyces clypeatus* (Namak Khukhri), *Armillaria, Clitocybe, Amanita*, etc are common edible mushrooms found in Jharkhand. These mushrooms are highly nutritious and best alternative for animal or plant derived product. Unlike other mushrooms, Rugda is indigenous to Jharkhand and special part of the tribal cuisine in the month of rainy season. However, its cultivation and preservation is still not commercialized. There is a need of value addition of this forest product so that tribal population can generate some income from this.

Jharkhand is also known as "the land of forest" and the major part is situated on plateau and hilly region with rich mineral resources. It is blended with diversified culture and tradition with 26% tribal population. These communities adopt low-resource strategies for their livelihood which do not have negative impact on the environment. There are many indigenous traditional foods in the forest area like plants, insects, and fungi which have high nutrition value. These tribal people are acquainted with use and benefit of wild mushroom since ancient era. In last few decades, use of these fungi as a dietary supplement is growing very rapidly due to high amount of proteins, minerals, vitamins and crude fiber. However, it is unutilized and remains unknown for several people of the state. Tribal community of Jharkhand is still undeveloped, neglected, poor and dependent on forest product for their survival. Malnutrition among tribal peoples is quite common and wild legumes as well as mushrooms are nonconventional source to meet nutritional and health requirement for these

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native people. Various wild mushroom are unexplored and need a determined efforts for the study of natural mushroom flora. However, some research is going on about use and preservation of these fungi. One of the wild mushrooms prevalent in Jharkhand in the month of June to September is *Rugda*. This is a wild mushroom which is still not domesticated for commercial purpose.

Rugda (*Astraeus hygrometricus*) a roundish oval shaped mushroom with no stalkis considered as meat for vegetarian due to its chicken like flavor. These mushrooms are healthy alternative of animal protein and its curry is quite popular among local people of Jharkhand. Rugda is underground wild rare mushroom which is non cultivated but naturally grown in the dense forests of Jharkhand and some parts of Uttarakhand, Bengal and Odisha. In Jharkhand they are extensively found in the humid forests of some district like Ranchi (Bundu, Tamar, and Pithoria), Chaibasa (Bandgaon), and Lohardaga. The sal and teak forest area which receives rainfall of more than 350 mm in the month of July with good sunlight, humidity and temperature of around 30°C is considered ideal for its growth and development. There is an assumption among tribal people that thundering provides nitrogen di-oxide to the soil, which provide nutrition to this mushroom. Local women collect it around the Sal tree canopies after the thunderstorm. The tribal women visualize the site by tracing white mycelial matrix. They simply dig the top layer of soil with their finger up to few inches and collect it and then sell it in local market. The price range for each kilo of Rugda may vary from ¹ 400 to 600. However, its export is not possible due to its highly perishable nature. People from other states are still unaware about the Rugda, since its addition in state culinary dish has no records in history. It is identified as flavor of Jharkhand but still fighting for its identity in Indian plates. If steps are taken by the state government for its processing and conservation, then rural economy may get a new dimension.

History

In 1801," Christiaan Hendrik Persoon" first described about this species and gave name *Geastrum hygrometricus* but in 1885 North American botanist "Andrew P. Morgan" refused his claim on the basis of microscopic characteristics and offered new genus name "Astraeus". According to Morgan, Asterus has no open chamber, no organized hymenium, larger spores, threads of the capillitium are long and much branched than *Geastrum*. He also concluded that these ectomycirizal fungi associated with tree species belongs to Dipterocarpacea family. The species "*hygrometricus"* is a greek word which means 'hygros' meaning wet and 'metron synonymous with measure. In 2005 German Mycological Society adopted this species for "Mushroom of the Year". In India, it was first identified and reported by Ahmad.

Description of Barometer Earthstars (*Astraeus hygrometricus*)

Basically Rugda is a fruiting body of fungi belonging to the Class of *Ascomycetes* or *Basidiomycetes*. They are also known as false earthstar, hygroscopic earthstar or barometer earthstar. However, its appearance is similar to genus *Geastrum.* Worldwide, genus *Astraeus* have 10 species in which *A. asiaticus, A. hygrometricus, A. odoratus and A. thailandicus* are edible while *A. koreanus and A. pteridis* are non-edible; edibility of rest of the species like *A. telleriae, A. sirindhorniae*, *A. morganii* and *A. smithii* are yet not decided. These are ectomychorrizal fungi and colonize with spacious variety of forest trees. In Indain condition, *Astraeus hygrometricus* is only cited in the lateritic region. Unlike the common mushroom, it grows underground in debris. The outer layer of mushroom *i.e.* exoperidium consists many layers of tissue, the inner tissue layer is hygroscopic in nature. Exoperidium breaks in star shaped pattern with 4-20 irregular rays. Due to hygroscopicity, these mushrooms open their ray in humid condition and shrinks it again when drier condition prevails.This facility helps the mushroom to disperse their spores when congenial weather prevails. Curling or uncurling of the rays also help to protect them from dehydration in dry period.

White mycelial matrix of *Astraeus hygrometricus* in the soil

The immature fruit bodies of *Astraeus hygrometricus* is collected after the onset and before receding of monsoon under the Sal forest. Spores of *Rugda* develop quickly under the shade of Sal tree (*Shorea robusta*) in continuous rainfall of three to four days. These immature fruit bodies develop on soil cracks with white matrix under the trees. On careful observation, these fungi body are collected by villagers after scratching the soil. These are harvested in the month of July (early monsoon) to September (before receding monsoon). These juvenile basidiomata either present singly or in group of 4 -10 in 0.5 -1 cm depth of soil. These mushroom are highly perishable and may be preserved for 3-4 days under soil. They are collected, sold and preferably consumed on the same or subsequent day. These puffball has tough rubber like external surface which protect a yolk like black and white substances. Before cooking each immature basidium will be cut to check its tenderness. Only those balls are chosen for eating which consist white flesh or blackish spot along the margin and rest are discarded. Out of its 10 species, white and black colored Rugda is considered to be the most nutritious. In vernacular language, these earth stars are also called Puff valve, Kallanabe in Kannada, Putto in MP, Rugda in Jharkhand, Sehula in UP and Putka in West Bengal.

Habitat

These fungi are cosmopolitan having variety of habitat except alpine and cold temperate region. Till date, it is reported all around the world especially in tropical rain forest of Africa, Asia, Australia, Europe, North America and South America. They are developed either solitary, scattered or in cluster of 4 to 10 as white bone mycelial mass, fully or partially buried in the soil. They are mostly confined to open and undisturbed area of woodland. These fruiting bodies prefer acid substrate and avoid substrate rich in lime. These are abundantly found in lateritic regions of India, in slightly acidic soil (pH 5.5-6) of forest to sandy loam soil. These mushrooms are widespread in Chhattisgarh, Madhya Pradesh, West Bengal, Himachal Pradesh, Karnataka, Kerala, Odisha, Jharkhand and West Bengal in Sal forests. They are occasionally found in Areca planted area and their adjacent area of grass land in lateritic soils. Since, Chhota nagpur forest are deciduous in nature, the fallen leaves provide a rich source of organic matter for the growth and development of these mushroom. It develops on the soil cracks below the sal tree (*Shorea robusta*) when rain water falls on it.

Host range

Some plant families like Dipterocarpaceae, Pinaceae, Betulaceae, Ericaceae and Fagaceae are important host for these ectomycorrhizal fungi. They have close association with ample number of tree species like Sal tree (*Shorea robusta*), Jamun or black plum (*Syzygium cumini*), Australian babool (*Acacia auriculiformis*), Kaju (*Anacardium occidentale,* amla (*Phyllanthus emblica*), *Eucalyptus*, Oak, Pine tree etc. The mycelium of fungus make mutualistic association with these tree roots and extracts nutrients (especially phosphorus from the soil mineral or organic substances) for the plant and in exchange they receives carbohydrates from plants. The spores of the fungus may persist for several years and again germinates from the dead *A. hygrometricus* inner rays surface.

What makes it black?

These immature fruit bodies contain unique texture and flavors. On opening of this basidium gives an earthy and pungent moss odour due to presence of eight carbon volatile compound including 1-octanol, 1-octen-3-ol, and 1-octen-3-one. These fruiting bodies have one outer tough layer

Fruit body of immature *Astraeus hygrometricus*

and a tender flesh inside the cap. The color of these flesh are white or white with black margin and considered for consumptions, however those mushrooms with fully black flesh are discarded.

Nutritional values

These wild mushrooms are good supplement in human diet as these have generous amount of proteins, minerals, vitamins, essential amino acid, and crude fiber with low fat content. These mushrooms have high medicinal value with antibacterial, antifungal, antiviral, antiparasitic, antioxidative, anti-inflammatory, antiproliferative, and anticancer properties. Cooked or uncooked tender wild edible fungus can be incorporated in regular diet to cure many ailments. The uncultivated *A. hygrometricus* are best possible nutraceutical source for tribal people as these are endowed with many bioactive principles and potential antioxidant properties. The polysaccharides (AE2) derived from *A. hygrometricus* extract, have capacity to restrict the growth of tumor cell established in laboratory test. These mushrooms contain various bioagents which makes them good for diabetes patient, heart patients, blood pressure and anemic patient. The traditional community used it as medicine against burn by mixing the spores with mustard oil.

Parameter	Quantity
Moisture	80-90%
Carbohydrate	50-65%
Protein	14-16.47%
Amino acid	6.48± 0.90 g/100 g dry weight
Fat	1.28-4.4%
Ash	5-12 %
Energy	336.74 g calories
Vitamin Ascorbic acid Thiamine	 3.26 (outer) and 0.26 (inner) mg/100g 5.23 (outer) and 3.54 (inner) mg/100g
Minerals	P, K, Ca, Mg, Fe, Zn, Mn

Conclusion

The familiarity of Rugda are widespread among tribal community of Jharkhnad but some scientific approach are needed for further innovation of *Astraeus hygrometricus.* These mushroom are non-wood forest product and may generate income in the season among the tribal community. However, its existence is in trouble due to changing climatic pattern of Jharkhand. The erratic pattern of monsoon, rise in temperature as well as deforestation and more human interference in its natural habitat may lead towards extinction of unique species. Once it is vanished, revival would be difficult, so rejuvenation of forest with awareness among local people for its restoration is the need of hour. There is also a need to carry out extensive research for its domestication, cultivation, conservation and processing. It is a delightful gift of nature, so steps must be taken to protect and conserve the native delicacy of Rugda.

Low cost interventions for improving livestock productivity in arid regions

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In arid regions scarcity of year round green fodder and higher cost of feed concentrates compromises the livestock productivity in terms of milk yield and animal body weight. Therefore, nutrient supplementation through additional feed like multi-nutrient mixture is necessary part of livestock nutrition in arid region. The results of on farm trial of nutrient supplementation through different technologies like multi-nutrient feed blocks to milching livestock, multi-nutrient mixture to growing goat kids and azolla feeding proved to be gainful technological interventions through enhancing of milk yield, body weight gain and economical cost of feeding.

The farming systems in the arid regions are predominantly livestock based and animal husbandry is main farming activity parallel to crop production. However, the milk and meat productivity of livestock is low in these dry regions. One of the main reasons for the low productivity of livestock is poor nutrition, traditional rearing methods, besides the low genetic potential of the non-descriptive animals. Therefore, scientific intervention on improved nutrition, community oriented breed improvement, animal health care and capacity building of farmers on improved livestock production techniques are the key areas to address for improving the productivity of livestock.

Improved nutrition through supplementary feeding

In traditional methods of rearing, the feed requirements of livestock are met out from agriculture residues and farmers in rainfed regions can rarely afford to provide green fodder and concentrate feeds. For balance nutrition, availability of quality feed at a reasonable price is a key to a sustainable and profitable dairy production system. Feed alone represents 70-75 per cent of total cost of dairy production. Hence, most of the farmers in arid regions feed their dairy animals with low protein ration because of high cost feed ingredients. Presently, the farmers are dependent on commercially available feeds, which are of low quality and costly hence not often economical for milk production.

Under ICAR funded Farmer-FIRST Programme following improved livestock nutrition techniques were implemented and evaluated in farmer participatory mode in different villages of Popawas and Beru Panchayat of Jodhpur district.

1. Multi Nutrient Feed Block (MNFB) and Multi Nutrient Mixture (MNM) feeding to mulching livestock

2. Multi Nutrient Mixture (MNM) feeding to goat kids

3. Azolla production and feeding to milching livestock

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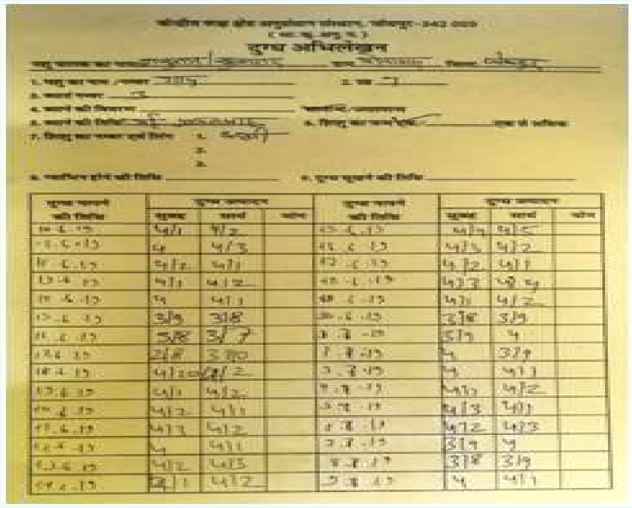
1. Supplementary nutrition to lactating livestock through MNFB and MNM



Milk Record Index Card

CAZRI-Multi-nutrient feed block

For balance feeding to livestock, MNFB and MNM are prepared in the livestock feed unit of CAZRI, Jodhpur with different constituents (Table 1). Interventions on supplementary feeding of multi-nutrient feeds in bovine and goats for enhancing milk production were undertaken with 25 farmers in the two villages namely Popawas and Ghantiyala. Eight multi-nutrient feed blocks (MNFB) were provided to farmers for individual cow/buffaloes and 2 kg multi-nutrient mixture (MNM) was provided to individual goat for a period of 12 weeks. The average age of animals was 5 to 8 years for bovine and 3 to 4 years for goats. The daily milk yield of animals was recorded by farmers in 'Milk Record Index Card' by measuring mugs.

Feeding of MNFB to bovine: The average daily milk yield of first 10 days was 10.50 and 8.17 litres/day for buffaloes and cows (as control), respectively. The average daily milk yield after 12 weeks of feed supplementation increased to 10.93 and 8.77 litres/day in buffalo and cow, respectively. The daily milk yield increase was recorded to the tune of 4.1% and 7.4% in buffaloes and cows, respectively due to feeding of MNFB. An increase of total 248 liters of milk yield was obtained from 7 buffaloes due to feeding of MNFB for 12-week period and B:C ratio of this intervention was estimated to be 3.16 in buffalo. In cows, total 391 liters of milk was additionally increased from 8 animals during 12 weeks with 3.49 B:C ratio (Table 2).

Table 1. Composition of multi-nutrient feed for supplementary feeding to livestock

Constituents	*Ratio for Multi Nutrient Feed Block	Ratio for Multi Nutrient Mixture
Molasses	45	45
Wheat bran	25	25
Guar meal	7	7
Mustard oilcake	10	10
Urea	5	5
Common salt	2	2
Mineral mixture	3	4
Dolomite	2	2
Guar gum (binder)	1	-
*Parts per 100 kg finished material		

Feeding of MNM to goat: The feed requirement of small ruminants is mainly met out through extensive grazing on common lands, degraded pasture, road side etc. in arid regions, which often causes

Table 2. Economics of MNFB feeding to mulching bovine

Livestock	No. of animals	Average weekly daily milk yield			Total quantity of MNFB/ animal (@ 2 kg/ block)	Total Milk yield increased (Ltr.)	Total cost of input (8 Block /animal @ Rs.70)	Gross returns (@ Rs.40/ Kg cow milk Rs.50/kg buffalo milk)	Net profit	B:C Ratio
		Before feeding	During 12 weeks	Cumulative increase (%)						
Buffalo	7	10.5	10.93	4.1	16	248	3920	12400	8400	3.16
Cow	8	8.17	8.77	7.4	16	391	4480	15640	11160	3.49

deficiency of certain nutrients especially in the scarcity period. This deficiency of nutrients can be rectified through supplementation with vitamin-minerals mixture to the animals but the acceptability of vitamin-minerals mixture was poor in the animals due to the bad odour of organic compounds present in the minerals mixture. Therefore, there was need to seek alternative supplements to sustain the productivity of goats. Therefore, the vitamin-minerals mixture powder as MNM was formulated at Feed Technology Unit of CAZRI as mentioned in Table 1. The feeding trials of MNM were conducted on lactating goats at farmers' fields. A total of 10 goats of 10 farmers in villages were selected in 3 to 4 years age group. The MNM were offered to the animals @ 100g/day/goat after grazing time. It was observed that the mixture was palatable and accepted by goats. The daily milk yield of goats was recorded in 'Milk Record Index Card'. The average daily milk yield in first 10 days was 0.533 ltr (as control) which increased to 0.575 ltr (7.9 %) after 12 weeks of MNM feeding trial. The B:C ratio of this intervention was estimated to be 2.66 in goats. The effect of MNM supplementation on goats was recorded to be positive on milk and overall health of animals. Farmers responded that MNM supplemented animals graze for longer time in the pasture in comparison to non-supplemented animals. The intake of forage and water increased in treated group.

Distribution of MNFB to partner farmers

Feeding of MNFB to cow

2. Supplementary feeding to male kids in early age for higher body weight gain

The arid breeds of sheep and goats have genetic potential to gain higher body weight in active growth period which is pre-weaning age (0-3 month) and post weaning period from 3 to 6-month age. However, due to poor availability of feed resources and lack of awareness, farmers generally dispose the lambs/kids at early age just after 3 months for family income. Therefore, due to low body weight of animals, they get lower returns. For increasing the body weight of growing small ruminants, the intervention of balanced supplemented feed was given to five goat male kids of 25 farmers of the project villages. The 3 months old kids (after weaning) were taken under the feeding trial for a period of 2 months and a total of 125 animals were addressed. The body weight of animals was recorded before start of intervention and weekly after initiation of feeding.

Feeding of goat male kids with multi-nutrient mixture

The results revealed that feeding of supplementary feed to growing animals resulted into perceptible gain in body weight at the end of 8th week. At two months feeding of MNM, the sale price of animals was Rs. 6400/kid with a meagre cost of MNM Rs. 270/kid. The average weight gained in the MNM fed kids after 2 months was 5.3 kg/kid. Hence, after covering cost an additional return of Rs. 780/kid was obtained under improved nutrition through MNM (Table 3).

3. Azolla Production and feeding to milching cows

The feed requirement of livestock is traditionally met out through grazing with stall feeding of dry crop residues and very rarely the farmers can afford to provide sufficient quantity of concentrate feeds due to high cost. Azolla (*Azolla pinnata*), a floating water fern, is a potential unconventional fodder and valuable protein supplement for increasing milk production of cattle for the feed scarcity in arid regions. Azolla contains 16-20% crude pro-

Table 3. Economics of nutrient supplementation through Multi-Nutrient Mixture (MNM) in male kids of goat (effective sample size n=120)

S.N.	Particulars	Value
1	No. of households	25
2	No. of animals/household	5
3	Duration of trial	2 months (60 days)
4	Multi-nutrient mixture (MNM) dose	150 g/day/animal
5	Total MNM during trial	9 kg/kid
6	Cost of MNM feeding (@Rs. 30/kg)	Rs. 270/kid
7	Average weight of MNM fed kids after 2 months (aged 5-6 months)	21.6 kg/kid
8	Average sale price of MNM fed kids (aged 5-6 months)	Rs. 6400/kid
9	Average weight of non MNM fed (control) kids (aged 5-6 months) (n=20)	16.3 kg
10	Average sale price of control kids (aged 5-6 months)	Rs. 5350/kid
11	Net returns of MNM feeding (S.N. 8 - S.N. 6)	Rs. 6130/kid

Demonstration of Azolla production

Farmer Innovation

tein. Possibility of Azolla as a low cost green fodder feed ingredient was explored through an on-farm trial in farmer participatory mode. A total of 10 households were provided HDPE-Azolla Bed (10x4x1.5 feet; 370 GSM) with azolla seed inoculum. Partner farmers were also motivated for establishing kaccha Azolla unit by digging pits lined with synthetic polythene sheet. For this trial readymade units were established in courtyard / backyard preferably in open space with adequate sunlight. Detailed economics of azolla production is given in Table 4.

Once the bed was ready, it was filled with water leaving top 10 cm empty and about 15 kg of fine sieved soil and 5 kg of pre-decomposed (2 days) cow dung. Soil was distributed evenly across the bottom of the tank. The depth of soil layer should be about 10 cm. Cow dung is to be added @1.0 to 1.5 kg/m^2 of the tank area (20 to 30 kg of cow dung per tank). Single Super Phosphate (SSP) added @ 5.0g/m^2 of the tank area every week. Filled the tank with water till the water reached to a height of 10 to 15 cm above the soil. Allow the soil particle to settle down. Prepare the fresh Azolla inoculum by adding 2.0g of carbofuran to prevent pest infestation. On the following day, about 1.5 kg of mother culture of azolla seed material brought from azolla mother nursery was spread uniformly

Table 4. Economics of azolla production

Particulars		Cost/quantity
Cost of HDPE-Azolla Bed - (10x4x1.5 Ft)		Rs. 2100
Cost of *Kaccha* azolla pit (10x4x1.5 Ft)		Rs. 800
Nylon Shade net (50%)		Rs. 500
Azolla seed inoculum 1.5 kg @ Rs. 100/ kg		Rs. 150
Super phosphate 500 g		Rs. 50
Total Cost	HDPE azolla Bed	Rs. 2800
	Kaccha azolla bed	Rs. 1500
Life span	HDPE azolla Bed	4 Years
	Kaccha azolla bed	1 Year
Rationalized cost/batch (3 months)	HDPE azolla Bed	Rs. 233
	Kaccha azolla bed	Rs. 500
Yield/batch (3 months)		60 kg
Substitute feed concentrates (3 months)		60 kg
Cost of substituted oilcakes (@ Rs. 50/kg)/month		Rs. 1500
Additional milk yield with 1 kg concentrate substitution (12 lit for 3 months)		4 lit/month
Gross returns/ month (milk price @ Rs. 40/litre + cost saving of concentrate)		Rs. 1660 (4 x 40 +1500)

Table 5. Effect of feeding of azolla on milk yield of cow

Feeding trial (60 days)	No. of cows	Average milk yield (litres/ day/cow)	Total milk yield (litres/ animal)	Difference over control (litres)	% Change over control
Dry fodder + 2 kg concentrate (Control)	5	7.6	456	-	-
Dry fodder + 1 kg azolla (T1)	5	7.3	432	-18	-3.95
Dry fodder + 1 kg concentrate + 1 kg azolla (T2)	5	7.8	468	12	2.63

over the bed after stirring the water in the azolla bed. It took about 2 weeks for azolla to form a mat over the water surface. Water level in the azolla unit should be maintained and to reduce excessive ambient light, a shade net was laid above the azolla unit. A mixture made of cow dung, minerals mixture, soil and water was added weekly. After every 60-90 days depending upon season, soil was removed from the bed and another 15 kg of fresh fertile soil was added into the bed to avoid nitrogen build up and also provide nutrient to the azolla. At Harvesting azolla was thoroughly washed with fresh water to remove the dung smell. To avoid the detection of bad odor mustard oil can also be applied over the nostrils of animal.

As per table 5, the azolla fodder was fed to 10 lactating cows for 60 days at 1.0 kg fresh Azolla /day/cow with regular dry fodder and concentrates; in addition to 5 cows as control fed on dry fodder and concentrates. The substitution of azolla for 1 kg of concentrates resulted in 12% higher milk yield increase during 60 days. This resulted in Rs. 1500/month cost saving of concentrate. The rationalized cost of establishing and running azolla unit of 40 sqft for 3 months to produce 1 Kg azolla per day was around Rs. 233 for HDPE sheet azolla unit and Rs. 500 for Kaccha azolla pit. With this, the cow owner was getting an additional income of Rs. 1660/animal/month alongwith improved condition of animal health and reproductive performance.

Launch of web portal for faster bank settlements of interest subvention claims under Agriculture Infrastructure Fund Scheme and Krishi Katha blogsite to amplify the voice of Indian farmers

Dr. Shailesh Kumar Mishra

The Agriculture Infrastructure Fund scheme was launched in 2020, with the objective of development of post-harvest management infrastructure for reducing losses, realisation of better value to farmers, innovation in agriculture and attracting investments for creation of Agriculture infrastructure with a total outlay of 1 lakh crore funding through the banks and financial institutions upto 2025-26. The scheme provides 3% interest subvention to beneficiaries of the scheme for the loans given by banks upto 2 crore for a maximum period of 7 years, besides reimbursement of credit guarantee fee paid by banks.

Shri Shivraj Singh Chouhan, Union Minister for Agriculture and Farmers' Welfare and Rural Development launched a web portal to automate and speed up the process of settlement of interest subvention claims of banks submitted under the Agriculture Infrastructure Fund (AIF) developed jointly by the Department of Agriculture and Farmers' Welfare (DA&FW), Ministry of Agriculture & Farmers Welfare (MoA&FW) GoI and NABARD at Krishi Bhawan, New Delhi. Minister of State for Agriculture and Farmers' Welfare Shri Bhagirath Choudhary, Chairman, NABARD, senior officers of DA&FW and banks were present during the launch programme.

Addressing on this occasion, Union Minister Shri Shivraj Singh Chouhan said that government is committed to increase farmer's income taking various measures. He said Agriculture Infrastructure Fund was launched by PM Modi with 1 lakh crore funding in a bid to increase storage capacity for crops and reduce losses for farmers. He said the newly launched automation of credit claims will ensure timely settlement of claims within a day, which otherwise took months for manual settlement. He said the move will also ensure transparency and check corrupt methods. Union Minister said that the investments of worth 72,000 crore have been mobilised with 43,000 crore already sanctioned for 67,871 projects under Agriculture Infrastructure Fund. Additionally, banks can anticipate quicker settlement of interest subvention claims.

Shri Shivraj Singh Chouhan informed that the automated system would help in calculating accu-

rate eligible interest subvention through the portal avoiding the possible human error in manual processing and also help in faster settlement of the claims. The portal shall be used by banks, Central Project Management Unit (CPMU) of DA&FW and NABARD. The automation of the interest sub-

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vention claim and credit guarantee fee claim processing will help the government in releasing accurate interest subvention, reduce the turn-around time and in turn help the farmers and agrientrepreneurs financially and encourage them to take up more such projects for development of agriculture in the country.

Union Minister Shri Shivraj Singh Chouhan also launched Krishi Katha, a blogsite meant to serve as a digital platform to showcase the voice of the Indian farmers, dedicated for amplifying the experiences, insights and success stories of farmers across the country.Shri Chauhan said the new portal on sharing of farmers experience will enable the farming community to gain from each other's experiences. He said there are several farmers who are self-experimenting and their successful stories should be brought forward for others to emulate. Krishi Katha Blog is a New Initiative of Extension Division, Deptt. of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt of India, New Delhi.

Behind every crop, every field, and every harvest, lies a narrative of resilience, struggles, challenges and triumphs. "Krishi Katha" aims to provide a comprehensive and immersive storytelling space where the narratives of India's agricultural community can be shared and celebrated.

Union Minister highlighted that the launch of Krishi Katha is a significant move towards acknowledging and amplifying the voice of our farmers. He emphasized that their stories of resilience and innovation are the cornerstone of our agricultural sector and expressed confidence that this platform will serve as a wellspring of inspiration for others. The objectives behind this initiative will be helpful in raising awareness, facilitating exchange of knowledge, fostering collaboration and empowering farmers.

Union Agriculture Minister said that farmer voices highlighted on Krishi Katha show us how farmers have used innovative farming methods and benefited from different schemes of government to aid in their farming practices along with stories of the transformative power of community-driven farming. It aims to inspire and showcase the stories of the Indian farmer and foster a sense of pride in the farming profession and promote resilience among farmers.

Recognizing the resilience and innovation within the farming community, "Krishi Katha" seeks to provide a digital platform for sharing success stories and promoting collaborative learning

among farmers across the country. Union Agriculture Minister expressed optimism that this initiative will foster a deeper understanding of agricultural challenges and triumphs, inspiring future generations to innovate and excel in farming practices.

The launch of "Krishi Katha" aligns with the present government's vision of leveraging digital platforms to empower farmers, promote sustainable practices, and elevate the agricultural sector's contribution to India's economy. By showcasing the transformative journeys of farmers and encouraging knowledge exchange, this initiative aims to cultivate a sense of pride and resilience within India's farming community.

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