

FARMER'S HANDBOOK ON BASIC AGRICULTURE



**A holistic
perspective of
scientific
agriculture**

**A joint initiative to
impart farmers with
technical knowledge on
basic agriculture.**

Disclaimer:

The opinions expressed provided in this publication are those of the authors and do not necessarily reflect those of GIZ . The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of GIZ concerning the legal status of any country, territory, city or area, or concerning the delimitation of its frontiers or boundaries.

FARMER'S HANDBOOK ON BASIC AGRICULTURE

Prepared & compiled by

Dr. P. Chandra Shekara

National Institute of Agricultural Extension
Management (MANAGE)
Ministry of Agriculture, GoI
Hyderabad, Andhra Pradesh
India

Dr. N. Balasubramani

National Institute of Agricultural Extension
Management (MANAGE)
Ministry of Agriculture, GoI
Hyderabad, Andhra Pradesh
India

Dr. Rajeev Sharma

Dr. Chitra Shukla

Desai Fruits & Vegetables Pvt. Ltd.
Navsari, Gujarat
India

Dr. Ajit Kumar

Desai Fruits & Vegetables Pvt. Ltd.
Navsari, Gujarat
India

Bakul C. Chaudhary

Desai Fruits & Vegetables Pvt. Ltd.
Navsari, Gujarat
India

Mr. Max Baumann

Planning Officer
Section "Agricultural Production & Resource Use"
Division 45 - Rural Development and Agriculture
Deutsche Gesellschaft für Internationale Zusam-
menarbeit (GIZ) GmbH
Germany
Max.Baumann@giz.de

Financed by

Desai Fruits & Vegetables Pvt. Ltd.
Navsari, Gujarat, India

German Federal Ministry for Economic Cooperation
and Development (BMZ)

Published by

Desai Fruits & Vegetables Pvt. Ltd.
Navsari, Gujarat
India

Second Edition: August 2016

The Authors acknowledge the contribution of following experts/professionals in developing the Handbook.

Mr. Max Baumann, Planning Officer, GIZ, Germany

Mr. Fredrick Oberthur, Planning Officer, GIZ, Germany

Mr. Ajit Kumar Desai, Chairman, DFV, Navsari, Gujarat

Dr. Sashidhar, Professor, University of Agriculture and Horticultural Sciences, Shimoga, Karnataka

Dr. Syed Ahmed Hussain, Professor, ANGRAU, Hyderabad, Telangana

Mr. V.Gunasekaran, Agricultural Officer, Pesticide Testing Laboratory, Dharmapuri, Tamilnadu

Dr. M.V.Shantharam, Former Dean, ANGRAU, Hyderabad, Telangana

Dr. K. Kareemulla, Principal Scientist, NAARM, Hyderabad, Telangana

Dr. K.V. Jayaraghavendra Rao, Principal Scientist, NAARM, Hyderabad, Telangana

Mr. Thomas A Vivian, Assistant Professor, College of Agriculture, Dhule, Maharashtra

Prof. T. M. Bahale, Professor of Agronomy, College of Agriculture, Dhule, Maharashtra

Dr. R. K Rahane, Professor of Agricultural Economics, College of Agriculture, Dhule, Maharashtra

Dr. G. D. Patil, Professor of Soil Science & Agricultural Chemistry, College of Agriculture, Dhule, Maharashtra

Dr. D. N. Padule, Professor of Plant Pathology, College of Agriculture, Dhule, Maharashtra

Dr. A. R. Pathak, Vice Chancellor, Navsari Agricultural University, Navsari, Gujarat

Dr. J. B. Patel, Professor, Anand Agricultural University, Anand, Gujarat

Dr. Bhaskar Gaikwad, Programme, Coordinator, KVK, Babhaleshwar, Maharashtra

Mr. Mahendra Dhaibar, CEO, Sustainable Agricultural Development Foundation, Pune, Maharashtra

Dr. R. M. Pankhaniya, Associate Professor, Department of Agronomy, NM College of Agriculture, Navsari Agricultural University, Navsari, Gujarat

Dr A. M. Bafna, Principal & Dean, Aspee Agri-Business Management Institute, Navsari Agricultural University, Navsari, Gujarat

Dr G. G. Radadia, Professor & Head, Department of Entomology, NM College of Agriculture, Navsari Agricultural University, Navsari, Gujarat

Dr B. P. Mehta, Professor, Department of Plant Pathology, Aspee College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat

Dr. L. J. Desai, Associate Professor, Department of Agronomy, NM College of Agriculture Navsari Agricultural University, Navsari, Gujarat

Dr. N. S. Manohar, Associate Professor, Department of Agricultural Economics, Aspee College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat

Dr O P Sharma, Associate Professor & Head, Department of Extension Education, College of Veterinary Science & AH, Navsari Agricultural University, Navsari, Gujarat

Dr. Bruno Schuler, Advisor and Planning Officer, Sustainable Agriculture-Rural Development, GIZ, Germany

Mr. Rajiv Ahuja, Technical Expert, Natural Resource Management, GIZ, India

Mr. Akhil Dev, Junior Technical Expert, Natural Resource Management, GIZ, India

Acknowledgement

Higher demand for agricultural raw material is now anticipated and agriculture is not any more about producing farm products and selling them exclusively at the local market. Instead farmers today have a world market to serve. But the new chances bring new challenges. Farmers and agricultural enterprises, willing to be part of the new expanding world market, not only have to take into consideration customers' preferences whom they want to serve, but also adhere to international trade regulations set by WTO and comply with high production and quality standards required by the importing countries.

Agriculture contributes around 17% to GDP and continues to be among the most important and successful sectors in India. Around 58% of the Indian population depend on agriculture for their livelihood. Apart from delivering the local industries with top quality raw materials for processing, agriculture provides almost 10% of total export earnings. However, to support the impressive Indian economic growth in the coming years, agriculture will have to contribute more towards value addition, productivity enhancement, high quality products and trained manpower to successfully tackle these challenges.

The states of Gujarat and Maharashtra have competitive advantages for the production of several commodities. However, productivity and competitiveness remains low. Rising quality requirements of export and domestic markets require an up-scaling of the production which is only feasible with educated farmers and skilled workers.

Desai Fruits and Vegetables (DFV) in cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) takes up the existing education gap by implementing a development partnership called "Partnership Farming India".

The goal of Partnership Farming India (PFI) is to enable farmers to be self-sufficient decision-makers, "agripreneurs", which allows for a more flexible production system and highlights farming as profession by choice and not by inheritance.

Furthermore, PFI strengthens farmers' and farm workers' management skills to adopt modern agricultural practices and concepts and enhance the international competitiveness of smallholders' agricultural produce by giving farmers and workers in Gujarat and Maharashtra access to practical agricultural education. Therefore, DFV and GIZ in close cooperation with the National Institute of Agricultural Extension Management (MANAGE, an organization of Ministry of Agriculture, Government of India) developed the training material on basic agricultural knowledge and skills.

The states of Gujarat and Maharashtra will serve as an example on how to establish long term successful and trustful business relationships by combining small scale production in the field with large scale processing and marketing. I am confident that this effort will serve the Indian agriculture as a replicable model make lasting contributions towards sustainable agriculture and prosperous farmers.

I would like to express my sincere gratitude to the people and institutions namely MANAGE, DFV and GIZ, which supported this project and enabled making information available. This is a useful source of information for farmers, trainers, and other interested persons to improve not only the agriculture but also the livelihood of the farming community.

Mrs. Sabine Preuss
GIZ-India Programme Director
Natural Resource Management

Preface

Agriculture is an important sector of Indian Economy as more than half of its population relies on Agriculture as principle source of income. Research and Extension systems play major role in generation and dissemination of Agricultural technologies aiming at enhancing the income of farmers. The extension system adopts series of extension methods such as Training, demonstration, exposure visit to transfer the technologies from lab to land. Majority of these extension efforts mainly focus on location and crop specific technologies, and mostly on solution to problem basis. However, there is a need for equipping the farmers with Basic knowledge of Agriculture in order to create a better knowledge platform at farmer level for taking appropriate farm management decisions and to absorb modern technologies.

In view of this, Desai Fruits and Vegetables Pvt. Ltd. (DFV), India, in cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) in close cooperation with National Institute of Agricultural Extension Management (MANAGE- An Organization of Ministry of Agriculture, Government of India) brought out Farmer's Handbook on Basic Agriculture to impart technical knowledge on Basic Agriculture to farmers to provide holistic perspective of scientific Agriculture.

This handbook is a product of series of brainstorming workshops and consultative meetings with various stakeholders such as Researchers, Academicians, Extension Functionaries, Agripreneurs, Master Trainers and Farmers. Based on the identified needs, the topics were prioritized and contents were developed with the help of experts. The farmer-friendly content has been written in simple language, using more pictures with practical examples for the benefit of farmers.

The book contains six chapters, each focusing on a particular topic. The first chapter, "General conditions for cultivation of crops", talks about the basic needs of farmers and farming sector, by providing basic knowledge on Good Agricultural Practices (GAP), enhancing the awareness of farmers on critical factors in selection of crops and cropping patterns, judicious use of natural resources such as soil and water, and emphasizing the importance of mechanization in the field of agriculture.

The second chapter "Soil and Plant Nutrition" is aimed at increasing the awareness and understanding of farmers about soil, its structure, physical, chemical, biological properties, soil fertility and managing the soil fertility in an economically and environmentally sustainable manner. It also focuses on the need for soil testing, plant nutrition requirement, organic & inorganic fertilizers, and Integrated Nutrient Management (INM) for efficient, economic and sustainable production of crops.

The third chapter of the book is about Pest Management, and focuses on enhancing the awareness of and understanding among farmers about the crop pests, diseases and weed management through Integrated Pest Management. It also aims at sensitizing farmers on safe handling of chemicals and plant protection equipments as also elaborated further in the fifth chapter on "Occupational health and safety of farmers". It creates awareness about causes, preventive measures of health hazards, risks & fatalities in agriculture, and use of first aid in emergencies. It further includes safety tips and care to reduce the risk of injuries and fatalities while handling machineries and pesticides by farmers.

Time and resources management is an integral part of each and every activity, be it service sector, business or day-to-day activities of life. Farming sector too has not remained untouched by it. Therefore, the fourth chapter of the book is devoted to "Farm Management". It is to educate and equip the farmers to make proper plans, take appropriate decisions and also to take advantage of the improved technologies to increase production, assure food security for the family and market opportunities to increase income considering available resources, anticipated risks, including market fluctuations.

"Farmer's access to services", the last chapter of the book, aims at enhancing awareness among farmers about sources of extension, information and services, public and private extension services, agricultural credit, insurance and legal aspects through Information & Communication Technologies. The content is useful not only for farmers but also for other stakeholders involved in farm advisory services such as Agri input dealers, Agripreneurs, Kisan Call Centers and extension functionaries working at grass roots level.

We trust that this Handbook will benefit maximum number of farmers to make farming economically and environmentally more sustainable.

B. Srinivas, IAS
Director General
MANAGE

Contents

1.	General Conditions for Cultivation of Crops	1-32
2.	Soil and Plant Nutrition	33-70
3.	Plant Protection	71-96
4.	Categories of Pesticides and Precautions	97-98
5.	Farm Management	99-120
6.	Occupational Health and Safety	121-130
7.	Farmer's Access to Service	131-136

1. General Conditions for Cultivation of Crops

1.1. Objectives of the session

- To enhance awareness of farmers on critical factors in selection of crops and cropping patterns.
- To create an understanding on judicious use of natural resources such as soil and water.
- To provide basic knowledge on seed and cropping systems.
- To emphasize the importance of mechanization.
- To sensitize the farmers on Good Agricultural Practices (GAP).

1.2. What do we know at the end of the session

- Critical factors in selection of crops and cropping patterns
- Judicious use of natural resources such as soil and water
- Basic knowledge on seed
- Cropping systems
- Mechanization
- Good Agricultural Practices (GAP)

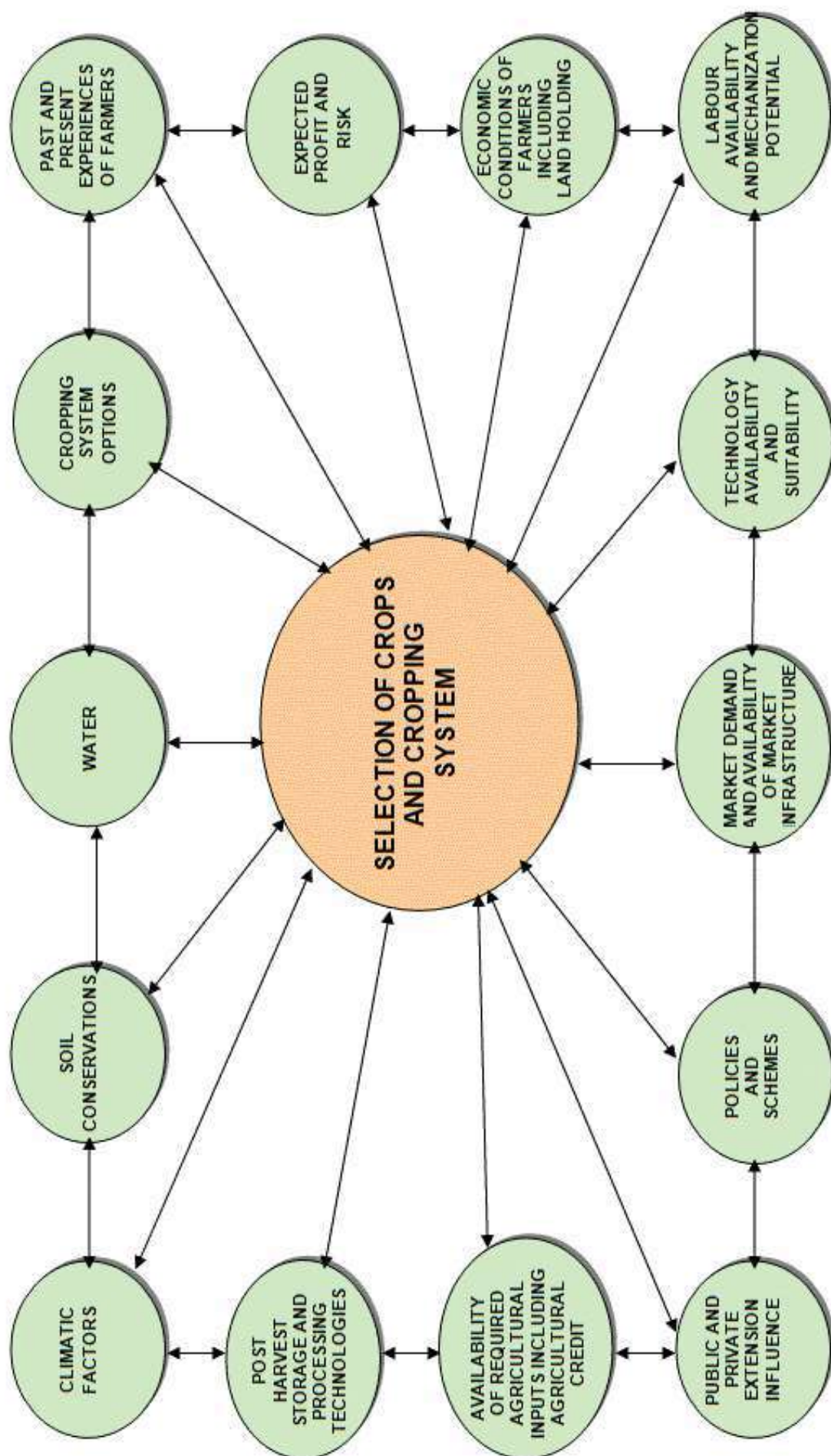
Agricultural Universities, Research Institutes, Krishi Vigyan Kendras have been generating ample technologies to improve the productivity and profitability of the farmers. How many of these technologies are reaching the farmers? Baseline Situation Assessment conducted by Partnership farming in India, in Gujarat and Maharashtra, clearly indicated that farmers with access to technical knowledge on agriculture realized better income compared to others. Fifty one percent of sample farmers who were part of partnership farming India had knowledge of soil testing compared to only 28% of control group. Mulching and intercropping as a practice were not widely adopted by control group of farmers. They were less aware about other organic fertilizers. Fertigation as a method of application of fertilizers was not widely practiced by control group. Farmers who accessed information from agricultural universities and magazines were less in number in the control group. The treatment farmers had an average yield of 35.65 tons and control farmers had yield of 22.36 tons of banana per acre. The average net income of the treatment farmers was Rs 93,822 and for the control farmers Rs.81,659. More than 85% of the farmers wanted basic education on agriculture and crop production and ready to pay for undergoing such basic education and training. There was a clear interest in the farmers to improve their skill and knowledge and they were ready to pay for the service.

The above study clearly indicates that the knowledge gap is prevailing among farmers and those who have access to knowledge harvested better profits.

Increase in productivity and profitability can be achieved through:

- Blending practical knowledge with scientific technologies
- Efficient use of natural resources
- Adopting time specific management practices
- Giving priority for quality driven production
- Adopting suitable farming systems
- Adoption of location specific technology
- Market demand driven production
- Adopting low cost and no cost technologies

Factors influencing decisions on the selection of crops and cropping system



1.3. Factors influencing decisions on the selection of crops and cropping system

Climatic factors

Is the crop/cropping system suitable for local weather parameters such as temperature, rainfall, sun shine hours, relative humidity, wind velocity, wind direction, seasons and agro-ecological situations?

Soil conditions

Is the crop/cropping system suitable for local soil type, pH and soil fertility?

Water

- Do you have adequate water source like a tanks, wells, dams, etc.?
- Do you receive adequate rainfall?
- Is the distribution of rainfall suitable to grow identified crops?
- Is the water quality suitable?
- Is electricity available for lifting the water?
- Do you have pump sets, micro irrigation systems?

Cropping system options

- Do you have the opportunity to go for inter-cropping, mixed cropping, multi-storeyed cropping, relay cropping, crop rotation, etc.?
- Do you have the knowledge on cropping systems management?

Past and present experiences of farmers

- What were your previous experiences with regard to the crop/cropping systems that you are planning to choose?
- What is the opinion of your friends, relatives and neighbours on proposed crop/cropping systems?

Expected profit and risk

- How much profit are you expecting from the proposed crop/cropping system?
- Whether this profit is better than the existing crop/cropping system?

- What are the risks you are anticipating in the proposed crop/cropping system?
- Do you have the solution? Can you manage the risks?
- Is it worth to take the risks for anticipated profits?

Economic conditions of farmers including land holding

- Are the proposed crop/cropping systems suitable for your size of land holding?
- Are your financial resources adequate to manage the proposed crop/cropping system?
- If not, can you mobilize financial resources through alternative routes?

Labour availability and mechanization potential

- Can you manage the proposed crop/cropping system through your family labour?
- If not, do you have adequate labours to manage the same?
- Is family/hired labour equipped to handle the proposed crop/cropping system?
- Are there any mechanization options to substitute the labour?
- Is machinery available? Affordable? Cost effective?
- Is family/hired labour equipped to handle the machinery?

Technology availability and suitability

- Is the proposed crop/cropping system suitable?
- Do you have technologies for the proposed crop/cropping system?
- Do you have extension access to get the technologies?
- Are technologies economically feasible and technically viable?
- Are technologies complex or user-friendly?

Market demand and availability of market infrastructure

- Are the crops proposed in market demand?
- Do you have market infrastructure to sell your produce?
- Do you have organized marketing system to reduce the intermediaries?
- Do you have answers for questions such as

where to sell? When to sell? Whom to sell to?
What form to sell in? What price to sell for?

- Do you get real time market information and market intelligence on proposed crops?

Policies and schemes

- Do Government policies favour your crops?
- Is there any existing scheme which incentivises your crop?
- Are you eligible to avail those benefits?

Public and private extension influence

Do you have access to Agricultural Technology Management Agency (ATMA)/ Departmental extension functionaries to get advisory?

- Do you know Kissan Call Center?
- Do you have access to KVKs, Agricultural Universities and ICAR organizations?
- Do you subscribe agricultural magazines?
- Do you read agricultural articles in newspapers?
- Do you get any support from input dealers, Agribusiness Companies, NGOs, Agriclincs and Agribusiness Centers?

Availability of required agricultural inputs including agricultural credit

- Do you get adequate agricultural inputs such as seeds, fertilizers, pesticides, and implements in time?
- Do you have access to institutional credit?

Post harvest storage and processing technologies

- Do you have your own storage facility?
- If not, do you have access to such facility?
- Do you have access to primary processing facility?
- Do you know technologies for value addition of your crop?
- Do you have market linkage for value added products?
- Are you aware about required quality standards of value added products of proposed crops?

Farmers need to answer all the above questions while making decisions for choosing a crop/cropping pattern. During this decision making process, farmer cross check the suitability of proposed

crop/cropping systems with his existing resources and other conditions. Thereby, they justify choosing or rejecting a crop/cropping systems. This process enables the farmers to undertake a SWOT analysis internally which in turn guides them to take an appropriate decision.

1.4. Climatic factors

Climate and agriculture

- Monsoon is a key source of water in agriculture
- Most of our rivers are seasonal fed by the monsoon; even irrigated agriculture depends on monsoon.
- Cropping pattern has evolved over years based on climate.
- Market forces influence cropping patterns in recent times.

Climatic factors and crops

- Rainfall drives water availability and determines sowing time (rainfed crops).
- Temperature drives crop growth, duration and influences milk production in animals.
- Temperature and relative humidity influence pest and diseases incidence on crops, livestock and poultry.
- Wet and dry spells cause significant impact on standing crops, physiology, loss of economic products (e.g. fruit drop).
- Extreme events (e.g. high rainfall, floods, heat / cold wave, cyclone, hail, frost) cause enormous losses of standing crops, livestock and fisheries.

Climate and seasons

- Rainy (June-September) season also known as Kharif, supports most of the rainfed crops (coarse cereals, pulses, oilseeds, etc.).
- Post-rainy (October-February) season also known as Rabi, supports the irrigated or stored moisture grown crops (wheat, mustard, chickpea, etc.).
- Summer season (March-May) supports short duration pulses and vegetables.
- Rabi production is more assured, has a higher yield and reduces pest and disease related problems.
- Over time, with irrigation development, the contribution of Kharif is declining and Rabi is increasing.

Climate, cropping pattern and agricultural production issues

- Cropping patterns based on climate and land capability are sustainable but market forces and farmers' aspirations are forcing unsustainable systems.
- Farmers must innovate in producing more even from less endowed areas by adopting suitable technologies to cope with changing climate.
- Climate change will likely to cause further problems in our crop production and is likely to become the most important environmental issue in the 21st century.

Important agricultural related factors responsible for climate change

- Deforestation and forest degradation
- Burning of fuel and farm waste
- Water logged condition
- Excessive use of external input
- Large-scale conversion of land for non-agricultural purpose

Impact of climate change in India

- **Rainfall:** No long-term trend noted. However, regional variations seen, increased summer rainfall and less number of rainy days.
- **Temperature:** About 0.6 °C rise in surface temperature during 100 years. Projected to increase 3.5 to 5 °C by 2100.
- **Carbon dioxide:** Increasing at the rate of 1.9 ppm per year and expected to reach 550 ppm by 2050 and 700 ppm by 2100.
- **Extreme events:** Increased frequency of heat wave, cold wave, droughts and floods observed during last decade.
- **Rising sea level:** Rise of 2.5 mm/year since 1950.
- **Glaciers:** Rapid melting of the glaciers in the Himalayas.
- **Rainfall distribution:** Shift in peak rainfall distribution also noticed in some parts of country.

Expected impact of climate change on agriculture

- Due to increase in temperature, crop may require more water.
- Yield may be reduced in cereal crops especially in Rabi; i.e. wheat.



Impact of Drought



Impact of Flood



Heat Wave on Maize



Cold wave damage to chana harvest

Change in pest and disease scenario due to climate change

- **Due to increase in rainfall:** Pests like bollworm, red hairy caterpillar and leaf spot diseases may increase. Due to increase in temperature: Sucking pests such as mites and leaf miner may increase.
- **Due to variation in rainfall and temperature:** Pest and diseases of crops to be altered because of more enhanced pathogen and vector development, rapid pathogen transmission and increased host susceptibility. Sometimes a minor pest may become a major pest.
- Agricultural biodiversity is also threatened by decreased rainfall and increased temperature, sea level rise and increased frequency and severity of drought, cyclone and flood. Quality of farm products such as fruits, vegetables, tea, coffee, aromatic and medicinal plants may be affected.

Water

- Demand for irrigation to increase with increased temperature and higher amount of evapo-transpiration. This may result in lowering of groundwater table at some places.
- The melting of glaciers in the Himalayas will increase water availability in the Ganga, Brahmaputra and their tributaries in the short-run but in the long-run the availability of water will decrease considerably.
- A significant increase in runoff is projected in the rainy season, however, may not be very beneficial unless storage infrastructure could be vastly expanded. This extra water in the rainy season, on the other hand, may lead to increase in frequency and duration of floods.
- The water balance in different parts of India will be disturbed and the quality of ground water along coastal track will be more affected due to intrusion of sea water.

Soil

- Organic matter content, which is already quite low in Indian soil, would become even lower. Quality of soil organic matter may be affected.
- Reduction in rate of decomposition and nutrient supply.
- Increase in soil temperature may reduce Nitrogen availability due to volatilization and denitrification.

- Change in rainfall volume and frequency as well as wind may alter the severity, frequency and extent of soil erosion.
- Rise in sea level may lead to salt water entry in the coastal lands turning them less suitable for conventional agriculture.

Livestock

- Affect feed production and nutrition of livestock. Increased temperature would reduce digestibility. Increased water scarcity would also decrease the food and fodder production.
- Major impacts on vector-borne diseases through expansion of vector populations during rainy years, leading to large outbreaks of diseases.
- Increase water, shelter, and energy requirement of livestock for meeting projected milk demands.
- Climate change is likely to aggravate heat stress in dairy animals, adversely affecting their reproductive performance.

Fishery

- Increased sea and river water temperature is likely to affect fish breeding, migration and harvest.
- Impacts of increased temperature and tropical cyclonic activity would affect capture, production and marketing costs of the marine fish.

Coping options for farmers

Access to information

- Progressive Farmers
- ATMA extension functionaries – Block Technology Manager, SMS, farmer friend, Farm School
- Trained input dealers
- Agri Clinics and Agribusiness Centers
- KVK
- Agricultural Research Stations
- Agricultural Universities
- ICAR Organisations
- Kissan Call Centers (Toll free no.1551 or 1800 – 180 – 1551)
- Concerned NGOs
- Agribusiness Companies
- Radio, TV, Agricultural Magazines, Community Radio, Newspapers, Agricultural Websites etc.

Coping options for farmers



Enlarging the Food Basket

- Diversifying the livelihood sources.
- Changing cropping patterns.
- Increased traditional coping strategies.
- Change to a mixed cropping pattern.

E.g: Crop Mixture-Nutri Millets, Pulses and Oilseed

Integrated Farming System

- Increased share of non-agricultural activities

E.g: Type of Integrated Farming Systems

Agriculture +vegetable cultivation

Agriculture + animal husbandry



Neem, Mulberry & Cowpea

- Planting more drought tolerant crops and increased agro-forestry practices.
- Agro-forestry systems to provide more stable incomes during years of extreme weather events.

Mango, Pumpkin, maize mixed cropping



Mixed farming/Multi level farming

Coping options for farmers continued....



Lucerne & Sunhemp for green manuring & fodder

Farm Pond



Conservation Furrow

- Improved on-farm soil & water conservation.
- Adopting scientific water management, nutrient management and cultural practices.

Vegetative Barriers



Percolation Tanks

Coping options for farmers continued....



Contour trenching for runoff collection

Conventional Raised Bed Planting

- 20-25% Saving in irrigation water



Shelterbelts

- Shelterbelts reduce wind velocity.
- Moderate temperature.
- Reduce evaporative loss and conserve soil moisture.

Straw Thatching

- Protecting young seedlings against cold by covering with straw thatching.



Frost Protection

1.5. Soil and Water Conservation

Soil and water are our precious heritage. Hence, it is obligatory on our part to protect and hand over these resources to further generations. It is estimated that about 50% of the cultivated area in India suffers from severe soil erosion and requires remedial measures.

- Water resources are essential for increasing and stabilizing crop production.
- Wind erosion has been responsible for destroying the valuable top soil.

1.5.1. Degradation of soil and water takes place with water and wind erosion

- The main cause of water erosion is unmanaged runoff.
- Runoff is the portion of the rainfall or irrigation water applied which leaves a field either as surface or as subsurface flow.

Several factors are responsible for runoff

- **Climatic factors:** Precipitation characteristics - duration, intensity, distribution, direction, temperature, humidity, wind velocity.
- **Watershed characteristics:** Geological shape of the catchments, size and shape of the catchments, topography, drainage pattern.
- **Barren land without vegetation**
- **Soil types:**
 - **Sandy soil:** Average rain – no problem of erosion. High intensity – More serious of less binding material i.e. fine soil particle.
 - **Clay soil:** Ordinary rain – more runoff in moderate and steep slopes but high water holding capacity.
 - **Silt loam, loamy and fine sandy loam:** More desirable soils from the point of view of minimizing soil erosion.

How vegetation reduces runoff

- Interception of rainfall
- Root structure
- Biological influences
- Transpiration effects
- Intercept, absorb the impact of raindrop
- Hindrance to runoff water slows down the rate at which travels down the slope
- Knitting and binding effect aggregates the soil

into granules

- Die and decay increase pore space and water holding capacity
- One cubic meter of soil has several kilometres of root fibre
- More vegetative cover, most active soil fauna, channels of earth worm, beetles and other life
- Vegetation increases the storage capacity of the soil for rainfall by the transpiration of large quantities of moistures from the soil

Soil erosion

Soil erosion is the detachment and transportation of soil material from one place to another through the action of wind, water in motion or by the hitting action of the rain drops.

- When the vegetation is removed and land is put under cultivation the natural equilibrium between soil building and soil removal is disturbed.
- The removal of surface soil takes place at a much faster rate than it can be built up by the soil forming process.

Erosion by water: Known as water erosion, is the removal of soil from the lands surface by water in motion.

Sheet erosion: The removal of a thin relatively uniform layer of soil particles by the action of rainfall and runoff.

- Extremely harmful
- Usually so slow that the farmer is not conscious of its existence
- Common on lands having a gentle uniform slope
- Results in the uniform removal of the cream of the top soil with every heavy rain
- Shallow top soil overlies a tight sub soil are most susceptible to sheet erosion
- Movement of soil by rain drop splash is the primary cause of sheet erosion
- Sheet erosion has damaged millions of hectares of slopping land throughout the India

Rill erosion is the removal of soil by running water with the formation of shallow channels that can be smoothed out completely by normal cultivation.

- There is no sharp lines of demarcation where sheet erosion and rill erosion begins but rill erosion is more readily apparent than sheet erosion.



Sheet and Rill Erosion



Gully Erosion



Landslide



Shelterbelts for Moderating microclimate

- Rills develop when there is a concentration of runoff water which, if neglected, grow into large gullies.
- More serious in soils having a loose shallow top soil.
- Transition stage between sheet erosion and gullying.

Gully erosion: Removal of soil by running water with the formation of channels that cannot be smoothed out completely by cultivation.

- Advance stage of rill erosion.
- Any concentration of surface runoff is a potential source of gullying.
- Cattle paths, cart tracks, dead furrows, tillage furrows or other small depression down a slope favour concentration of flow.
- Unattended rills deepen and widen every year and begin to attain the form of gullies.
- Unattended gullies may result over a few years for an entire landscape to be filled with a network of gullies.
- More spectacular than other type of erosions.

Stream channel erosion: Erosion caused by stream flow.

- Closely resembles rill erosion.
- Intensive channel erosion areas are on the outside of lands where flow shear stresses are high.

Mass movement: Enmass movement of soil.

- Landslides, land slips, soil and mudflows are various forms of mass movement.

Wind erosion: Movement of soil particles is caused by wind force exerted against or parallel to surface of the ground.

1.5.2. Conservation

Conservation is the utilization without wastage of resources is required to ensure a high level of production.

Important soil conservation measures are

- Conservation Tillage
- Minimum tillage
- Zero tillage
- Stubble mulching
- Trash farming

Conservation farming

- Farming across the slope
- Strip cropping
- Rotations
- Mixed cropping and intercropping
- Surface mulching
- Timely farm operations
- Improved water user efficiency
- Land levelling
- Providing safe drainage
- Intermittent terraces
- Growing vegetation on the bunds

Vegetation and vegetative management

- Strip cropping
- Stubble mulching
- Mulching

Wind erosion management

- Protect the soil surface with a cover of vegetation or vegetative residues.
- Produce or bring to the surface soil aggregates or clods which are large enough to resist the wind force.
- Roughen the land surface to reduce wind velocity and trap drifting soil.
- Establish barriers or trap strips at intervals to reduce wind velocity and soil drifting.

Best practices to control soil blowing

- Deep ploughing
- Summer ploughing
- Surface roughness
- Conserving moisture
- Wind breaks and shelterbelts
- Mechanical or vegetative barriers

For instance: Shelterbelts for moderating micro-climate

- Shelterbelts reduce wind velocity
- Moderate temperature
- Reduce evaporative loss and conserve soil moisture

Water erosion can be managed by

- In situ water harvesting
- Summer ploughing

Overland flow management

- Contour bund
- Graded bund
- Broad based bund

- Bench terrace
- Water harvesting and recycling

Zero tillage

- Several practices are in use such as zero tillage, minimum tillage and direct seeding.
- Planting crops in previously untilled soil by opening a narrow slot, trench or band only of sufficient width and depth to obtain seed coverage. No other soil tillage is done.

Advantages of zero tillage farming

- Erosion control: Retained stubble and crop residue reduces soil erosion and enhances soil fertility
- Moisture conservation: Stubble traps water, reduce runoff water, better infiltration leading to improved soil moisture condition
- Higher nitrogen availability
- Seedling protection: Stubbles protect young seedling from wind and heat
- Crop yields will be on par with traditional tillage system. However good yield can be harvested during dry years
- Reduce labour and save time
- Savings on equipment cost
- Savings on oil/fuel cost

Mulching: Benefits of crop residue mulching are

- Increased availability of water and organic matter
- Less erosion
- Environment protection

Additional benefit to farmers

- Less drought susceptibility
- Improved soil quality and fertilizer efficiency
- Minimises long term dependency on external inputs

1.6. Irrigation

An adequate water supply is important for plant growth. When rainfall is not sufficient, the plants must receive additional water from irrigation.

Points consider for irrigation decisions

- Land suitability for irrigation like slope
- Effective rainfall: Part of the total rain is useful for crop production
- When to irrigate: Decide based on soil, crop and climatic condition
- How much to irrigate: Decide based on crop water requirement
- How to irrigate: Select appropriate method for irrigation
- Quality of irrigation water

1.6.1. Various methods can be used to supply irrigation water to the plants

- Surface irrigation:
 - Basin irrigation
 - Furrow irrigation
- Sprinkler irrigation
- Drip irrigation

Surface Irrigation

Surface irrigation is the application of water by gravity flow to the surface of the field.

- Either the entire field is flooded (Basin Irrigation) or the water is fed into small channels (furrows) or strips of land (borders).

Basin Irrigation

- Basins are flat areas of land, surrounded by low bunds.
- The bunds prevent the water from flowing to the adjacent fields.
- Basin irrigation is commonly used for rice grown on flat lands or in terraces on hill-sides. Paddy grows best when its roots are submerged in water. Hence, basin irrigation is the best method to use for this kind of crop.
- Trees can also be grown in basins, where one tree is usually located in the middle of a small basin.
- In general, the basin method is suitable for crops that are not affected by standing in

water for longer periods.

- Basin irrigation is suitable for many field crops.
- Crops suitable for basin irrigation include pastures, citrus, banana and crops that are broadcasted such as cereals and to some extent row crops such as tobacco.
- Basin irrigation is generally not suited to crops, which cannot stand in wet or water-logged conditions for periods longer than 24 hours; eg: potatoes, beet root and carrots
- The flatter the land surface, the easier it is to construct basins.
- It is also possible to construct basins on sloping land, even when the slope is quite steep. Level basins, called terraces, can be constructed like the steps of a staircase.
- Soils suitable for basin irrigation depend on the crop grown.

Basin should be small if the:

- Slope of the land is steep
- Soil is sandy
- Stream size to the basin is small
- Required depth of the irrigation application is small
- Field preparation is done by hand or animal power

Basin can be large if the:

- Slope of the land is gentle or flat
- Soil is clay
- Stream size to the basin is large
- Required depth of the irrigation application is large
- Field preparation is mechanized
- The land slope, the soil type, the available stream size, the required depth of the irrigation application and farming practices mainly determine the shape and size of basins
- If the land slope is steep, the basin should be narrow; otherwise too much earth movement will be needed to obtain level basins.
- Three other factors, which may affect basin width, are depth of fertile soil, method of basin construction, agricultural practices.
- **There are two methods to supply irrigation water to basins:** (i) The direct method: Irrigation water is led directly from the field channel into the basin through siphons,

or bund breaks. (ii) The cascade method: irrigation water is supplied to the highest terrace, and then allowed to flow to a lower terrace and so on.

Maintenance of basins

- Bunds are susceptible to erosion. This may be caused by, for example, rainfall, flood or the passing of people when used as foot-paths.
- Rats may dig holes in the sides of the bunds.
- Therefore, it is important to check the bunds regularly, notice defects and repair them instantly, before greater damage is done.

Advantages of basin irrigation

- Conservation of rainfall and reduction in soil erosion.
- High water application and distribution efficiencies.
- Useful in leaching of salts.
- Suitable to all close growing crops, row crops and orchards.



Basin Irrigation

Furrow irrigation

- Furrows are small channels, which carry water down the land slope between the crop rows.
- Water infiltrates into the soil as it moves along the slope.
- The crop is usually grown on the ridges between the furrows.
- This method is suitable for all row crops and for crops that cannot stand in water for long periods. Crops such as maize, sunflower, sugarcane, and soybean can be irrigated by furrow irrigation.
- Crops that would be damaged by inundation, such as tomatoes, vegetables, potatoes, beans; fruit trees like citrus and grape as well as broadcasted crops like wheat.

- Irrigation water flows from the field channel into the furrows by opening up the bank of the channel or by means of siphons or spiles.
- Furrows must be on consonance with the slope, soil type, stream size, irrigation depth, cultivation practice and field length.
- Uniform flat or gentle slopes are preferred for furrow irrigation.
- On undulating land, furrows should follow the land contours.

Advantages of furrow irrigation

- Suitable for row crops and vegetables.
- Suitable for soils in which the infiltration rates vary between 0.5 and 2.5 cm/hr.
- Ideal for slopes varying from 0.2 to 0.5 per cent and a stream size of 1-2 liters/sec.
- In areas requiring surface drainage or prone to temporary water logging, furrows are very effective.
- In areas where water for irrigation purposes is scarce, the practice of alternate or skip furrow irrigation can save considerable quantity of water without significantly affecting yields.



Furrow Irrigation

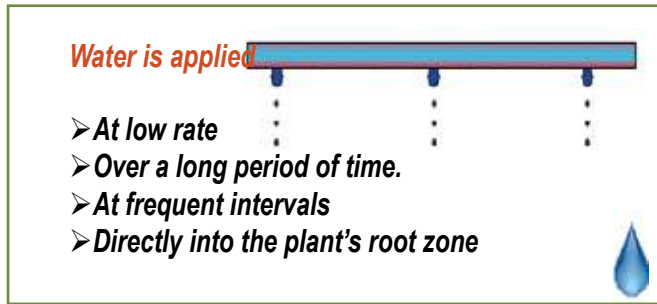
Sprinkler irrigation

Water is pumped through a pipe system and then sprayed onto the crops through sprinkler heads.

Advantages

- Water conservation
- Soil conservation
- Efficient use of water
- Saving of labour
- Early seed germination
- Fertigation
- Soil amendments
- Frost protection

- Cooling of crops
- Higher productivity of crops



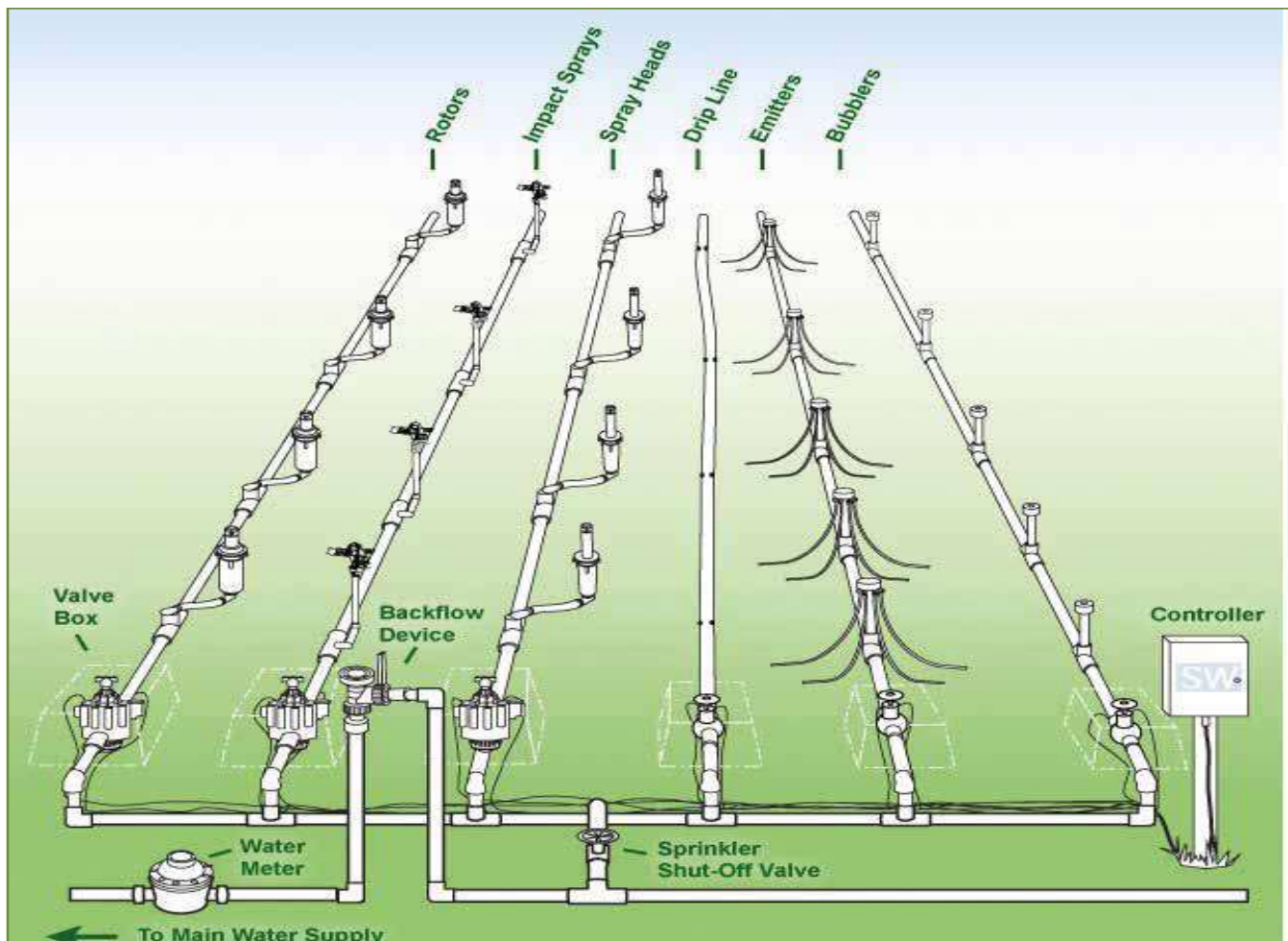
Drip Irrigation

Use of Sprinklers for different crops

Crop Type	Crop Example
Cereals	Maize, Sorghum, Wheat, Jowar
Flowers	Carnation, Jasmine, Marigold
Oilseeds	Groundnut, Mustard, Sunflower
Vegetables	Onion, Potato, Radish, Carrot
Fodders	Asparagus, Pastures
Pulses	Gram, Pigeon pea, Beans
Plantation	Coffee, Rubber, Tamarind
Fibre	Cotton, Sesame
Spices	Cardamom

Response of different crops to sprinkler irrigation

Crop	Water saving (%)	Yield increase (%)
Bajra	56	19
Barley	56	16
Bhendi	28	23
Cabbage	40	3
Cauliflower	35	12
Chillies	33	24
Cotton	36	50
Cowpea	19	3
Fenugreek	29	25
Garlic	28	6
Gram	69	57
Groundnut	20	40
Jowar	55	34
Lucerne	16	27
Maize	41	36
Onion	33	23
Potato	46	4
Sunflower	33	20
Wheat	35	24



Lay out of Sprinkler Irrigation System

Drip irrigation

Water is conveyed under pressure through a pipe system to the fields, from where it is discharged slowly or at a pre designed rate. The latter can be matched to the soil infiltration capacity through emitters or drippers that are located close to the root zone of the plants.

A typical drip irrigation system consists of the following components:

- Pump unit
- Control unit
- Filtering unit
- Mainline and sub mainlines
- Laterals
- Emitters



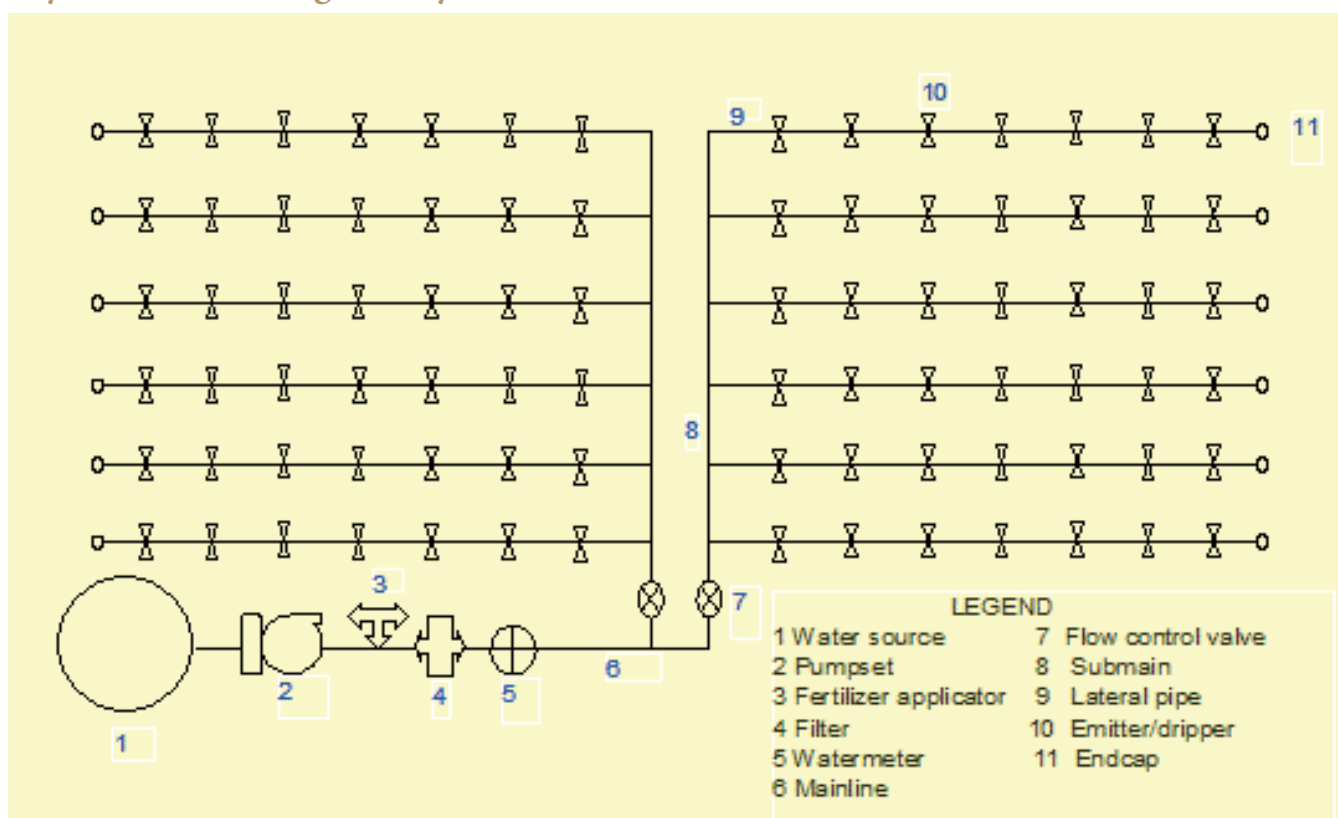
Head Control Unit

Critical stages for irrigation in different crops

Name of the Crop	Critical Stages
Cereals	
Rice/Paddy	Tillering, Panicle Initiation, Heading and Flowering
Wheat	Crown Root Initiation, Tillering to Booting
Sorghum	Booting, Blooming and Milky Dough Stage
Maize	Silking and Tasseling to Dough Stage
Pearl millet	Heading and Flowering
Finger millet	Primordial Initiation and Flowering
Pulses	
Chickpea	Late Vegetative Phage
Black gram	Flowering and Pod Setting
Green gram	Flowering and Pod Setting
Beans	Flowering and Pod Setting
Peas	Flowering and Early Pod Formation
Alfalfa	After Cutting and Flowering

Name of the Crop	Critical Stages
Oil Seeds	
Ground nut	Flowering, Peg Formation and Pod Development
Sesame	Blooming to Maturity
Sunflower	Pre-flowering to Post-flowering
Soybean	Blooming and Seed Formation
Vegetables	
Onion	Bulb Formation and Pre-maturity
Tomato	Flowering and Fruit Setting
Chilies	Flowering and Fruit Setting
Cabbage	Head Formation
Potato	Tuber Initiation to Maturity
Carrot	Root Enlargement
Others	
Cotton	Flowering and Boll Formation
Citrus	Flowering, Fruit Setting and Fruit Enlargement
Mango	Pre-flowering and Fruit Setting

Layout of micro irrigation system



Benefits of drip irrigation over surface irrigation

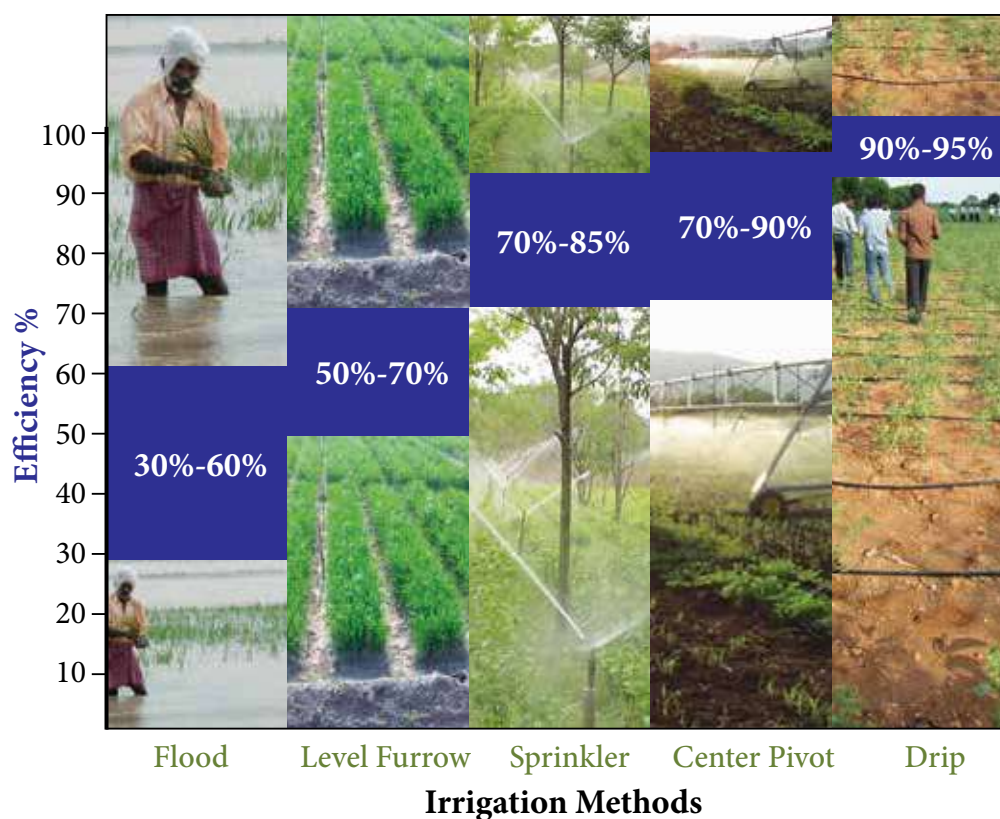
Crop	Yield increase (%)	Water saving (%)
Mango	80.0	34.8
Banana	52.0	45.0
Grapevine	23.0	48.0

Crop	Yield increase (%)	Water saving (%)
Pomegranate	98.0	45.0
Tomato	50.0	39.0
Watermelon	88.0	36.0

Benefits of drip irrigation over surface irrigation continued....

Crop	Yield increase (%)	Water saving (%)	Crop	Yield increase (%)	Water saving (%)
Lady's finger	16.0	40.0	Sugarcane	133.3	49.3
Brinjal	14.0	53.0	Cotton	88.0	46.6
Chillies	44.0	62.0	Onion	53.8	46.1
Papaya	75.0	68.0	Potato	79.5	54.1

On-farm irrigation efficiency of different irrigation methods



1.6.2. Centrally sponsored micro irrigation scheme

It is clear from the above diagram that drip irrigation is the most efficient irrigation in terms of water use efficiency compared to all other methods. Flood irrigation method is found to be the most uneconomical irrigation method in terms of water use efficiency when compared to all other methods.

In order to popularize micro irrigation, the Govt. of India is implementing the Micro Irrigation Scheme through which interested farmers be supported. The farmers can approach nearest extension functionary. The details are as follows:

Name of Scheme	Micro Irrigation
Type	Centrally Sponsored Scheme (CSS)
Year of Commencement	2005-06
Objectives	To increase the area under efficient methods of irrigation viz. drip and sprinkler irrigation as these methods have been recognized as the only alternative for efficient use of surface as well as ground water resources.

Salient Features

- Out of the total cost of the Micro Irrigation (MI) System, 40% will be borne by the Central Government, 10% by the State Government and the remaining 50% will be borne by the beneficiary either through his/her own resources or soft loan from financial institutions.
- Assistance to farmers will be for covering a maximum area of 5 hectare per beneficiary family.
- Assistance for drip and sprinkler demonstration will be 75% of the cost for a maximum area of 0.5 ha per beneficiary, which will be met entirely by the Central Government.
- The Panchayati Raj Institutions (PRIs) will be involved in selecting the beneficiaries.
- All categories of farmers are covered under the Scheme. However, it needs to be ensured that at least 25% of the beneficiaries are small and marginal farmers.
- The scheme includes both drip and sprinkler irrigation. However, sprinkler irrigation will be applicable only for those crops where drip irrigation is uneconomical.
- There will be a strong HRD input for the farmers, field functionaries and other stakeholders at different levels.
- Moreover, there will be publicity campaigns, seminars/workshops at extensive locations to develop skills and improve awareness among farmers about importance of water conservation and management.
- The Precision Farming Development Centres (PFDCs) will provide research and technical support for implementing the scheme.
- Supply of good quality system both for drip and sprinkler irrigation having BIS marking, proper after sales services to the satisfaction of the farmer is paramount.

Subsidy Pattern: Assistance is provided @ 50% (40% by the Government of India and 10% by the State Government) for drip/sprinkler Irrigation System. Assistance to the extent of 75% of the cost of demonstration is provided up to a limit of 0.5 ha.

Structure of Scheme

- At the National level, National Committee on Plasticulture Application in Horticulture (NCPAH) will be responsible for coordinating the Scheme, while the Executive Committee of NCPAH will approve the Action Plan. At the State level the State Micro Irrigation Committee will coordinate the programme, while at the District level the District Micro Irrigation Committee will oversee the programme.
- The Scheme will be implemented by an Implementing Agency (IA), appointed by the State Government, which will be the District Rural Development Agencies (DRDAs) or any identified Agency, to whom funds will be released to directly on the basis of approved district plans for each year.
- The IA shall prepare Annual Action Plan for the District which will be forwarded by the DMIC and SMIC for approval by the Executive Committee (EC) of NCPAH.

Funding Pattern

80:20 by the Centre and States

Eligibility

As indicated in column 5 above.

Area of Operation

The focus will be on horticultural crops being covered under the National Horticulture Mission in 24 States/UTs. A cluster approach will be adopted. The focus has also been extended to non horticultural crops.

Procedure to Apply

Project proposals are submitted through the State Government for release of assistance.

1.6.3. Drainage

Drainage it is a removal of water from the field as a moisture control mechanism.

- Drainage and irrigation are important aspects to be understood by the farmers
- Drainage provides desirable environment in the crop root zone
- Necessity of drainage is felt when there is excess water in root zone
- Source of excess water are
- Uncontrolled irrigation
- Seepage loss from an unlined channel
- Ground water moving from a shallow aquifers
- Non maintenance of natural drainage system

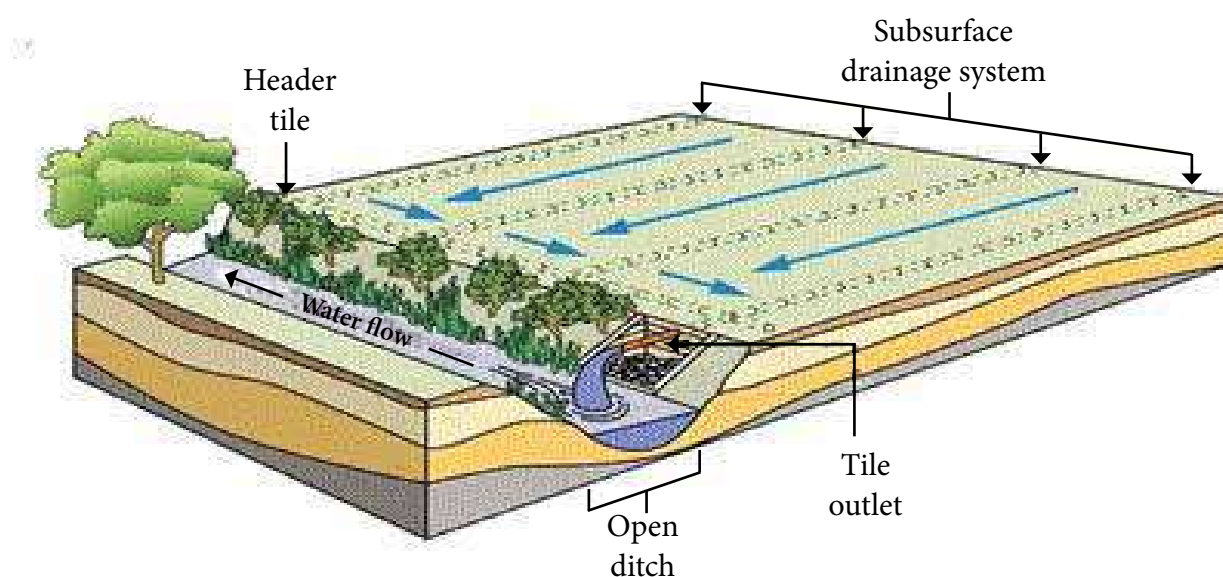
Generally two types of drainage systems are adopted based on techno-economic feasibility:

Surface drainage: Can be achieved by following any one of the below method based on the need and intensity of the problem.

- Land forming
- Land smoothening
- Land grading or levelling
- Bedding system
- Open ditches

Sub surface drainage: Can be achieved by following any one of the below method based on the need and intensity of problem.

- Horizontal sub surface drains
- Vertical drainage
- Other methods like
 - Mole drainage
 - Seepage intercepting farm pond
- Bio drains



1.7. Seed

A 'seed' (in some plants, referred to as a 'kernel') is a small embryonic 'plant' enclosed in a covering called the seed coat, usually with some 'stored food'. Seeds fundamentally are a means of reproduction and most seeds are the product of 'sexual reproduction', which remixes genetic material and 'phenotype variability' that 'natural selection' acts upon.

The seed is the basic input in agriculture upon which other inputs are applied. A good vigorous seed utilizes all the resources and realizes a reasonable output to the grower. It is wealth to the farmer since yesterday's harvest is tomorrow's hope. Good seed in good soil realizes a good yield. Moreover, it is the link between two generations.

Functions of seeds

- Nourishment of the embryo
- Dispersal to a new location
- Dormancy during unfavourable conditions

Characteristics of good seed

- Genetically pure

- Breeder /Nucleus - 100%
- Foundation seed - 99.5%
- Certified seed - 99.0%
- Required level of physical purity for certification
 - All crops - 98%
 - Carrot - 95%
- High pure seed percentage
 - Bhendi - 99.0 %
 - Sesame, soybean & jute - 97.0 %
 - Ground nut - 96.0 %
- Free from other crop seeds
- Free from designated diseases like loose smut in wheat
- Free from objectionable weed seed like wild paddy in paddy
- Have good shape, size, colour, etc. according to specifications of variety
- Have high physical soundness and weight
- Posses high physiological vigour and stamina
- Posses high longevity and shelf life
- Have optimum moisture content for storage
 - Long term storage: 8% and below
 - Short term storage: 10-13%
- Have high market value

Seed types and characteristics

Seed Type	Characteristics	Genetic Purity	Tag Colour
Nucleus Seed	Produced by the breeder and it is genetically pure seed	100%	-
Breeder Seed	Produced by the breeder from nucleus seed	100%	Yellow
Foundation Seed	Produced by the breeder seed under the supervision of the concerned seed certification agency	99.5%	White
Certified Seed	<p>Certified seed is the progeny of foundation seed and its production is supervised and approved by certification agency.</p> <p>The seed of this class is normally produced by the State and National Seeds Corporation and Private Seed Companies on the farms of progressive growers.</p> <p>This is the commercial seed which is available to the farmers.</p>	99.0%	Azar Blue

Seed treatment

Seed treatment is usages of specific products and specific techniques to improve the growth environment for the seed, seedlings and young plants. It ranges from a basic dressing to coating and pelleting.

Seed dressing: This is the most common method of seed treatment. The seed is dressed with either a dry formulation or wet treated with a slurry or liquid formulation. Dressings can be applied at both, the farm and industries. Low cost earthen pots can be used for mixing pesticides with seed or seed can be spread on a polythene sheet. The required quantity of chemical can be sprinkled on the seed lot and mixed mechanically by the farmers.

Seed coating: A special binder is used with a formulation to enhance adherence to the seed.



Seed Dressing

Seed pelleting: The most sophisticated Seed Treatment Technology changes the physical shape of a seed to enhance pelletability and handling. Pelleting requires specialized application machinery and techniques and is the most expensive application.

The farmer must take care of the following while buying the seeds

- When purchasing the seed farmer should obtain a bill/cash memo wherein the lot number and seed tag number is mentioned.
- After purchasing the seed, empty bag/packet (pouches) and receipt should be kept safely.
- Out of purchased seed, 100 seeds are taken from each purchased variety to test them for germination before sowing in the field. Knowing the germination percentage, the farmer can decide the seed rate when sowing in the field.



Pelleted Onion Seed

Recommendation of seed treatment for different crops contiued...

Name of Crop	Pest / Disease	Seed Treatment	Remarks
Sugarcane	Root rot, wilt	Trichoderma spp. 4-6 gm/kg seed	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
Rice	Root rot disease	Trichoderma 5-10 gm/kg seed (before transplanting)	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
	other insects /pests Bacterial sheath blight	Pseudomonas flourescens 0.5% W.P. 10 gm/kg.	

Recommendation of seed treatment for different crops contiued...

Name of Crop	Pest / Disease	Seed Treatment	Remarks
Chillies	Anthracnose spp. Damping off	Seed treatment with Trichoderma viride 4g/kg	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
	Soil borne infection of fungal disease	Trichoderma viride @ 2 gm/kg. seed and Pseudomonas fluorescens@10gm/kg Captan 75 WS @ 1.5 to 2.5 gm a.i./litre for soil drenching.	
	Jassid, aphid, thrips	Imidacloprid 70 WS @ 10-15 gm a.i./kg seed (To be used in proper doses under guidance of an agriculture expert)	
Pigeon pea	Wilt, Blight and Root rot	Trichoderma spp. @ 4 gm/kg. Seed	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
Pea	Root rot	Seed treatment with 1. Bacillus subtilis 2. Pseudomonas fluorescens	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
	White rot	Soil application @ 2.5 – 5 kg in 100kg FYM	
Bhendi	Root knot nematode	Paecilomyces lilacinus and Pseudomonas fluorescens @ 10 gm/kg as seed dresser.	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
Tomato	Soil borne infection of fungal disease	T. viride @ 2 gm/100gm seed.	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
	Early blight	Pseudomonas fluorescens and V. clamydosporium @ 10gm/kg as seed dresser.	
	Damping off		
	Wilt		
Sunflower	Seed rot	Trichoderma viride @ 6 gm/kg seed.	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
	Jassids,	Imidacloprid 48FS @ 5-9 gm a.i. per kg. Seed (To be used in proper doses under guidance of an agriculture expert)	
	Whitefly	Imidacloprid 70WS @ 7 gm a.i. per kg. Seed (To be used in proper doses under guidance of an agriculture expert)	

1.8. Cropping systems

Farmers resort to cultivation of a number of crops and rotate particular crop combinations. More than 250 cropping systems are being followed in India, of which 30 cropping systems are more prevalent. Some of the important cropping systems are:

1. Sequential cropping system:

Growing crops in sequence within a crop year, one crop being sown after the harvest of the other. For example, rice followed by pigeonpea, pigeonpea followed by wheat.

2. Intercropping System:

Growing more than one crop in the same area in rows of definite proportion and pattern.



Cereals + Legumes

The following intercropping practices were found to be remunerative in India's groundnut growing states.

State	Crop combination
Maharashtra	Groundnut + Red gram (6:1/4:1)
	Groundnut + Soybean (6:2)
	Groundnut + Sunflower (6:2/3:1)
Gujarat	Groundnut + Castor (9:2/3:1)
	Groundnut + Sunflower (3:1/2:1)
	Groundnut + Red gram (4:1)

Alley cropping

Is an agroforestry practice in which perennial, preferably leguminous, trees or shrubs are grown simultaneously with an arable crop. The trees, managed as hedgerows, are grown in wide rows and the crop is planted in the interspace or 'alley' between the tree rows.

During the cropping phase, the trees are pruned. Prunings are used as green manure or mulch on the crop to improve the organic matter status of the soil and to provide nutrients, particularly nitrogen, to the crop.



Alley Cropping and Silviculture

a. Season based cropping system

- i. Kharif rice based cropping system
- ii. Kharif maize based cropping system
- iii. Kharif sorghum based cropping system
- iv. Kharif millet based cropping system
- v. Kharif groundnut based cropping system
- vi. Winter wheat and chickpea based cropping system
- vii. Rabi sorghum based cropping system

b. Mixed cropping

In order to minimise the risk and uncertainty of mono cropping and to have sustainable yield and income, farmers are advised to go for mixed cropping.



Mixed Cropping

Integrated farming System (IFS)

To feed ever-increasing population of the country, extensive cropping system give ways to intensive cropping which are exploiting natural resources. Therefore in future more thrust will be on efficient natural resource management and sustainable production system. This encompasses an animal component, an perennial and annual crop component, aqua culture, agro based production and processing units. Integrated farming system typically involves:

- Many enterprises including animal component
- Planning is based on resource available
- It is purely location specific/farmer/holding specific activity plan
- Very high resource use efficiency
- Sustainable farming



IFS - Duck & Fish rearing

Objectives of IFS

- To compliment and maximize use of by products
- To provide useful employment to all the family members
- Maximizing land use
- Value addition

- Self sustainability
- Less dependence on external resources

Crop production in IFS

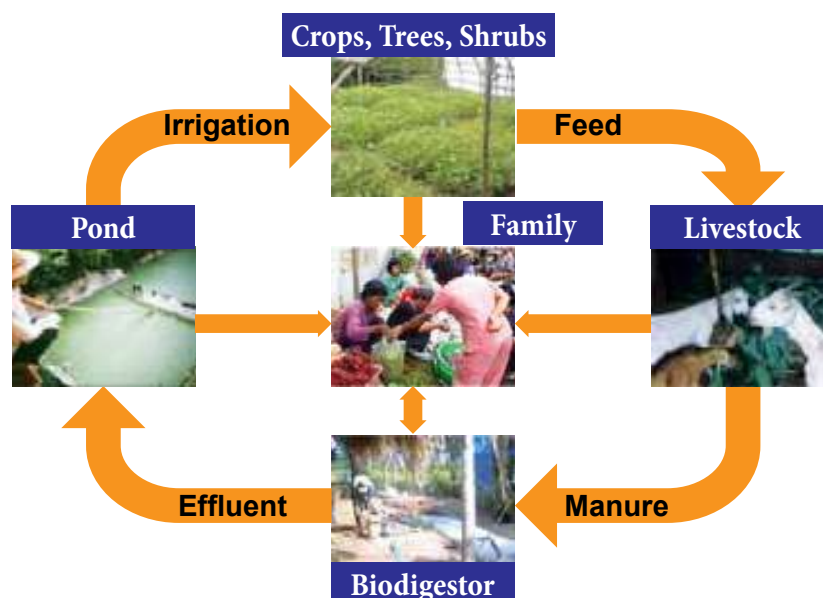
- Food crop should find a place
- Family food requirement should be planned
- Fodder production to meet the demand of animal component
- Specific enterprise based crops; e.g. mulberry/sunflower linked to honey
- Infrastructure based cropping
- Sufficient employment to family members

Animal component in IFS

- One or more animal components or combination of animal component may be planned
- Complimentary enterprises should be identified
- Composting should be the interface between animal and crop enterprises
- Market should be considered before hand
- Need based demand driven enterprises should be prioritized

Allocation of resource in IFS

- List the resources available and required
- Prioritize the resources based on scarcity
- Resource demand will be prioritized based on economic impact and sustainability
- Scarce resource on the farm should be allocated for the most important activity
- Recycling of resources should be planned
- Resource based contingent plan should be prepared in advance. This will serve as a security and sustainable alternative in case of crisis



1.9. Mechanization

Modernization of agriculture requires appropriate machinery for ensuring timely field operations, effective application of agricultural inputs and reducing drudgery in agriculture.

Advantages of mechanization

- Increase cropping intensity
- Ensure large area coverage and timeliness
- Increasing farm labour productivity
- Increases crop productivity and profitability

First step in mechanization

- Get good hands on training
- Read manufacturer information
- Give attention to maintenance
- Understand do's and don'ts with respect to equipments and machinery used
- Take utmost care in following safety tips given in the manufacture information booklet.

Selection of farm machinery

- Select based on holding size
- Economic feasibility
- Availability of skilled labour to operate
- Workout the feasibility of hiring v/s owning
- Decide between universal equipment v/s crop specific equipment when multiple crops are grown
- If the initial investment is huge, think of community ownership/custom hire centres, etc.

Benefits of Agricultural Mechanization

Benefits	Value, %
Saving in seed	15-20
Saving in fertilizer	15-20
Saving in time	20-30
Reduction in labours	20-30
Increase in cropping intensity	5-20
Higher productivity	10-15
Substantial reduction in drudgery of farm workers especially that of women	

Farm Mechanisation Potential

Land Preparation



Wooden Plunk



Bullock Drawn Country Plough



Laser Guided Land Leveller



Field Operation of Tractor Drawn Disc Plough

Seeding and Planting Machinery



CRIDA 2 Row Planter



Seed Treating Drum



Field of Operation of Yanji Transplanter for SRI



Tractor Drawn CRIDA 9 Row Planter

Inter-Cultivation Equipments



Grubber Weeder

Cost savings of up to 60% are possible at the early stages of crop growth.



Cono Weeder

Weeding under wetland paddy cultivation



Wheel Hoe

Reduces the cost of weeding up to 50%



Tractor - Operated Cotton Weeder



B.D. 3 Tyne Cultivator

Plant Protection Equipments



Knapsack Power Sprayer



Tree Sprayer



Blower Sprayer



Power Tiller Mounted Sprayer

Harvesting Equipments



Coconut Tree Climber

- Used for picking of coconuts
- Average time taken for climbing up and down is about 6.30 min for a 13 m tree and time for fixing and removing the device on the tree is 4 minutes.



Groundnut Digger



Banana Clump Remover



Austoft Chopper Harvester



Cotton Stalk Puller

Threshing Equipments



Groundnut Pod Stripper

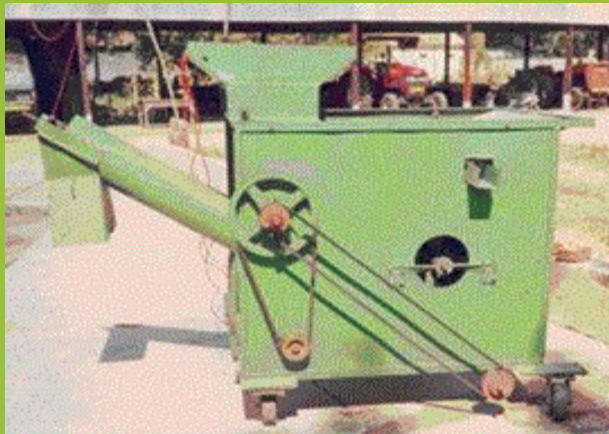


Castor Sheller

Winnowing and Clearing Equipments



Winnowing Fan



Seed Cleaner

1.10. Good Agricultural Practices (GAP)

Good Agricultural Practices (GAP) are *"practices that address environmental, economic and social sustainability for on-farm processes, and which result in safe and quality food and non-food agricultural products"*.

What are GAP codes, standards and regulations?

Good Agricultural Practices (GAP) codes, standards and regulations are guidelines which have been developed in recent years by the food industry, producers' organizations, governments and NGOs aiming to codify agricultural practices at farm level for a range of commodities.

Why do GAP codes, standards and regulations exist?

These GAP codes, programmes or standards exist because of:

- Growing concerns about food quality and safety worldwide.
- Fulfilment of trade and government regulatory requirements.
- Specific requirements especially for niche markets.

Objectives

- Ensuring safety and quality of produce in the food chain.
- Capturing new market advantages by modifying supply chain governance.
- Improving natural resources used, workers' health and working conditions to creating new market opportunities for farmers and exporters in developing countries.

The benefits of GAP codes

- Standards and regulations are numerous, including food quality and safety improvement.
- Facilitation of market access.
- Reduction in non-compliance risks regarding permitted pesticides, Maximum Residue Limits (MRLs) and other contamination hazards.

GAP related to crop protection

- Use resistant cultivars and varieties.
- Crop sequences, associations and cultural practices.
- Biological prevention of pests and diseases.
- Maintain regular and quantitative assessment of the balance status between pests and diseases and beneficial organisms of all crops.
- Adopt organic control practices where and when applicable.
- Apply pest and disease forecasting techniques where available.
- Determine interventions following consideration of all possible methods and their short and long-term effects on farm productivity and environmental implications. This will allow the minimizing of agrochemicals, in particular, to promote Integrated Pest Management (IPM).
- Store and use agrochemicals according to legal requirements of registration for individual crops, rates, timings, and pre-harvest intervals
- Ensure that agrochemicals are only applied by specially trained and knowledgeable persons.
- Ensure that equipment used for the handling and application of agrochemicals complies with established safety and maintenance standards.
- Maintain accurate records of agrochemical use.
- Identify the GAP in each protection method.

Crop rotation systems

- Sequence crops by selecting pest host relation.
- Selected crop for rotation in order to break the life cycle of pest (Jowar should be rotated with pulses to combat striga weed).
- The selected crop for rotation should not be the food of previous crop pest.
- To select appropriate crops for rotation:
 - Analyze the pest habitat
 - Follow forecasts
 - Monitor pest and natural enemies

Privilege resistant species

- Cultivate plant varieties which are less prone to pest attack.
- The resistant varieties reduce production cost.
- Pest resistant transgenic crops developed for specific pest can be used. This is new avenue for reducing pesticide load.

Seeding techniques

- Depth of placement
- Method of placement
- Time of placement
- Seed treatments
- Managing the above based on pest nature will give good results

Promote useful animals

- Keep good predator population.
- Promote growth of beneficial insects.
- Create an environment congenial for predators; e.g. keeping bird perch in the field.
- Identify the useful animals and study their habitat for providing the required environment.

Observe and control populations

- Follow forecast-short term and long term.
- Study habitat of pest and congenial weather.
- Accordingly take necessary precautions to manage pest.

Give priority to mechanical and biological measures (instead of chemical)

- Get the full knowledge about botanical pesticides.
- Get the knowledge on available parasites and predator/friendly insects and pests.
- Accordingly develop action plan for mechanical and biological measures.
- **Use non cash inputs:** Saves money.
- **Use information on plant protection:** Analyze spatial and temporal distribution and trend analysis.

Monitoring of performance through taking notes each year/season.

- Keep the pest management record along with season, weather and other agriculture activity.
- Document the pest load and control achieved
- Use this experience for future planning.

Precision farming: Use precision farming modules and apply Information Technology (IT) to economize and for effective monitoring.

Good Agriculture Practices help the farmers to make use of the opportunities available in International Markets for selling their products and realising better farm profits.

1.10. Lessons Learnt

1. Critical factors to be considered while deciding the crops and cropping pattern are climatic factors, soil conservation, water, cropping system options, past and present experiences of farmers, expected profit and risk, economic conditions of farmers including land holding, labour availability, mechanization potential technology availability and suitability, demand and availability of market policies and schemes, public and private extension influence, availability of required agricultural inputs including agricultural credit and post harvest storage and processing technologies.
2. Soil, water and wind erosion may be managed through various recommended practices.
3. Method of irrigation has to be decided considering the quantity of water available and crop to be grown.
4. Recommended certified seeds may be used.
5. Mechanisation enhances quality of agricultural operations and minimises the cost and dependence on labour.
6. Good Agricultural Practices (GAP) may be considered essentials to enhance the price and market competitiveness of the produce.

2. Soil and Plant Nutrition

2.1. Objectives of the session

- To increase the awareness and understanding about the soil, its structure, physical, chemical and biological properties and soil fertility.
- To strengthen the farmer's knowledge to manage the soil fertility in an economically and environmentally sustainable manner.

2.2. What we know at the end of the session

- Soil composition
- Physical, chemical and biological characteristics of soil
- Soil testing
- Plant nutrition requirement
- Organic and inorganic fertilizers
- Integrated Nutrient Management (INM) for efficient, economic and sustainable production

Know your Soil

2.3. What is Soil?

Soil is a thin layer of earth's crust, which serves as a natural medium for the growth of plants. Rocks are the important sources for the parent materials over which soils are developed.

Soil Constituents

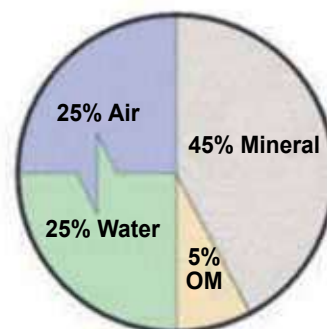


Rocks, the source of parent material

Soil is a dynamic medium made up of minerals, organic matter, water, air and living creatures including bacteria and earthworms.

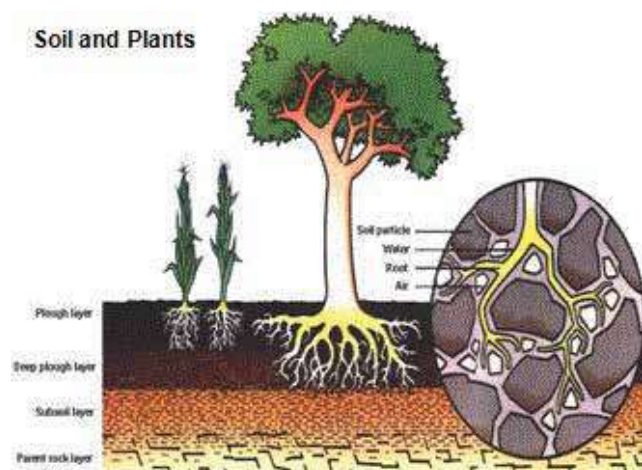
It was formed and is forever changing due to 5 major

physical factors: parent material, time, climate, organisms present and topography. The way in which we manage soil is another major factor influencing the character of the soil.



Soil Constituents

Soil features, properties and their importance



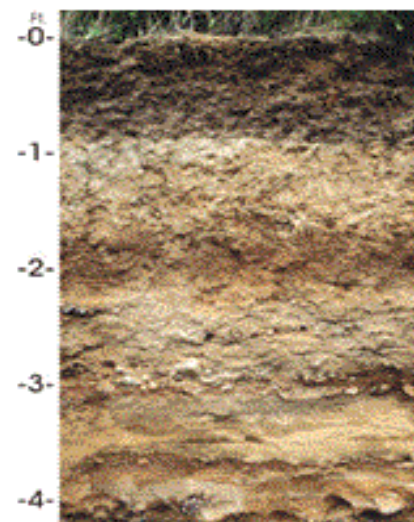
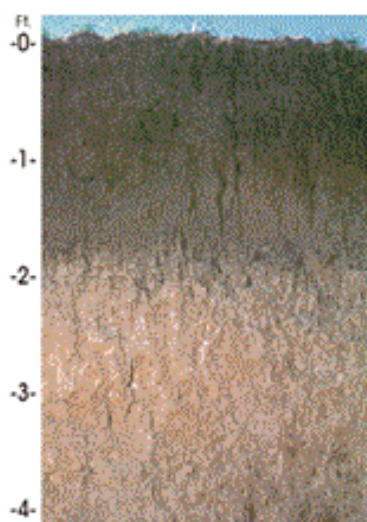
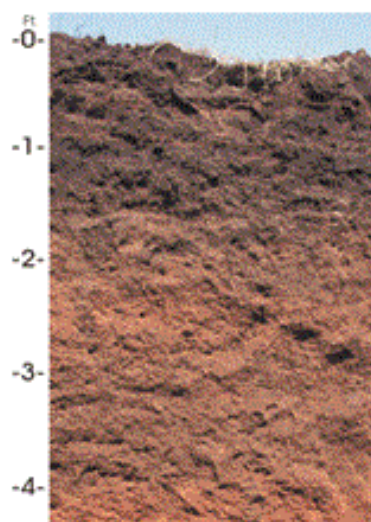
Soil features and properties

Soil colour

- Dark colour indicates usually medium to high fertility due to high amount of organic matter. These soils have usually high amount of nutrients, good water holding capacity and structure and are well aerated.
- Light colour indicates medium to low fertility. These soils may have leaching issue (water makes organic matter and other nutrients move downward faster).

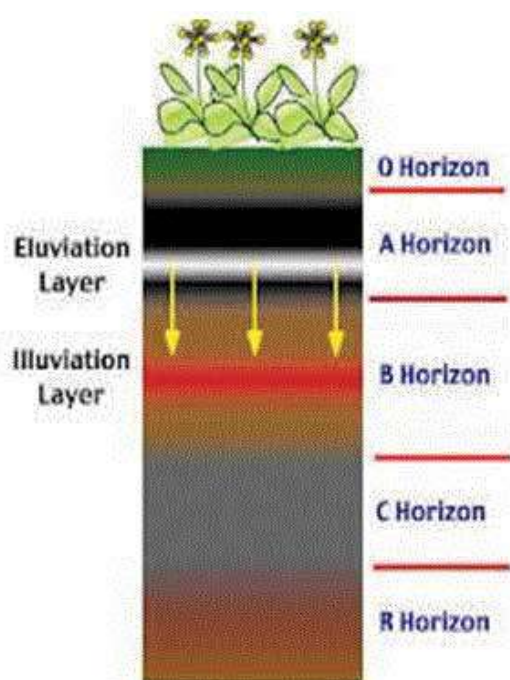


Soil



Soil depth

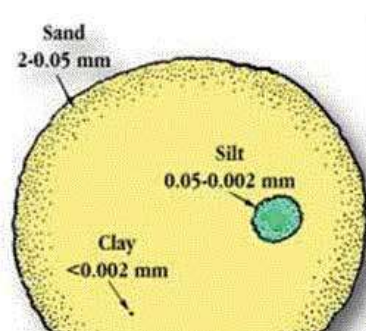
- The depth of soil to which the roots of a plant can readily penetrate to in order to reach water and nutrients.
- Minimum of 3-5 feet is desirable, deeper soils are better because they can hold more nutrients and water.



Soil Depth

Soil texture

- Texture refers to relative proportion of mineral particles (sand, silt, and clay) in soil. Many properties of soils; e.g. drainage, water holding capacity, aeration and the nutrient availability; depend largely on soil texture.
- **Sandy:** Low fertility and water holding capacity but good aeration.
- **Loamy:** Medium fertility and good aeration.
- **Clayey:** High fertility and poor aeration, hard to plough.

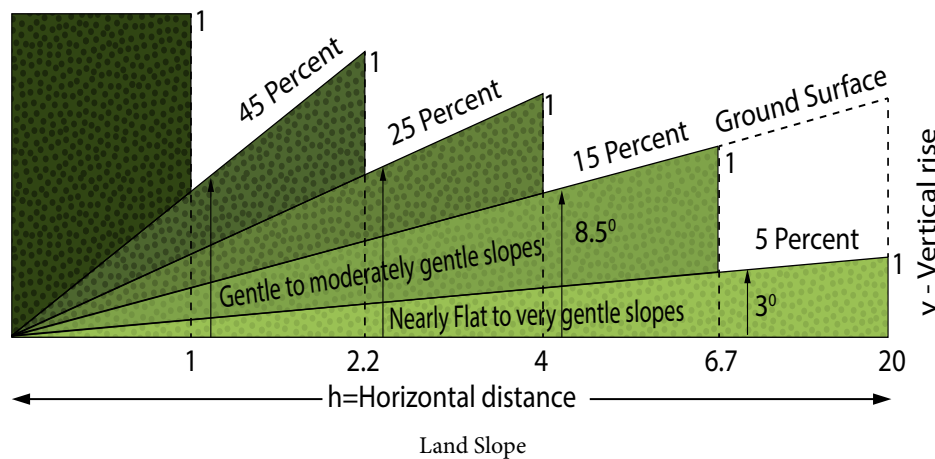


Soil Constituents

- Farmers may refer to their soil as heavy or light, illustrating the ease of working. The heavy soils are usually hard to plough and require much more effort than light soils. Organic matter may be added to improve the soil texture.

Land slope

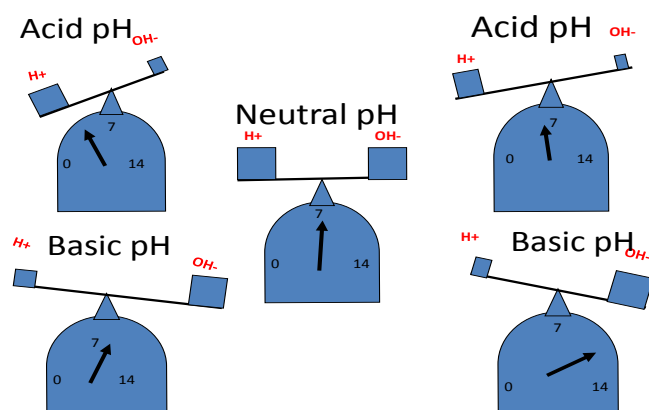
- Soil gradient is the angle of inclination of the soil surface from the soil.
- It is expressed in percentage, which is the number of feet raise or fall in 100 feet from the horizontal distance.
- Mild gradient up to 1% is desirable.
- Higher gradients are not desirable as it leads to soil and water erosion.
- Perfect levelling is required only for paddy crop.



Soil pH

- Soil pH is of utmost importance in plant growth as it influences nutrient availability, toxicities and the activity of soil organisms.

PH Range	Soil Reaction Rating
<4.6	Extremely acid
4.6-5.5	Strongly acid
5.6-6.5	Moderately acid
6.6-6.9	Slightly acid
7.0	Neutral
7.1-8.5	Moderately alkaline
>8.5	Strongly alkaline



Tips for soil pH management

- Acid soils are to be corrected by using lime, quantity of lime application is as per soil test report.
- Alkali soils are to be corrected by gypsum/sulphur, quantity of application is as per soil test report.
- Saline – alkali soils should be treated with gypsum and improved drainage.

Soil organic matter

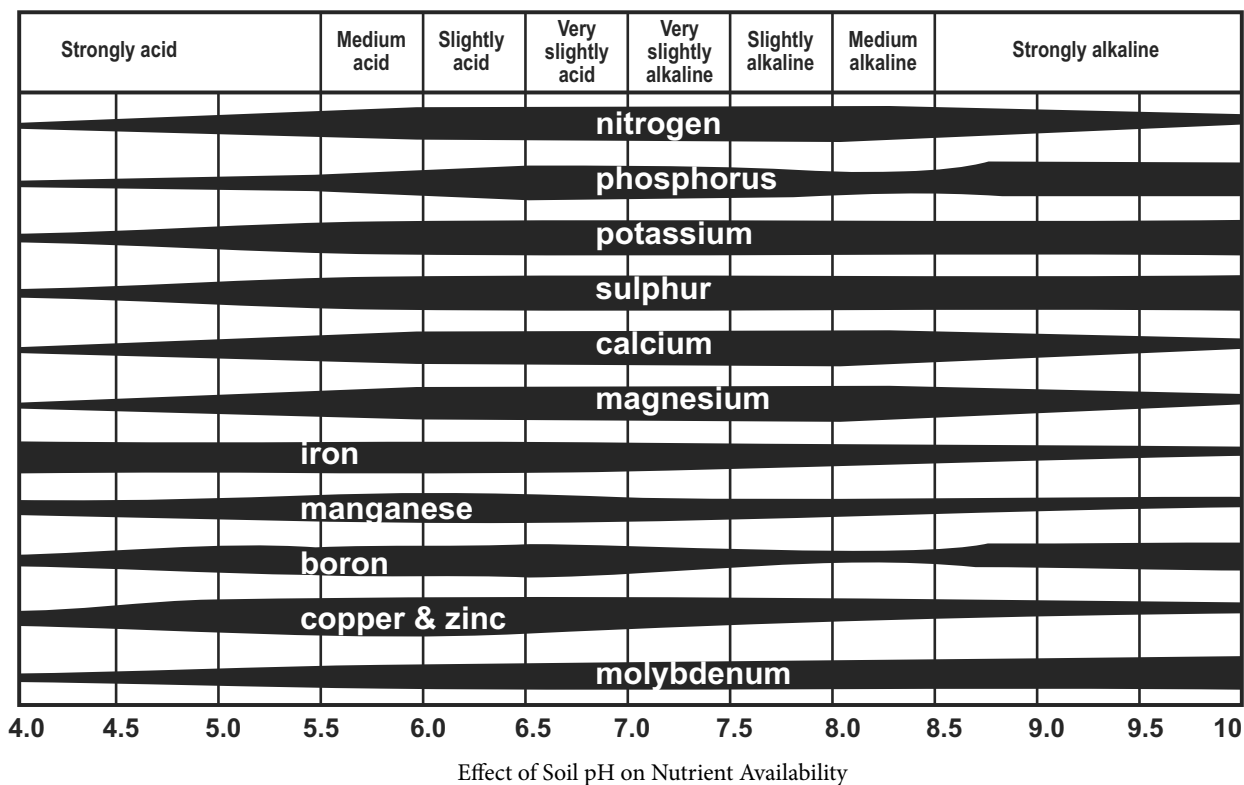
- Soil organic matter is the mix of plant and animal matter in different stages of decay.
- Soil organic matter plays a key role in biological, physical, and chemical function in soil.

Soil organic matter helps by:

- Providing nutrients for soil organisms
- Acting as major reservoir of plant nutrients
- Making nutrient exchange between soil and root of the plants easier
- Improving soil structure
- Influencing soil temperature
- Reducing the risk of soil erosion
- Increasing water holding capacity

Soil organic matter can be improved through:

- Recycling the crop residue back to field without wasting and burning
- Applying compost



- Applying various organic manures
- Mulching organic wastes
- Using green manures and cover crops
- Suitable crop rotation
- Reducing soil tillage
- Avoiding soil erosion

and approach extension officials for further guidance.

Carbon - Nitrogen Ratio (C:N Ratio)

There are chemical elements in the organic matter, which are extremely important, especially in their relation or proportion to each other. They are Carbon and Nitrogen. The relationship is called Carbon - Nitrogen Ratio (C:N Ratio). For example, composed manure has 20:1 and sawdust has 400:1 of carbon and nitrogen. Generally speaking, the legumes are highest in nitrogen and have low C:N Ratio, which is highly desirable. Farmers can use blood meal, bone meal, poultry manure, cottonseed meal and soybean meal and other nitrogen rich material as organic matter, which enhance the decomposition.

Electrical Conductivity (EC): EC is normally considered to be a measurement of the dissolved salts in a solution.

General interpretation of EC values

Through application of gypsum, the saline/sodic soils can be amended. The quantity of gypsum to be applied is decided by EC value. Farmers having problem of saline/sodic soils can go for soil testing

Soil	EC (mS/cm)	Crop reaction
Salt free	0 - 2	Salinity effect negligible, except for more sensitive crops
Slightly saline	4 - 8	Yield of many crops restricted
Moderately saline	8 - 15	Only tolerant crops yield satisfactorily
Highly saline	> 15	Only very tolerant crops yield satisfactorily

Soil fertility

- Soil fertility is generally defined as “ability of soil to supply plant nutrients”. Soil structure, soil texture, temperature, water, light and air also play an important role in maintaining soil fertility.
- Plant nutrients which are often scarce in soil are nitrogen, potassium and phosphorus since plants use large amounts for their growth and survival.
- Important nutrients, their function and deficiency symptoms are described below.

2.4. Deficiency Symptoms of Nutrients in Plants



Nitrogen (N) – deficiency symptoms

Nitrogen (N) – deficiency symptoms

1. Stunted growth.
2. Appearance of light green to pale-yellow colour on the older leaves, starting from the tips. This is followed by death and/or dropping of the older leaves depending upon the degree of deficiency.
3. In acute deficiency, flowering is greatly reduced.
4. Lower protein content.



Phosphorous (P) – deficiency symptoms

Phosphorous (P) – deficiency symptoms

1. Overall stunted appearance, the mature leaves have characteristic dark to blue-green colouration, restricted root development.
2. In acute deficiency, occasional purpling of leaves and stems; spindly growth.
3. Delayed maturity and poor seed and fruit development.



Potassium (K) – deficiency symptoms

Potassium (K) – deficiency symptoms

1. Chlorosis along the leaf margins followed by scorching and browning of tips of older leaves. These symptoms then gradually progress inwards.
2. Slow and stunted growth of plants.
3. Stalks weaken and plant lodge easily.
4. Shrivelled seeds of fruits.



Calcium (Ca) – deficiency symptoms

Calcium (Ca) – deficiency symptoms

1. Calcium deficiencies are not seen in the field because secondary effects associated with high acidity limit growth.
2. The young leaves of new plants are affected first. These are often distorted, small and abnormally dark green.
3. Leaves may be cup-shaped and crinkled and the terminal buds deteriorate with some breakdown of petioles.
4. Root growth is markedly impaired; rooting of roots occurs.
5. Dessication of growing points (terminal buds) of plants under severe deficiency.
6. Buds and blossoms shed prematurely.
7. Stem structure weakened.



Magnesium (Mg) – deficiency symptoms

Magnesium (Mg) – deficiency symptoms

1. Interveinal chlorosis, mainly of older leaves, producing a streaked or patchy effect; with acute deficiency, the affected tissue may dry up and die.
2. Leaves usually small, brittle in final stages and curve upwards at margin.
3. In some vegetable plants, chlorotic spot between veins, with tints of orange, red and purple.
4. Twigs weak and prone to fungus attack, usually premature, leaf drop.



Sulphur (S) deficiency symptoms

Sulphur (S) deficiency symptoms

1. Younger leaves turn uniformly yellowish green or chlorotic.
2. Root growth is restricted, flower production often indeterminate.
3. Stems are stiff, woody and small in diameter.



Zinc (Zn) deficiency symptoms

Zinc (Zn) deficiency symptoms

1. Deficiency symptoms mostly appear on the 2nd or 3rd fully mature leaves from the top of plants.
2. In maize, from light yellow striping to a broad band of white or yellow tissue with reddish purple veins between the midrib and edges of the leaf, occurring mainly in the lower half of the leaf.
3. In wheat, a longitudinal band of white or yellow leaf tissue, followed by interveinal chlorotic mottling and white to brown necrotic lesions in the middle of the leaf blade; eventual collapse of the affected leaves near the middle.
4. In rice, after 15-20 days of transplanting, small scattered light yellow spots appear on the older leaves which later enlarge, coalesce and turn deep brown, the entire leaf becomes rust-brown in colour and dries out within a month.
5. In citrus, irregular interveinal chlorosis; terminal leaves become small and barrowed (little-leaf); fruit-bud formation is severely reduced, twigs die back plants.



Copper (Cu) - deficiency symptoms

Copper (Cu) - deficiency symptoms

1. In cereals, yellowing and curling of the leaf blades, restricted ear production and poor grain set, indeterminate tillering.
2. In citrus, die back of new growth; exanthema pockets of gum develop between the bark and the wood; the fruit shows brown spots.



Iron (Fe) - deficiency symptoms

Iron (Fe) - deficiency symptoms

1. Typical interveinal chlorosis; youngest leaves first affected, points and margins of leaves keep their green colour longest.
2. In severe case, the entire leaf, veins and interveinal area turn yellow and may eventually become bleached.



Boron (B) - deficiency symptoms

Boron (B) - deficiency symptoms

1. Death of growing plants (shoot tips).
2. The leaves have a thick texture, sometimes curling and becoming brittle.
3. Flowers do not form and root growth is stunted.
4. “Brown heart” in root crops characterized by dark spots on the thickest part of the root or splitting at centre.



Manganese (Mn) - deficiency symptoms

Manganese (Mn) - deficiency symptoms

1. Chlorosis between the veins of young leaves, characterized by the appearance of chlorotic and necrotic spots in the interveinal areas.
2. Greyish areas appear near the base of the younger leaves and become yellowish to yellow orange.
3. Symptoms of deficiency popularly known in sugarcane as “streak” disease.



Molybdenum (Mo) - deficiency symptoms

Molybdenum (Mo) - deficiency symptoms

1. Chlorotic interveinal mottling of the lower leaves, followed by marginal necrosis and in folding of the leaves.
2. In cauliflower, the leaf tissues wither leaving only the midrib and a few small pieces of leaf blade (“whiptail”).
3. Molybdenum deficiency is markedly evident in leguminous plants.

Some common deficiency symptoms are:



Chlorosis - It is the loss of chlorophyll leading to yellowing in leaves. It is caused by the deficiency of elements like K, Mg, N, S, Fe, Mn, Zn and Mo.





Necrosis are death of tissues, particularly leaf tissue is caused by deficiency of K, Ca, Mg

Inhibition of cell division is caused due to lack or deficiency of N, K, S and Mo.



Premature fall of leaves and buds

- deficiency of K and P.

	<p>Stunted/Retarded plant growth caused by the deficiency of N, P, K, Zn, Ca.</p>
	<p>Delay in flowering due to deficiency of N, S and Mo.</p>

In case the farmers observe the above symptoms, farmers are advised to consult the local extension worker for remedies.

2.5. Different fertilizers and their nutrient content

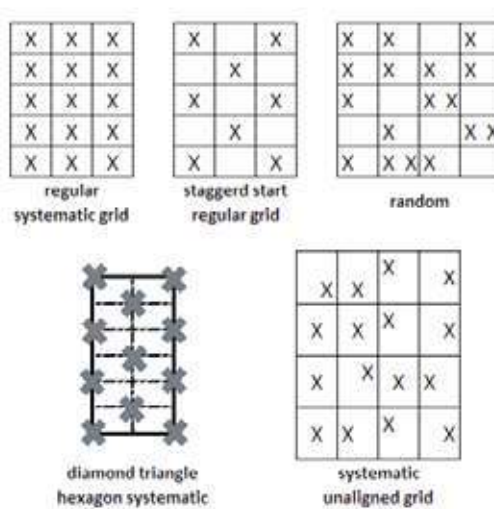
Important chemical fertilizers are the source of major nutrients. Different fertilizers and their nutrient content are illustrated in the table below:

Fertilizer	Nutrient content (%)		
	N	P*	K
Single nutrient fertilizers			
Ammonium sulphate	20	0	0
Urea	46	0	0
Calcium ammonium nitrate ¹	28	0	0
Single super phosphate	0	7	0
Triple Super Phosphate	0	20	0
Potassium sulphate	0	0	40
Muriate of Potash ²	0	0	48
Double fertilizers			
Ammonium Phosphate	11	23	0
Diammonium Phosphate ³	18	20	0
Complete Fertilizers			
Sampurna ⁴	19	19	19
Vijaya Complex ⁵	17	17	17
IFFCO Grade I ⁶	10	26	26

A. Soil Analysis: Key to a Successful Nutrient Management Plan

Higher crop yields and quality of the crops depend largely on the efficient supply of nutrients. Soil provides not only the medium but also functions as the source of these nutrients for the plants. Soil resources get depleted with every harvest and need to be replenished for every crop. However, one must know which nutrients are to what extent depleted and what addition of fertilizers should be planned accordingly. Soil analysis, in this regard, helps in determining the level of nutrients and in deciding the required amount of fertilizer application.

Accuracy of soil analysis is directly related to the quality of the soil sample taken. Application of appropriate fertilizers with the proper nutrient mix will help not only to increase the productivity and farm income but also provide a more realistic chance to obtain the desired yield. There are various methods for taking a soil sample from a field. The right method of sampling may be decided by consulting local extension officer or your DESAI-trainer.



¹Calcium ammonium nitrate- To be used with caution.

²Muriate of Potash- To be used with caution and protective equipment (Respirator)





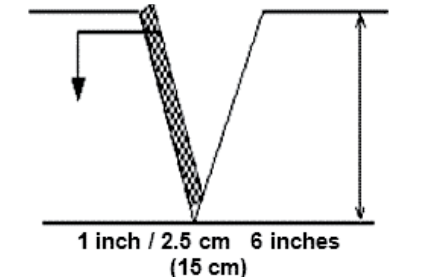







³Diammonium Phosphate- To be used with caution.

⁴Sampurna- Compilation Source- Manufacturer (Zuari Agro Chemicals).

⁵Vijaya Complex- Indigenous Complex Fertilizer.

⁶IFFCO Grade I- Compilation Source- Manufacturer
(To be used with caution.)

Soil sampling: an illustration

		
Selecting sampling spot	Remove the surface litter at the sampling spot	Make a 'V' shaped cut to a depth of 15 cm in the sampling spot
		
Collect soils - V shaped cut: Remove thick slices of soil from top to bottom of exposed face of the 'V' shaped cut and place in a clean container		Mix the samples thoroughly
		
Quartering is done by dividing the thoroughly mixed sample into four equal parts	Two opposite quarters are discarded and the remaining is mixed	Collect the sample in a clean cloth or polythene bag
		
Process of collection	Label with required information: <ul style="list-style-type: none"> • Name of the farmer • Location of the farm • Survey number • Previous crop grown, present crop • Crop to be grown in the next season • Date of collection • Name of the sampler, etc 	Places for soil testing: <ul style="list-style-type: none"> • Krishi Vigyan Kendra (KVK) • State/district agricultural labs • Agriculture University, Research Stations • ATMA Officials/Agripreneurs

B. Plant Analysis

Plant Analysis is the second tool, after soil testing that is critical to improve crop nutrition and yield. Only plant analysis can identify the actual nutrient status of a plant or crop. While soil testing identifies the nutrients offered to the crop or plants, Plant analysis identifies how well the plants utilizes the soil nutrients and applied nutrients. Plant analysis allows the plant to tell us what nutrients it needs.

It is critical that the correct plant part and stage of growth be sampled. The normal nutrient concentration differs between the various plant parts. Also, the normal nutrient concentration of each plant part changes as the plant matures. It is important to keep these factors in mind to assess the nutrients status of plants. The plant parts required to be collected for different crops are as follows.

Crop	Growth stage	Plant part to be sampled	Quantity	Nutrient requirement and productivity
Cotton	(a) Seedling, 6” to 12” tall	Entire above ground portion of plant.	15 –20 plants	Keeping soil fertility and soil nutrients at optimum level helps in increasing the productivity of the soil. Although the ability of the soil to supply the plants with the required
	(b) Prior to or at first bloom	Youngest fully mature leaves from the main stem of plant.	15 – 20 leaves	
	(c) When first squares appear	Discard the petioles.		
Sugar Cane	2 Months to mature	Second fully mature leaf without sheath.	15 to 25 leaves	
Sunflower	(a) Seedling stage	Entire above ground portion of plant.	15 to 20 plants	
	(b) Vegetative to full bloom	Youngest fully mature leaf. No petiole.	15 to 20 leaves	

C. Irrigation Water Analysis

Irrigation water, irrespective of its source, always contains some soluble salts. The suitability of waters for a specific purpose depends upon the types and amounts of dissolved salts. Some of the dissolved salts or other constituents may be useful for crops but the quality or suitability of water for irrigation purposes is assessed in terms of the presence of undesirable constituents. Some of the dissolved ions such as NO₃ are useful for crops.

The most important characteristic that determine the quality of irrigation water are:

- pH
- Total concentration of soluble salts are judged

through Electrical Conductivity (EC).

- Relative proportion of sodium to other cations such as Ca and Mg are referred to as Sodium Adsorption Ratio (SAR).
- Concentration of boron or other elements that may be toxic to plants.
- Concentration of carbonates and bi-carbonate as related to the concentration of calcium plus magnesium are referred to as Residual Sodium Carbonate (RSC).
- Content of anions such as chloride, sulphate and nitrate.

Methods of water sample collection

As water quality and suitability plays an important role in deciding production and productivity of crops, farmers are advised consult extension worker to test the water.

nutrients depends also on the soil condition like i.e. soil texture, soil structure and soil organic matter. Therefore, soil fertility management does not only include nutrient management but also soil condition management.

Apart from other soil management practices, soil fertility focuses on:

- Maintain a balance between nutrient uptake and nutrient application.
- Adequate fertility for the plants at the specific growth stages.
- Soil fertility and organic matter maintenance
- Minimizing the nutrient loss by avoiding excess application.

The soil nutrient demand usually is based on:

- Soil nutrient level
- Crop variety and yielding ability
- Soil moisture
- Targeted yield

Soil analysis direct the farmer on quantity and quality of fertilisers to be used. Farmers can get the crop specific nutrient (fertilizer) recommendations after consulting the local extension service or their DESAI-trainer and discussing with them the soil analysis report.

C. Recommended Fertilizer Dose for Important Crops

	N (kgs/ha)	P2 O5 (kgs/ha)	K2O (kgs/ha)	Remarks
Banana	110	35	330	Apply 50% extra fertilizers at 2nd , 4th, 6th & 8th months after planting for tissue culture banana
Cotton	120	60	60	(TCHB – 213)
Citrus (sweet orange)	0.6 kgs	0.2 kgs	0.3 kgs	From 6th year onwards
Mango	1.0 kg	1.0 kg	1.5 kg	Kg of NPK/tree for 6th year onwards
Sugar cane	275	-	112.5	
Sun flower	60	90	60	Irrigated Hybrid
	40	50	40	Rainfed/Varieties

General considerations before fertilizer application:

- Nutrients and not fertilizers should be bought. (Think nutrients, not fertilizers).
- Each nutrient applied as fertilizer should give a desired production response.
- The cost of fertilization must be calculated on the basis of applied plant nutrients per unit area of land.
- Calculate one nutrient at a time, considering available sources, prices and feasibility of using.
- A sample Soil Health Card, issued to the farmers based on the soil test results, should be used by the farmer to calculate the quantities of fertilizers required:

Soil Health Card – Macro Nutrients

Farmer's Name: _____ Date: _____

Village: _____

Mandal: _____

District: _____

Sl. No.	Lab No.	Sl. No./ Sample details	Texture	Calcium Status	pH			Electrical Conductivity (mS/cm)		Organic Carbon	Available Phosphorus (P2O5) (kg/ha)		Available Potassium (K2O) (kg/ha)	
					Value	Status	Gypsum (T/A) or Lime (kg/ha)	Value	Status		Value	Status	Value	Status

Signature of the Scientist _____

Soil Health Card – Micro Nutrients

Farmer's Name: _____ Date: _____

Village: _____

Mandal: _____

Sl. No.	Lab No.	Texture	Zn (PPM)	Status	Mn (PPM)	Status	Fe (PPM)	Status	Cu (PPM)	Status

Signature of the Scientist _____

If the samples are all above the critical level, there is no deficiency of any element.

Nutrient	SL, SCL	CL
Zn	0.65	0.70
Cu	0.20	0.30
Fe	4.00	6.00
Mn	2.00	3.00

Fertilizers: Chemical or Organic

Chemical fertilizers

Advantages:

- Nutrients are immediately available for plant uptake.
- Price is lower as compared to organic fertilizer.
- Small quantities are required because they are nutrient rich.

Disadvantages:

- Over application usually results in economic and environmental losses.
- Over supply makes plant tissues soft and vulnerable to diseases and pathogens.
- Increased rate of soil organic matter decomposition resulting in soil degradation.
- Many nutrients applied are easily lost through different chemical reactions.

Organic fertilizers**Advantages:**

- Balanced nutrient supply.
- Enhance the soil biological activity.
- Help in improving soil structure.
- Increase the organic matter content.
- Slow release of nutrients makes soil on the long run fertile.
- Help in combating plant diseases.

Disadvantages

- Low nutrient content.
- Only effective in the long run.
- It may not supply all the nutrients required for plant growth.
- High cost.
- Bulkiness.

Efficient fertilizer use

Good knowledge and management practices can improve the fertilizer use efficiency.

- Select the crops and varieties that suit the locality and have best fertilizer response.
- Select right kind of fertilizer according to crop and soil.
- The fertilization should be planned for the cropping pattern and not for single crops.
- Fertilization application rate should be decided only after discussing your soil analysis report with your local extension officer or Desai-Trainer.
- Balanced fertilization should be practiced.
- Crops should only be sown at the locally recommended periods.
- Maintain optimum plant population and proper plant spacing.
- Effective control of pests and diseases will help in maximizing the fertilizer efficiency.
- To maximize the yield increase through fertilizer, all other growth critical factors must also be optimum e.g. crop must be irrigated at critical growth stages.

Fertilizer application methods

Broadcasting: fertilizer is distributed manually over the cropped field.

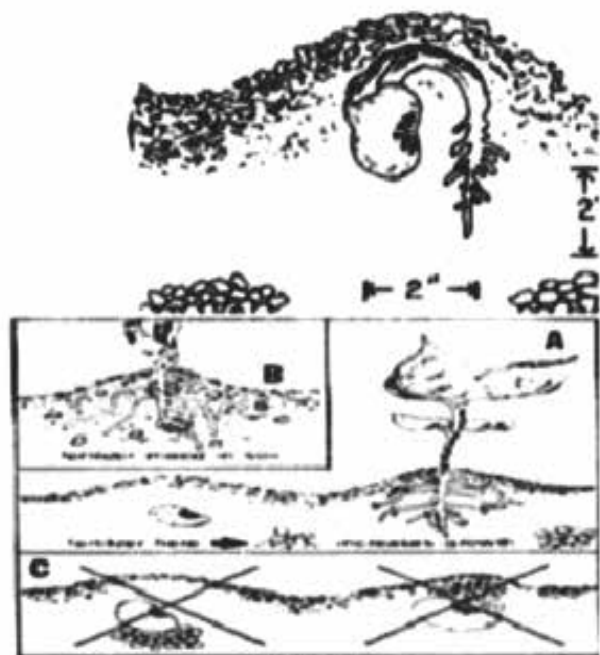
- The most common fertilizer application method.
- Highly inefficient method
- High economic and nutrient losses



Broadcasting

Placement: application in band or packets near the plants.

- Two sub-types:
 - i. Band application
 - ii. Spot Application
- The fertilizer use efficiency is high.
- Labour intensive.
- Efficient method but with high labour input.



Placement

Ring application: Spread the fertilizer around the tree at a distance of about one meter.



Ring Application

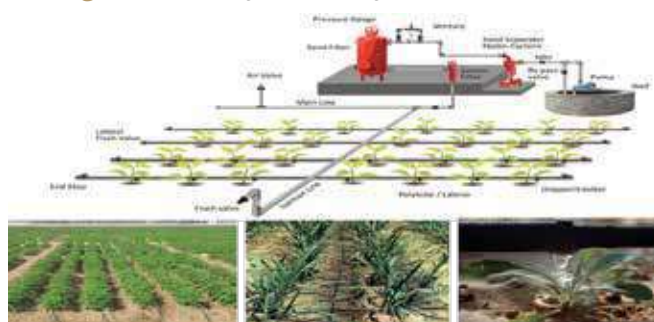
Foliar application: liquid fertilizers are sprayed on the crops.



Foliar Application

- Highly efficient
- Special equipment required
- High cost
- Only selected fertilizers can be applied

Fertigation along with irrigation



Fertigation

Method of application and nutrients

The method of application should be chosen according to the nutrient, crop, soil and cultivation method.

- **Nitrogen** application should be applied in splits and slow release mode to minimize loss.
- Frequent application in small quantity through foliar application is most efficient and results in quick recovery of crops.

- Use slow release nitrogen for plantation crops and long duration crops.
- Under puddle condition, use coated urea-neem oil. Coal tar sulphur coating will make urea to release nitrogen slow to match the uptake pattern.
- Urea can be cured with soil (1 part urea with 5-10 parts soil) to reduce the losses.
- Phosphate should be placed 4 to 6 cm below and 4 to 6 cm away from the seeds to ensure maximum availability.
- Phosphatic fertilizers give better response when placed in bands near the plant rows.
- Potassic fertilizers can be applied in one dose as basal application but for long duration crops the fertilizer application may be done in 2 to 3 splits.

Fertilizer calculations

Here is an example for the application of fertilizers based on the soil test recommendations. Suppose the recommendations are 120 kg N, 60 Kg P and 40 Kg K per ha. Calculate the quantity of urea, super-phosphate and muriate of potash fertilizers needed to supply the recommended doses!

Urea content is 46%, so to supply 46 kg N/ha 100 kg urea is required. To supply 120 kg N/ha $100/46 \times 120 = 260.9$ or 261 kg urea is required. Similarly super phosphate content is 16% P_2O_5 and the recommendation is given in the form of **Phosphorous**.

- $\% P = \% P_2O_5 \times 0.44$
- $Kg P = kg P_2O_5 \times 0.44$
- $Kg P = 16 \times 0.44$
- $Kg P = 7.04$

So super phosphate contains 7.04 P and the recommendation is given as 60 kg P.

To supply 60 kg P $= 100/7.04 \times 60 = 852.27$ or 852 kg single super phosphate is required. Similarly, we have to calculate the dose of potash through Muriate of Potash (MOP) as MOP contains 60% K_2O .

So MOP contains 49.8 K and the recommendation given is 40 kg K/ha.

To supply 40 kg K $= 100/49.8 \times 40 = 80.3$ kg or 80 kg MOP is required. So based on fertilizer analysis and soil test information the fertilizer application rates are calculated as above.

The formula for calculating the fertilizer to be applied (kg/ha) =

$$\frac{100}{\text{Nutrient content in the fertilizer material (\%)}} \times \text{recommended dose (kg/ha)}$$

Nutrient cost comparison

Example - 1

1. Urea with 46% N costs Rs.562.20 per 100 kg.
2. Ammonium sulphate 20% N costs Rs.1029 per 100 kg.

Urea has 46% N i.e. 46 kg N in every 100 kg urea. Therefore unit value of N in urea: $562.2/46 = \text{Rs.}12.22$ per kg N. Ammonium sulphate has 20.6% N i.e. 20 kg N in every 100 kg fertilizer and 24% sulphur. Therefore unit value of N in ammonium sulphate: $1029/20.6 = \text{Rs.}49.95$ per kg N. Thus, the nitrogen is cheaper in urea. Yet, ammonium sulphate also has 24% sulphur in it.

Therefore, for soils with sulphur deficiency, ammonium sulphate is a better choice and for soils with normal sulphur levels, urea presents a better N source.

Example - 2

1. Single Super Phosphate (SSP) with 7 % P costs Rs.480 per 100 kg.
2. Di - Ammonium Phosphate (DAP) 20% P and 18% N costs Rs.1596 per 100 kg.

SSP has 7% P i.e. 7 kg P in every 100 kg SSP. Therefore unit value of P in SSP: $480/7 = \text{Rs.}68.57$ per kg P.

Whereas, DAP has 20% P and 18% N, i.e. 20 kg P and 18 kg of N in every 100 kg of DAP.

Cost of Nitrogen in 100 kg of DAP = $(18 \times 12.22) = \text{Rs.}219.96$. Therefore unit value of P in DAP: $(1596 - 219.96 = 1376.00)$; i.e. $1376/20 = \text{Rs.}68.80$ per kg P

Thus, the unit cost of P is the same in both the fertilisers. Yet, DAP also has 18% N in it. Therefore, for soils with nitrogen requirement, DAP is the better choice.

GUIDE FOR MIXING FERTILIZERS

1. Muriate of Potash	2. Sulphate of Potash	3. Sulphate of ammonia	4. Calcium ammonium nitrate	5. Sodium Nitrate	6. Calcium cyanamide	7. Urea	8. Superphosphate single or triple	9. Ammonium phosphate	10. Basic slag	11. Calcium carbonate	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Muriate of Potash
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Sulphate of Potash
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	3. Sulphate of ammonia
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	4. Calcium ammonium nitrate
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5. Sodium Nitrate
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. Calcium cyanamide
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	7. Urea
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	8. Superphosphate single or triple
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	9. Ammonium phosphate
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10. Basic slag
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11. Calcium carbonate

- ☐ Fertilizers which can be mixed
☒ Fertilizers which may be mixed shortly before use
☒ Fertilizers which can not be mixed

Note: The crossing point of the required vertical column and horizontal column indicates the possibility of mixing or otherwise of the fertilizer

Compatibility of Fertilizers

Organic fertilizers

Organic manures are natural products used to provide the nutrients to crops. Examples of organic manure are cow dung, farmyard manure, green manure, compost from crop residues, vermicompost and other biological waste.

Organic manures increase the organic matter in the soil. Organic matter in turn releases the plant food in available form for the use of crops. However, organic manures should not be seen only as carriers of plant food. These manures also enable a soil to hold more water and also help to improve the drainage in clay soils. They provide organic acids that help to dissolve soil nutrients and make them available for the plants.

Additionally, organic manures have low nutrient content and, therefore, need to be applied in large quantities. For example, to get a standard mixture of 25 kg NPK, almost 1000-2000 kg organic manure is required, whereas the same amount of NPK can be easily obtained with a 50 kg bag of NPK fertilizer.

Compost: Compost is well decomposed organic wastes like plant residues, animal dung and urine earth from cattle sheds, waste fodder, etc.

Tips for FYM preparation

- Provide shade to compost site
- Make compost pit in a well drained elevated place
- Smaller heaps of manageable shape are better
- Keep the pit free from weeds
- Pit should be near to cattle shed and water source
- Allowing for full maturity
- Also use urine
- If ash is added do not heap in the pit but spread uniformly

How to use

- Manure should not be kept exposed in the field before application
- Preferably apply in bands into the soil instead of broadcast. In case broadcast, work it into the soil immediately

Advantage

- Complete plant nutrient
- Improved soil structure increases soil aeration and drainability
- Organic matter acts as biological clay and increase nutrient and water holding capacity of soil

- It reduces the bulk density to desirable level (1.3g/cc)
- It provides enough food for micro organisms in the soil and helps to build up microorganisms in the soil
- Nutrients slow release nature is very useful for long duration and plantation crops

Disadvantage

- It is bulky
- Cost of handling, transportation and storage are high
- High labour input
- High cost per kg of nutrients

Vermi-Compost: Vermicomposting is a process by which earthworms convert organic waste into fertile manure. Important spp of earthworm used for vermicomposting in Indian conditions are Epi-geic *Eugeniae*, *Eisenia Foetida*, and *Perionyx Exca-vatus*.

Earthworms

- Feed on soil and soil organic matter and convert it into compost
- Encourage growth of useful micro organisms
- Aerate and pulverize the soil
- Make soil porous and improving drainage
- Increasing water holding capacity of soil
- Give strength to plant immunity system

Advantages of vermi-compost

- Easy to use
- Low cost to produce
- Convert organic matter in to good manure in short time

How to make it

- Enrich vermi-compost with bio-agents
- Earthworms are our friends. Protect them and nurture in the field

Green manures

- Select important species
- Find a season to fit the green manuring crop in to cropping system
- Incorporate when 45 days old
- Allow 15-20 days before next planting for decomposition

Example: Sunhemp and Daincha

Green leaf manure

- Grow leguminous trees on road side, on bunds and waste land

- Loppings of trees can be incorporated 15 days before planting
 - Provide approximately 5 to 10 tons
- Example: Pongamia and Neem

Oilcakes

- Concentrated organic matter
- Mix with chemical fertilizer is useful as they make fertilizer slow release
- Use to enrich compost/organics
- Use preferably non edible oil cakes

Liquid Fertilisers

- Liquid form of fertilizers are applied with irrigation water or for direct application through foliar spray to augment yield and improve quality of a variety of crops like fruits, vegetables, oil seeds, pulses, cereals, cotton, tobacco, sugarcane, tea, etc.
- It will ease handling, less labour requirement as well as the possibility of mixing with herbicides have made the liquid fertilisers more acceptable to farmers

Fertigation

- Fertigation is the judicious application of fertilizers by combining it with irrigation water
- Fertigation can be achieved through fertilizer tank, venturi system, injector pump, Non-Electric Proportional Liquid Dispenser (NEPLD) and automated system

Advantages of Fertigation

- Ensures a regular flow of water as well as , resulting in increased growth rates for higher yields
- Offers greater versatility in the timing of the nutrient application to meet specific crop demands
- Improves availability of nutrients and their uptake by the roots
- Safer application method which eliminates the danger of burning the plant root system
- Offers simpler and more convenient application than soil application of fertilizer, thus, saving time, labour, equipment and energy
- Improves fertilizer use efficiency
- Reduction of soil compaction and mechanical damage to the crops
- Potential reduction of environmental contamination
- Convenient use of compound and ready-mix

nutrient solutions which also contain a small concentration of micronutrients

Nutrient content of important organic manures

Nutrient content of important organic manures

Organic Manure	Percentage of Nutrients		
	Nitrogen	Phosphorus (P ₂ O ₅)	Potassium (K ₂ O)
Poultry Manure	1.2-1.5	-	-
Sheep Manure	0.8-1.6	-	-
Farmyard Manure	0.4	0.3	0.2
Compost	0.5	0.25	0.5
Bone Meal	3.5	21.0	-

Bio-Fertilizers

These are products of microbial origin containing live cells of micro organisms multiplied in a laboratory and mixed with a carrier material like finely powdered coal, lignite or humus and supplied in a solid form.

Basically two types of bio fertilizer distinguished based on their capacity to supply nitrogen or phosphorus. Some bio-fertilizers have the capacity to supply nitrogen because they have the capacity to absorb nitrogen gas from the atmosphere in association with plants and use the nutrient for their cell synthesis. The nitrogen fixed becomes available to crop plants after the plant material is incorporated in to soil. This process is known as symbiotic nitrogen fixation. Other nitrogen fixing organisms can live freely in soil and fix nitrogen. There is one more type where the organism establishes a weak or associative symbiosis and fixes nitrogen.

In addition to nitrogen fixers there are some bacteria and fungi, which are used as bio-fertilizers to enhance phosphorus supply to crops. They solubilize insoluble or difficultly soluble phosphorus through their capacity to produce organic acids.

Plant Nutrient	Microorganism	Crops Benefited
NITROGEN	a) Symbiotic Rhizobium Azolla	All leguminous crops; Rice
	b) Associative Symbiosis Azospirillum	All cereal crops; Sugar cane
	c) Non Symbiotic Azotobacter Blue- green Algae	All crops; Rice

PHOSPHORUS	Microorganism	Crops Benefited
a) Solubilizing Effect	Bacteria: (Bacillus, Pseudomonas)	All Crops
	Fungi: (Aspergillus Penicillium)	All Crops
b) Absorbing Effect	Ecto Mycorrhizal	Tree crops
	Endomycorrhizae	All Crops

All bio-fertilizers are microorganisms belonging to group of bacteria or fungi or blue-green algae.

The capacity of N-Fixers to supply N to crops varies from 10 kg – 100 kg/ha and symbiotic nitrogen fixers particularly rhizobium bacteria are very efficient. The P-Solubilizers and P-Absorbers can mobilize insoluble phosphorus to the extent of 10 Kg to 50 kg P/ha. Mycorrhizae are symbiotic fungi, which get associated with plant roots. Azolla is a water fern which establishes a very active and beneficial association with blue-green algae - Anabaena

Algal inoculants are cultivated on submerged soils in tanks, dried and supplied as soil based culture (Inoculants). Endomycorrhizal inoculants are supplied as pieces of roots of grass plants infected with mycorrhizae. Ectomycorrhizal inoculants are cultivated in the laboratory and mixed with carrier material for supply. Azolla are supplied as fresh fronds (leaf). The bio-fertilizers are inoculated to seeds or applied directly to soil after suspending them in water. Azolla is applied directly to soil, which on multiplication establishes a very active symbiotic association with Anabaena, a blue-green alga.

- The best nutrient management method is Integrated Nutrient Management.
- Use bulk quantity of organic matter to provide good physical and chemical properties to soil.
- Smaller quantities of chemical fertilizer to provide quick release, which matches the uptake pattern of crops.

I. Package of Practices – Banana

Banana is one of the most commonly grown fruit crop of the country. India produces about 26.217 MT of banana from an area of 0.709 Mha with an average productivity of 37.0 mt/ha. Major producing states are Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Assam and Madhya Pradesh. Tamil Nadu has 0.1244 mha under banana and the total production during 2008-09 is 6.667 Mmt with 53.6 mt/ha productivity. In Gujarat, banana crop is cultivated in 11 districts covering an area of about 60900 ha. Gujarat is ranking 3rd among the states of India with an average productivity of 58.7t/ha. Unripe fruits are used for making chips, vegetable flour, etc. Ripened fruits are used for preparing drink, jam, beer, salad, etc. Banana fruits are having numerous medicinal uses (as per Ayurveda). From pseudostem threads are obtained and used for making rope and cloths.

Prevailing Varieties: Basarai, Lokhandi, Robasta, Shreemanti and Grand Naine.

Climate: Banana grows well in warm and humid climate with an average temperature of 27°C and rainfall of 2,000 to 2,500 mm. However, it requires assured irrigation facility.

Soil type suitability: Loamy and salty clay loam soils with good fertility status are best suited for banana cultivation. However, extremely clayey and sandy soils are not suitable for banana crop.

Land preparation: The land should be ploughed, harrowed and planked to achieve levelled fields. For planting banana, dugout a pit of 30 x 30 x 30 cm size at a spacing of 1.5 x 1.5 m.

Soil sterilization: After land preparation, the pits should be exposed to the sunlight for 10 to 15 days. In the case of heavy infestation of soil born pest and diseases, the soil solarization should be done using transparent plastic for a period of 15 to 20 days during summer season (preferably during May).

Time of plating: Optimum time for planting is 15th June to 15th July. Banana planting is done either by suckers or tissue culture plant.

Suckers: Suckers should be selected from a healthy field of banana. Sufficient care should be taken that suckers should not be damaged during digging and transport. Fresh sucker, weighing about 500 to 1,500 g, should be selected. For control of fungal diseases, suckers should be dipped in a solution of aureofugine¹ (10 g / 100 litres of water) for 1.5 hour prior to planting.

Tissue culture plant: Select healthy and uniform plants.

Irrigation and scheduling: The water requirement of banana crop by surface method of irrigation (25-30 irrigations) is 1,500-1,800 mm. By drip irrigation method, water requirement is 900-1,080 mm. The drip system should be operated on alternate day for a period of 1.05 to 2.25 hours during winter and 2.5 to 2.75 hrs during summer at a pressure of 1.2 kg/cm².

¹Aureofugine- To be used with caution.

Details of Drip System

Lateral spacing	1.5 m
Dripper per plant	2
Spacing between two drippers	30 cm away on either side of stem
Dripper discharge rate	4.0 lph

Water requirement for banana under drip irrigation

Months after planting	Liters / day / plant
1-3	5
3-5	9
5-8	11
8-11	10

Application of Fertilizers

Basal

FYM should be applied @ 20 to 25 t/ha at the time of land preparation. Top dressing of fertilizer should be done as given below

For using water-soluble fertilizers, the following schedule of fertigation may be followed:

Nutrient	Fertilizer application schedule
N (180g/plant)	7 to 8 splits at an interval of 15 to 20 days.
P (72g/plant)	7 to 8 splits at an interval of 15 to 20 days.
K (180g/plant)	7 to 8 splits at an interval of 15 to 20 days.

Time of application: The total quantities of water-soluble fertilizers should be applied in 7 to 8 splits at an interval of 15 to 20 days. The first split should be applied at the time of planting before monsoon and the rest should be applied after the cessation of monsoon.

Weeding: Banana fields should be kept weed free either by hand weeding/interculturing or by weedicide (diuron @ 1.2 kg/ha as pre emergence) application. Mulching with black plastic (50 micron) or sugarcane trash (@ 10 t/ha) should be done. If required, hand weeding should be done prior to mulching.

Desuckering: First desuckering should be done manually. To minimize the regeneration of suckers, 3 ml of diesel or kerosene should be injected into the cut portion of the suckers.

Plant protection measures

Diseases	Control Measures
Bunchy top	Aphid should be controlled by applying systemic insecticide viz; Acetamiprid: (0.2gm/litre).
Premature fruit ripening	Sucker should be dipped in the solution of Aurofugin ¹ 10 g in 100 litres of water for 1.5 hrs.
Pests	Control Measures
Rhizome weevil and nematode	Neem based products such as Neem oil, Neem cake, Neem seed Kernal extract (NSKE) can be applied.

Bunch coverage: After the complete formation of the bunch, it should be covered by LLDP film bag (blue, white or black colour). This improves quality as well as yield of banana.

Time of harvesting: Maturity varies with variety but usually the crop takes about 12-14 months to mature.

Yield: By adopting the above practices, the banana yields about 70 to 80 t/ha. Generally, size and colour based grading is done.

Post harvest handling and storage: Bananas can be stored for up to a week in a cool place but unripe bananas should not be stored in the refrigerator as this may irreversibly interrupt the ripening process. If the banana is no longer green, then it is ripe and can be stored for a maximum of one week. For storage, banana should be stored at 13o to 14oC. Bunches should be kept out of light after harvest since this hastens ripening and softening. For export, hands are cut into units of 4-16 fingers, graded for both length and girths and carefully placed in poly-lined boxes to hold 12 to 18 kg depending on export requirement. Prior to packaging fruits are cleaned in water or dilute sodium hypochlorite solution to remove the latex and treated with thiobendazole.

Plastic packaging: Keeping quality of banana can be increased when packed in 400 gauge LDPE (Low-Density Poly Ethylene) bags with or without ventilation either under ambient temperature or in a zero energy cool chamber (13.5°C). Storing of banana fruits in unvented polybags at low temperature could extend the shelf life of the fruits up to 19.33 days.

Cost economics

Annual system cost (Rs /ha)	17,500
Cost of cultivation (Rs/ha)	1, 08,000
Total cost (Rs/ha)	1, 25,500
Total income (Rs/ha)	2, 10,000 to 2, 40,000
Net income (Rs/ha)	84,500 to 1, 14,500
C:B ratio	1:1.67

¹Aurofugin- To be used with caution.

II. Packages of Practices – MANGO

Mango is the most important fruit crop of India. India produces about 12.750 Mt of Mango from an area of 2.309 Mha with an average productivity of 5.5 mt/ha. Major producing states are Andhra Pradesh, Uttar Pradesh, Bihar, Karnataka, Tamil Nadu, West Bengal, Orissa & Maharashtra. Uttar Pradesh has 0.2712 mha under mango and the total production during 2008-09 is 3.465 Mt with 12.8 mt/ha productivity. India ranks first in the world for mango production and area under cultivation. Mango is a rich source of vitamin A and has a fairly good content of vitamin C. Mango fruits are used for preparation of pickle, chatani, amchur, jam, squash, nectar and many other delicious products.

Climate and soil: Mango can be grown from alluvial to lateritic soils except black cotton soil which has poor drainage. The temperature between 24 and 27°C is ideal for mango cultivation.

Variety: Dashehari, Langra, Chausa, Bombay Green, Lucknow Safeda, Mallika and Amrapali.

Multiplication of genuine planting material: Mango can be propagated by veneer, wedge and soft wood grafting. The protected nurseries in polyhouses and use of sprinkler and drip is becoming common for raising humidity level, which is required for higher grafting success rate.

Preparation of land: The land should be prepared one month before planting. The pits of 1m x 1m x 1m size are dug. The pits are exposed for 2 to 4 weeks to kill harmful soil organisms.

Soil sterilization: Soil sterilization can be achieved through both physical and chemical means. Physical control measures include steam and solar energy. Chemical control methods include herbicides and fumigants. Soil sterilization can also be achieved by using transparent plastic mulch film (25 micron thickness) termed as soil solarisation.

Planting: Square and rectangular systems are popular. Before planting, pits are filled with FYM at the rate of 15-20 kg/plant. The grafts should be planted during July to September.

Planting density: High density (3m x 6m or 5m x 5m) planting helps increase the yield/unit area. Normal planting distance of mango is 8m x 8m.

Canopy Management: Training should be done after 6th month of planting. It is essential to space the branches properly and to help in intercultural operation. At initial branching height between 60 to 70 cm is appropriate.

Water requirement of the crop

Age of the plant	Water requirement of the crop in litres/day/tree
Young plant (up to 3 years)	9-12 lts
3-6 years	30-35 lts
6-10 years	50-60 lts
9-12 years	80-90 lts
Fully grown trees	120 lts

A young tree requires 2 drippers at a distance of 1m on lateral lines, while fully-grown trees require 2 drippers with double lateral lines at 1-1.5 m distance.

Application of fertilizers: Mango should be manured with phosphorus twice in a year i.e. the beginning of the monsoon (June-July) and during the period of post-monsoon (September-October). Usually fertilizers (N and K) are applied in split doses in the month of June-July, September-October, January-February and March-April. For adult trees (10 years or above) 1,000g N, 75g P₂O₅, 75g K₂O and 100 kg FYM per year should be applied. Application of micronutrients such as Zinc and Boron help in cell elongation process.

Malformation: Deblossoming at bud stage (1 cm long) alone or in combination with spray of 200 ppm NAA lowers the number of malformed panicle.

Alternate bearing management: Use of paclobutrazol (5-10g/m canopy diameter), 3 months before budburst applied through soil drenching can be used for obtaining regular bearing.

Weed management: Black plastic mulch (100 micron) restricts the germination of weed seeds and suppresses the weed growth. The size of the film requirement for young plant is 1 m x 1 m, and for 8 years onwards film requirement is 2.5 m x 2.5 m around the tree.

Intercropping: In the interspaces of mango orchard, certain vegetable can be intercropped viz. onion, tomato, radish, carrot, ginger, turmeric, methi, cabbage, etc. Moreover, fruit crops can also be grown viz. papaya, pineapple, etc. for the initial 4-5 years.

Mulching: Soil drenching with paclobutrazol (5g and 10g/tree) coupled with black polythene mulch (100 micron) results into minimum outbreak of September to October vegetative flushing, giving an early and profuse flowering and a higher annual yield.

Plant Protection Measures

Insect pests	Symptoms	Control measures
Mango hopper	Pest starts attacking during flowering season.	Spraying of acetamiprid or thiamethoxam (0.2gm/litre of water).
Mealy bug	Nymphs suck juice from young shoots, panicles and flower pedicels.	Raking of soil around the trunk and mixing with neem cake around tree trunk is effective.
Stem borer	Pest makes tunnel through the main trunk and branches.	Clearing tunnels with hard wire, pouring, Emamectin benzoate (50 gm / litre) and plugged with mud.
Fruit fly	Pest makes the fruits rot by laying its eggs in clusters, just before the ripening, under the peel of fruits.	Application of acetamiprid or thiamethoxam (0.2gm/litre of water).

Disease	Symptoms	Control measures
Anthracnose	It attacks leaves, flowering panicles and fruits.	Spraying of Copper Oxychloride (0.03%) can control this disease.
Powdery mildew	Whitish powdery growth on the leaves.	Wettable sulphur (0.02%) and Bayleton (0.05%).
Bacterial Canker	Unattractive fruits because affected parts of fruits show longitudinal crack and oozing of bacterial exudate and leading to fruit drop.	Streptocycline (100-200ppm), agrimycin (17% streptomycin) - 100 (100ppm) and copper oxychloride ¹ (0.03%).

Yield and quality control:

From a well grown up tree one can expect an average yield of 50-225 marketable fruits (50 kg) per plant per year.

Harvesting and post harvest management:

From the 4th year onwards the mango fruits can be harvested at the mature green stage during morning hours. After harvesting fruits are graded according to their size, weight, colour and maturity. Packaging of fruits should be done in corrugated fibreboard (CFB) boxes. Tissue paper and polythene foam paper are used for wrapping high-value fresh mangoes. Polyethylene lining has been found beneficial as it maintains humidity, which results in lesser shrinkage during storage. Dashahari treated with calcium chloride solution (4%) at sub-atmospheric pressure of 500 mm Hg for 5 minutes can be stored at 12 °C for 27 days.

Cost economics of drip irrigated mango (one ha)

Rate of interest	10.5%
Life of system	7.5 years
Expected yield	19 t/ha
Planting distance	5m x 5m
Cost of cultivation	Rs.24, 000
Fixed cost	Rs.30, 298
Annual cost of drip system	Rs.8,713
Expected cost benefit ratio	1: 6.0

III. Package of Practices - Sugarcane

Time Schedule	Recommended Operations
Before planting	<p>Plough the land up to 45 cm depth.</p> <p>Apply 25 tons per hectare of well-decomposed Farm Yard Manure (FYM) or decomposed molasses or compost and deep plough the field with tractor.</p> <p>Make ridges and furrows with 80 cm spacing having 20 cm height and up to 10 m length.</p> <p>Apply 375 kg super phosphate in the furrows.</p>
Planting day	<p>Select about 75,000 two-budded setts per hectare from 6-8 months old nursery or raise seedlings in poly bags with single-budded setts.</p> <p>Treat the setts for 10 minutes by dipping in a solution prepared with Thiamine, 2.5 kg urea and 2.5 kg lime in 250 litres of water.</p> <p>Plant the setts 2 cm deep with buds on the sides.</p> <p>For every 10 furrows, plant setts on 2 rows in one furrow for gap filling purpose.</p>
3rd day after planting	To control weeds, spray atrataf @ 2.5 kg/ha in 500 litres of water with hand sprayer.
5th day after planting	Spread sugarcane trash up to a height of 15 cm on the ridge.
25th day after planting	Gap-fill with seedlings raised in polybags or the plants taken from the 2 rows planted- furrows in every 10th furrow.
30th day after planting	Mix 5 kg Azospirillum and 5 kg phosphobacterium per ha mixed with 250 kg powdered FYM. Apply at the bottom of the plants and irrigate immediately.
From 35th day after planting	<p>From 35 to 100 days after planting Irrigate once in 7-10 days.</p> <p>To prevent attack by early shoot borer, apply Sulphur on the setts and cover with soil.</p> <p>If 25-30% of the shoots are affected, then for every 100 metre length of furrow, mix Sulphur and apply using a hand sprayer on the tips and bottom of the shoots.</p>

45th day after planting	<p>Do hand weeding.</p> <p>Apply in pits a mixture of 110 kg nitrogen¹, 60 kg of potash and 35 kg of neem cake per hectare.</p>
60th, 90th and 120th days after planting	<p>Spray a mixture of urea 2.5%, potassium chloride 2.5% during periods of drought.</p> <p>On the 60th day, apply a mixture of 5kg azospirillum, 5kg phospho-bacterium and 250 kg of decomposed FYM in powder form at the bottom of the plants and irrigate immediately.</p> <p>On the 90th day, do hand weeding; apply in pits (after earthing up) a mixture of 110 kg of nitrogen¹, 60 kg of potassium and 35 kg of neem cake per hectare.</p>
120th day after planting	<p>Under drought conditions, apply 60 kg of potassium and irrigate immediately.</p>
150 days to 225 days after planting	<p>Carry out de-trashing at 150 days after planting.</p> <p>If inter-node borer exists, release parasites 6 times @ 5 cc per hectare once in 15 days.</p> <p>101-210 days – irrigate once in 7 days.</p> <p>210th day- detrash and tie lodged canes.</p> <p>225th day- spray acetamiprid or thiamethoxam (2ml/litre of water) to control mealy bugs, white fly and scales.</p>
260th day	<p>Spray Emamectin benzoate (50 gm / litre) of water under the leaves (if required) to control pyrilla and all sucking pests.</p>
270 to 360 days	<p>Irrigate once in 15 days.</p> <p>Stop irrigation 15 days before harvesting.</p>
Harvest	<p>Cut canes at the bottom close to the ground with sickles or sharp knife. Remove trash, roots, water shoots and cane tops and send clean canes to the factory.</p>

¹Nitrogen- To be used with caution and preventive measures (Gloves, etc).

SCHEDULE OF OPERATIONS: RATOON CROP

Time Schedule

Recommended Operations

Remove trash, stubble shave uniformly under correct moisture conditions with sharp spades.

Mix 15 tons of FYM or 25 tons of compost or 25 tons of decayed molasses with 375 kg Superphosphate (75 kg of P_2O_5), 135 kg of nitrogen and 35 kg of neem cake per hectare in pits.

Irrigate immediately, cutting the sides of the ridges and ensuring mixing of applied manures well with the soil.

Control weeds by spraying atrataf @2.5 kg in 500 litres of water with hand spray.

9th -10th day

Mix 5kg azospirillum and 5 kg phosphobacteria per hectare with 250 kg of powdered FYM and apply at the bottom of the plants and irrigate immediately.

Spread trash obtained from plant canes on the furrows.

25th – 30th day

Gap-fill with grown up plants.

To prevent attack by early shoot borer, apply Sulphur on the setts and cover with soil.

35th day

Mix 5kg azospirillum per hectare with 250 kg of powdered FYM and apply at the bottom of the plants and irrigate immediately.

From 1-35 days

Irrigate once in 7 days.

From 35-90 days

Irrigate once in 10 days.

60th day

Do hand weeding.

Apply in pits a mixture of 110 kg nitrogen, 60 kg of potash and 35 kg of neem cake per hectare and follow light earthing-up.

90th day

Apply 60 kg of potash additionally in drought situations.

91- 250 days

Irrigate once in 7 days.

30, 60 and 90 days	Spray a mixture of urea 2.5%, and potassium chloride 2.5% on the leaves in drought situations.
120th day	Detrash and earth up well.
121 to 210 days	Release Trichogramma parasites (when required) once in 15 days.
180 days:	Detrash a second time.
210 days	Spray acetamiprid or thiamethoxam (0.2gm/litre of water) to control mealy bugs, white fly and scale insects.
251-360 days	Irrigate once in 15 days and stop irrigation 15 days before harvest.
Harvest	Cut canes at the bottom close to the ground with sickles or sharp knife. Remove trash, roots, water shoots and cane tops and send clean canes to the factory.

Note: Water Management – Irrigation gap has to be adjusted depending up on quantity of rain fall Reduce gap between irrigation in sandy soils and increase it in block soils.

IV. Package of Practice for Nagpur Mandarin Cultivation

Selection of site

Orchard: Soil should be well drained and of shallow or medium depth. Deep heavy soils having more than 60% clay contents are not suitable for citrus plantation. **Nursery:** Nursery should be located at least 500 meters away preferably on western side of the orchard to minimize incidence of insect pests and diseases.

Raising of citrus nursery

Sowing of Rootstock Seeds

Potting mixture of soil, sand and FYM or compost should be used in equal proportion (1:1:1) for filling of trays in primary nursery and polythene bags in secondary nursery. Before it is used for filling the bags/trays, the potting mixture should be solarised. For solarisation, it is spread on the concrete platform in 4" thick layer in the month of April – May, sufficiently moistened with water, then covered fully with the white polythene sheet, sealing its edges with soil. Then it should be left undisturbed for 11/2 to 2 months in the hot sun for solarisation.

- Only certified seeds of rough lemon or Rangpur lime rootstocks should be used.
- Shade dried medium size bold seeds of rootstocks should be treated with vitavax or thiram (@ 3g/kg seed) and sown on the raised beds or in plastic trays during September – October.
- Stagnation of water in beds should be avoided otherwise roots of young plants may start rooting.
- Uniform seedlings of medium height only be selected discarding either vigorous or the weak and dwarf ones while transferring to secondary nursery. Plants having hooked or bent roots should be discarded.
- Disease free budgrafts of nagpur mandarin

Plant Protection Measures

- Phytophthora infected plants must be eliminated. In case of phytophthora infection drenching of plants with either metalaxyl MZ72 @ 2.75 g/l water or fosetyl Al @ 2.5 g/l water should be done. Second spray should be given after 40 days.
- To prevent infestation of insect pests like citrus leaf miner and thrips plants should be sprayed either with acetamiprid or thiamethoxam (0.2gm/litre of water) at 10 days intervals.
- The growth of plants is also affected adversely due to mite attack which can be controlled by spraying plants with Fenazaquin 10% EC @ 4ml/litre and wettable sulfur @ 3 g/l water, alternatively at 15-20 days interval.
- In containerized nursery irrigation, fertilizer application, weed control, insect pest and disease control as well as cultural operations can be performed at ease.

Budding

- Budsticks should be used from the authorized and certified source only.
- Budstick should be drawn from the last years flush. The stick should have pencil thickness, be roundish and have whitish longitudinal streaks.
- Budstick should not be drawn from rubbery wood or kikarpani plants.
- Budding should be performed at 10" – 12" height on the rootstock seedling.



Disease Free Bud Grafts of Nagpur Mandarin

Orchard Establishment

Pits size

- Pits for planting should be 2'6" x 2'6" x 2'6" (75 x 75 x 75 cm) size and spaced at 6 x 6 m distance.
- To avoid soil borne fungi or nematodes soil of roots should be removed.

Pre-planting treatment for budlings

- Roots of budling should be dipped in the solution of metalaxy1MZ72 2.75 g for 10-15 minutes before planting.

Planting of budlings

- While planting care should be taken that rootstock union remains at least 6" above ground.

Manure and fertilizer application

- Nitrogen containing fertilizers should be applied in three equal splits in January, July and November months; phosphorus containing fertilizers in two splits in January and July months and Potassium containing fertilizers may be applied as singly dose in January.
- Surveys conducted by NRCC in Kalmeshwar, Katol, Narkhed, Saoner, Hingna and Ramtek tehsils of Nagpur district have revealed N deficiency in most of the orchards and P deficiency in leaf and soil of 50% orchards. Similarly, leaf and soil K was either at desired levels or even more than it. Citrus trees are nitrogen loving plants. They respond well to the applied nitrogenous fertilizers. During fruit development K may also be applied as it may fell deficient. Supplementary doses of P and K at 200 and 100 g/tree, respectively, may be included in the fertilizer package recommended for bearing orchard.

Fertilizer doses

Fertilizers /Age of tree	I Year	II Year	III Year	IV Year and Above
Nitrogen	150	300	450	600
Phosphorus	50	100	150	200
Potassium	25	50	75	100

As far as possible 1/3rd of the dose of N may be given through farm yard manure/compost, oil cakes etc.

Leaf sampling

For correct diagnosis of nutritional status use of correct sampling technique is very important. For this, it is important to know as to how many leaves, when, from which part of the plant and from how many trees should be sampled. In case of ambia bahar, 5-6 month old leaves in August-October and for mrig bahar 6-8 months old leaves in December and February should be sampled. As far as possible, the 2nd, 3rd or 4th leaf should be picked from the tip of the non-bearing shoot, preferably at 1.5 – 2 m above the ground and sampled.

Drip irrigation

With the help of a drip system of irrigation, the required quantity of water can be provided right at the feeder root system. Similarly, water-soluble fertilizers and micronutrients also can be given through the drip system. Water requirement of irrigation depends upon age of the tree and season of the year (Table 1). Mulching with drip irrigation maintains moisture in soil for a longer period.

Water requirement of the nagpur mandarin (litres / day / tree)

Month	Age of the three (years)									
	1	2	3	4	5	6	7	8	9	>10
January	7	15	22	30	44	62	72	82	92	102
February	9	20	30	40	60	82	96	101	121	137
March	12	26	40	53	78	109	127	145	163	181
April	14	29	43	63	87	123	143	163	183	204
May	17	34	52	74	102	143	166	188	211	235
June	11	22	34	48	67	95	110	126	142	157
July	8	18	26	41	56	79	92	105	118	131
August	7	14	23	34	42	60	70	80	90	100
September	8	15	25	36	45	65	76	87	98	108
October	9	17	27	40	52	79	92	105	118	131
November	8	15	25	36	45	63	74	85	96	150
December	6	11	19	24	35	49	57	65	73	82

Weed control

For effective and economic control of mono and dicotyledonous weeds, pre-emergence weedicides, diuron 3 kg at the end of May and 120 days thereafter should be done. For post-emergence weed control, glyphosate @ 4 l/ha should be sprayed on weeds before flowering.

Fruit drop

Fruit drop in citrus is of serious nature which occurs at least twice; i.e. the first time when the fruits are little more than the marble size and the second time when the fruits are fully developed or at the time of colour break. This drop is very serious in the ambia bahar crop pre-harvest fruit drop in

nagpur mandarin, which is called as pre-harvest fruit drop and is important from economic point of view to the orchardists. To control the fruit drop that occurs after fruit set, two foliar sprays of either 2,4-D or GA3 at 15 ppm + urea 1% and copper oxychloride² (0.3%) at monthly intervals in April – May are recommended. Same spray concentration is recommended for controlling pre-harvest drop in the months of September and October. 2,4-D and GA3 may be dissolved earlier in little quantity (30 – 40 ml for 1g) of some organic solvent such as alcohol or acetone before making the spray solution.

Control of Insect Pests

Blackfly (Kolshi): Nymphs of citrus blackfly attack the young flush, suck the sap and excrete sweet and sticky liquid, which favours rapid development of black sooty mould that covers entire plant surface. The process of photosynthesis is hampered greatly resulting in stunted growth of plants, low intensity of flowering, scarce fruiting which are insipid in taste and decline of citrus orchard sets. For control of blackfly two sprays of insecticides viz. acetamiprid 0.2 g/litre water should be given at 50% egg hatching stage that normally occurs in the II week of July and the I week of December and April. One additional spray which targets the adult blackfly population when it is at its peak helps tremendously in controlling the pest.

Method of spraying: Spraying should be directed at the underside of the leaf, ensuring the complete drenching of the tree. For proper coverage and penetration of canopy, use of power sprayers for spraying operation should be envisaged. Insecticides should be used alternatively for better results.

Citrus psylla: Numerous young brownish nymphs of psylla are seen crawling on the young flush. Several dirty gray colour adults can be seen sitting in line with tails upwards. Voluminous desapping by the nymphs results into the drop of flush, flowers and berries. Affected branches dry and die-back sets in. The nymphs also excrete white crystalline powder, which invites fungal infestation. Psylla can be controlled by spraying acetamiprid 0.2 g/litre water twice with 10 days interval during the initial days of flushing. Bark eating caterpillar (Larva) are incidence of mites on fruits (Lalya).

Leaf miner: Serpentine mines are seen on the new leaves and also young stems are mined when the incidence is severe. At times death of young shoots may occur. The problem is quite serious in nursery and in young orchard. To control citrus leaf miners, spray either imidacloprid 5 ml (To be used in proper doses under guidance of an agriculture expert) and thiamethoxam 0.2g/litre water.

Bark eating caterpillar: The pest is noticed predominantly in the older and ignored orchards. The hanging wooden frass and tunnel at the joint of two branches during October – April indicates the presence of the pest. Larva remains hidden inside the tunnel during daytime and becomes active in the night and feeds on the bark nearby the tunnel. This results into snapping of food supply, ultimately yellowing of leaves on the branch and its slow decline. For control of the pest the wooden frass should be cleaned and each tunnel should be administered with Emamectin benzoate/spinosad @0.4 ml/litre water.

Fruit sucking moth: The moth attacks the ripening fruits during late hours in the evening. The moth punctures it making a hole in the ripening fruit to suck the juice through which an infection may take place. Soon rotting starts, leading to fruit drop. Collection of dropped fruits and their

destruction followed by smoking of orchard late evening hours is suggested. For fruit fly control, hanging of methl eugenol (feromone) traps is an effective method to check the pest.

Mites: Citrus rust mites attack in mrig bahar fruits especially during September – November. The fruit surface, particularly the side exposed to sun, is brushed and develops a big patch of dark brown colour – called ‘Lalya’ – only after 1 to 1 1/2 months. To check this, two alternating prophylactic sprays at 15-20 days interval with Fenazaquin 10% EC @ 4ml/litre and wettable sulphur @ 3 g/l water are recommended in September – October. Similarly, a phytophthora caused gummosis spray of acetamiprid/thiamethoxam @0.2g/litre water at the berry stage of the ambai fruits is required to protect the fruits from unpleasant scars.

Precautionary measures: Avoid water stagnation in orchard by providing channels along the slope for proper drainage. Moreover, pruning of intermingling branches to allow aeration and sunlight to prevent dampness in orchard are suggested. Presence of guava, pomegranate, chiku, mango trees, etc. near the orchard act as the alternate hosts for blackfly, therefore, such trees should also be covered with insecticidal sprays.

Control of Diseases

Twig Blight: Drying of fruit bearing branches after harvest is a common phenomenon. Removal of such dried shoots along with the 2 cm lower live part, followed by a fungicidal spray i.e. copper oxychloride or bordeaux paste application is recommended to check twig blight.

Gummosis, root rot and collar rot

- Proper diagnosis of the disease is must.
- Affected trees should be treated with metalaxyl MZ 72 @ 2.75 g or fosetyl AL @ 2.5 g/l water till drenching once in May – June. The second spray should be given after 40 days. The tree trunk and soil of the tree basin should also be sprayed/drenched.
- Removal of the rotten roots, cleaning the wound on the gum-oozing trunk with sharp knife and then pasting with metalaxyl³ MZ 72 should be done.
- Apply bordeaux paste (1 kg CuSO₄ + 1 kg CaOH + 10 l water) on tree trunk upto 2 to 2 1/2 ft from ground twice i.e. before monsoon (May) and after monsoon (October).

Precautionary measures

- Avoid flood irrigation
- Follow the double ring system of irrigation so that water does not come in contact with the tree trunk.
- Avoid deep ploughing under the tree to prevent damage/injury of the root system. Declining nagpur mandarin orchard rejuvenated orchard.

Pre-harvest spray of fungicide: Three pre-harvest sprays of fungicides like difenoconazole @2ml/litre water at 15 day intervals till drenching prevent pre-harvest fruit drop by 54%. It also controls post harvest diseases upto 70%. This spray remains effective for 3 weeks at normal temperatures.

Post-harvest fungicidal treatment: Fruits dipped in fungicidal solution difenoconazole for 5 minutes are safe to minimize rotting upto 70% and can safely be stored for 3 weeks under normal condition.

Precautionary measures

- Follow plant protection measures to keep bearing tree disease free and healthy.
- Post-harvest handling of fruits must be followed carefully to avoid any sort of injury of fruits.
- Avoid the use of copper fungicides like b,ordeaux mixture, blitox, phytolan etc. at this stage.

Rejuvenation of declining citrus orchards: Declining citrus orchards can be rejuvenated with the use of developed technologies and brought into productive stage.

Harvesting

- Traditionally fruits are harvested by twisting and pulling forcefully which may lead to a hole in the neck of the fruit or injury to the stem end. The fruits should be selectively harvested when $\frac{3}{4}$ th of the skin turns yellow. TSS: Acidity ratio should not be less than 14 in both ambia and mrig bahar fruits. TSS should be at least 10%. Once this stage is reached, harvesting should not be delayed for colour development since other fruits may turn loose.
- Fruit should not be allowed to come in contact with soil and straw and also should not be exposed to hot sun.
- Packing should be done immediately after harvesting.
- For waxing on a large scale packing line can be used. Washing and waxing (stay fresh high shine was 2.5 g + Tebuconazole) and grading of fruits is also done automatically at the end.
- Graded fruits are packed in corrugated fibre board boxes (50 x 30 x 30 cm) which are telescopic with holes on both the sides covering 5% of total side portion. To keep the fruits safe from moisture in the store house, boxes should be externally laminated with plastic.
- For small scale (1 – 1.5 tonne) and short duration (20 – 25 days) storage an evaporative cool chamber is recommended, costing Rs.10,000/- to 12,000/-.
- For delaying or postponing the harvest of the fruits, two sprays of GA3 (100 mg / 10 litre of water) in 15 day intervals at the point of the colour break are recommended.
- For long duration cold storage, a temperature of 6-7 °C and humidity 90-95% is desirable. In such a situation, citrus fruits should not be stored for more than 45 days. To avoid chilling injury, care should be taken that the temperature does not go down upto 40 °C.

2.6. Lessons Learnt

1. Dark coloured soils are more fertile compared to light coloured soils. Neutral pH is more suitable for majority of crops. Lime is used for amending acid soils and gypsum for alkaline soil.
2. Soil testing is essential for judicious application of fertilisers based on nutrients status in the soils.
3. Integrated Nutrient Management (INM) practices are useful for efficient, economic and sustainable production.
4. Package and practices recommended by research stations may be adopted in totality

3. Plant Protection

3.1. Objectives of the session

- To increase the awareness and understanding about the crop pest, diseases and weeds.
- To strengthen the farmer's knowledge on effective management of insects, diseases and weeds in crops through Integrated Pest Management.
- To sensitise farmers on safe handling of chemicals.

3.2. What we know at the end of the session

- Insects and their life cycles
- Methods of insect control including Integrated Pest Management (IPM)
- Plant protection equipments
- Symptoms of major diseases
- Integrated disease management
- Major weeds
- Methods of controlling weeds
- Safe handling of chemicals

I. Pest Management

3.3. Crop pest and their importance

Pest is any organism which is detrimental to crop production. Pest cause damage to the plant to the extent of 30 - 90 per cent, sometimes it even causes total loss. Pest includes insects, diseases and weeds. Non insect pest includes nematodes, snails and rodents.

Insect is any of many small invertebrate animals having a segmented body and three pairs of legs and usually two pairs of wings. Some insects are beneficial and some are harmful to agriculture.

What is the difference between complete and incomplete metamorphosis in insects?

Incomplete and complete metamorphosis differs in the number of life cycle stages that insects go through during their transformation from egg to adult. The complete metamorphosis has 4 life cycle stages and an incomplete metamorphosis has 3 life cycle stages.

Complete metamorphosis

Complete metamorphosis has four distinct life cycle stages: **egg, larva, pupa and adult**.

Examples of insects that go through complete metamorphosis are butterflies, silkworms, mealworms and ladybugs. The larva can be worm-like even though the six legs are still visible. The larva form moths and butterflies are called caterpillars. Maggots are the larval stage of flies. The larvae eat constantly and grow rapidly. A hard, protective case forms around the larva at pupa stage. The pupa stage for a butterfly is called a chrysalis. The pupa stage for moth is called cocoon.

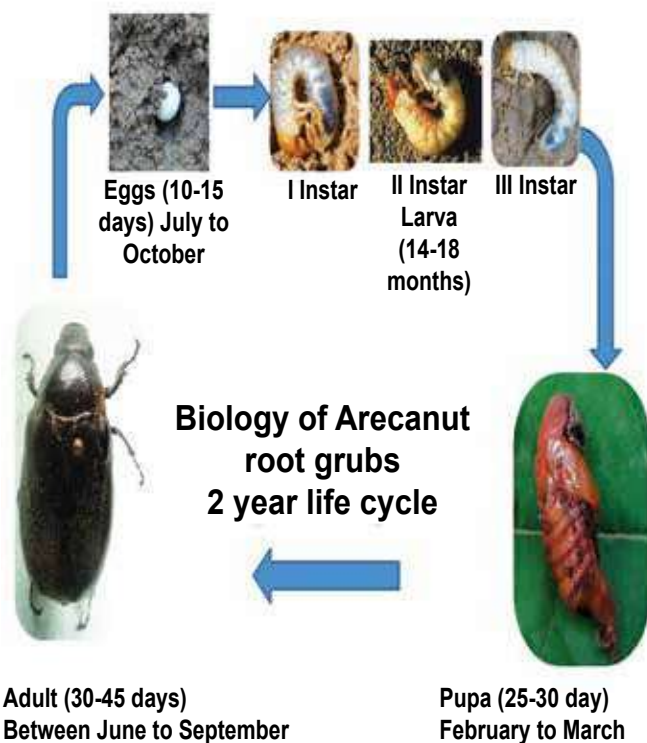
Incomplete metamorphosis

Incomplete metamorphosis has three life cycle stages: **egg, nymph and adult**. The nymph looks similar too but is a smaller version of the adult. The nymph is also wingless. Examples are grasshoppers, cockroaches, ants and praying mantids.

3.4. Life stages of insects

- **EGG** is the initial stages of the insect. Normally an insect lays at least 30 to 300.
- Egg hatch into **LARVA** or worms. Larva is the

damaging stage of insect to any crop. This stage is normally seen in the field.

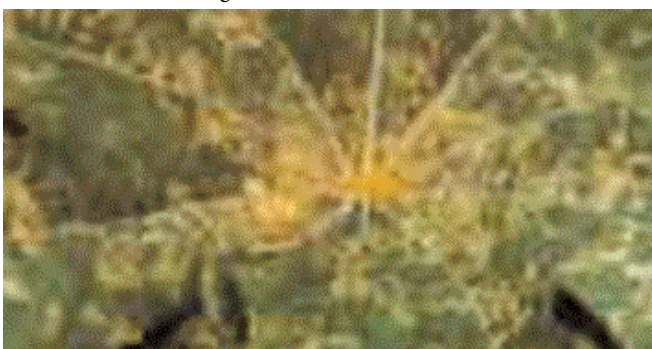


Life stages of insects

- **PUPA** is an inactive stage preparing itself to develop to an adult.
- Mostly **ADULTS** insects are harmless but many bugs and beetles are harmful to plants.



Mite damage in coconut buttons



Larva damaging leaves



Bollworm damaging cotton



Semilooper feeding on caster

How the damage is visible?

- The larva eats the leaf, fruits or the whole plant parts. Hence the damage is visible.
- Some insects scrape the plant tissues. They also cut the growing parts. Beetles, bugs, thrips and hoppers usually suck the sap from the plants and growing parts, affecting the healthy plant.



Grub of green lace wing



Ladybird beetle

- Not at all. **HONEY BEES** are also insects which help in pollination (brings pollen from one plant to another), thereby, increasing the yield.

They also provide us valuable HONEY and other products. Another example of “friendly” insects are SILK WORMS.

- NATURAL ENEMIES are insects that are beneficial to man since they feed from the egg or larvae and pupae of crop pest. They are called biological control agents. Examples are the trichogramma parasite for sugarcane borers, crab of green lacewing and ladybird beetle.

3.5. Insect classification

Insects can be classified into 3 groups, depending on their behaviour in the farm such as

- Pests
- Beneficial insects
- Neutral insects

Pest: Whether an insect species is a pest or not depends on the situation. This means that a certain insect could be a pest in one situation but not in another situation. For example, the caterpillars of diamondback moth feed on cabbage and other plants of the cruciferae family. A farmer who grows cauliflower will therefore consider it a pest. Yet, for a farmer who grows potatoes or bananas, the diamondback moth is a neutral insect. When there is nothing to feed it will not even occur. In a paddy crop, black gram is a weed/pest since it is growing unnecessarily. In a black gram field, cow pea is a weed since it can grow. Pest will occur only if there is a host.

Beneficial insects

Some insects are beneficial to the farmer, because they are the natural enemies of harmful insects. Predators feed on other insects and hence control the pest. For example, the assassin bug kills caterpillars and ladybird beetles feed on aphids. Some other insects are beneficial as they help in pollination of plants, e.g. honey bees. There are commercially beneficial insects such as silkworm, which produces silk.

Neutral insects

A neutral insect is neither a pest nor beneficial. Yet again, it really depends on the context. A mosquito in the rice field can be considered as neutral insect.

3.6. How to control pest

Natural control

Understanding insect life cycle: Insects multiply in large numbers. However the survival rate is very less as the nature maintains insect population. Factors like extreme temperature, heavy rains, heavy wind, water stagnation, birds, lizards, spiders, animals, other insects and diseases control the pest. Natural barriers like sea, river, lake, mountains, etc. prevent movement and spread of pest.

Mechanical control: Some of the recommended practices are

- Removal of affected parts
- Collection and destruction of insects
- Drying of seeds
- Tar coating of trees to protect from termites
- Provision of barriers to prevent the entry of pests like green house / screen house, covering of pomegranate fruits with butter paper, etc.
- Clipping off the withered shoots

Agronomical methods: Recommended cultivation practices are as follows.

- Summer ploughing: Opens up the soil and exposes pest to hot sun and predators.
- Trap crop: Is growing the most favoured crop of the insect along with the main crop. The insect feeds from the trap crop and the main crop remains not unaffected. Growing of resistant varieties also prevents the pest attack.

Main Crop	Trap Crop
Tomato	Marigold
Cotton	Okra, Castor, Onion, Garlic
Maize	Sorghum

- **Mixed cropping:** Is growing more than one crop.
- **Inter cropping:** Growing another crop along with main crop, which increases the population of natural enemy.

Main Crop	Intercrop
Cabbage	Tomato, mustard
Cotton	Black gram, green gram
Maize	Sorghum

- **Crop Rotation:** Is growing of different crops in

sequence instead of one single crop.

- **Keeping the fields clean:** Managing the weeds which provides home for pests, treating the seeds with pesticides, growing the crops in seasons where pest incidence is less, application of correct dose of fertilizer at correct time, optimum use of water are some of the agronomical methods to control pests.



Ladybird beetle

Pest load and monitoring

Pest monitoring: Is the practice of examining the crop to know whether the pest has affected the crop and the extent of damage to decide whether to spray the pesticide or not.

Economic Threshold Level (ETL): ETL is the pest population density at which the control measure has to be taken up to prevent the pest from reaching economic injury level.

ETL for some of the crops are as follows

- Brown plant hopper in paddy - nymph or adult hopper 5-10 / hill
- Leaf miner in groundnut: 2 larvae / 10 plant or 20-30% plant infestation
- Whitefly in cotton: 5-10 adults / leaf or 20 nymphs / leaf

Biological control methods: There are several biological agents that controls pest such as

- The insect that kills another insect by living inside its body is called Parasite. There is egg, larval and pupal parasites. Trichogramma is an egg parasite used commercially on sugarcane borers.
- Predators are insects that eat other insects. For example, the Ladybird Beetle, dragonfly, damselfly, etc. Insects are also affected by many diseases. Some are fungal, bacterial and viral. Verticillium, a fungal agent, bacillus, a bacterial agent, and NPV (Virus) are commercially used.

Physical Control

- An age old practice is to mix pulses with red earth to protect pulses from pulse beetle.
- Drying of seeds in hot sun and using radiation are some of the physical control methods.

Traps

- **Light Trap:** Most of the insects are attracted towards light. This principle is used to monitor and control pests.
- **Pheromone Trap:** Insects are trapped using the scent of one sex. This is commonly used for the control of cotton bollworms.
- **Yellow Sticky Traps:** Some of the small sucking insects are attracted by yellow colour. Hence yellow coloured containers smeared with sticky materials are kept inside the field to attract sucking insect.

Chemical control

Manual pesticide spraying

- Pesticide application is the last resort to control pests.
- Pesticides to be selected carefully to control the pests.
- Dose and spraying equipments should be selected carefully.
- Get the correct recommendation from the extension worker.
- Understand the difference between chemical name and trade name. Trade name is the trader given name but the chemical name is originated based on the chemical ingredient.

Botanicals: are plant origin pesticides like neem based formulations. We can also use neem seed kernal extract or neem oil along with soap as pesticides. Commercial botanicals are available in the market and botanicals can be prepared, which cost less and are eco friendly.



Trap

For example, Neem Seed Kernal Extract (NSKE) 5%, Gronim, Achook and Neemazal.

3.7. Pesticides

Pesticides are the chemicals used to control pests. The pesticides can be broadly classified into three groups based on how they act on insects.

Contact and stomach poison: When insect comes into contact or when the insect eats the pesticide sprayed parts, it gets killed. Contact and stomach poison is used for controlling larvae that feed on leaves. Examples include Flubendamide. Some of the pesticides derived from plants also have contact action, for example pyrethrum, sabadilla, etc.



Manual Pesticide Spraying

Systemic poison: When the chemical is sprayed on the plant, it is absorbed by the plant and transferred to the entire plant system. Sucking type of pest like aphids, leafhoppers thrips suck the sap from plants. This kind of sucking pests can be controlled by systemic poison like Imidacloprid (To be used with caution), flubendamide, acetamiprid, thiamethoxam, etc.

1) **Fumigant:** Forms vapour and acts on breathing system of the insects. When insects breathe it, they get killed. Examples include, hydrogen cyanamide, sulfuryl fluoride, etc.

Insecticides are poisons which cannot be used directly. They need to be used as per directions given on the container or as per the recommendation of extension workers. Insecticides are available in different forms of which some are:

- i) **Dust (D):** Poisons are mixed with gypsum, talc or clay so that it can be used in powder form. There is no need to mix with water.
- ii) **Wettable Powders (WP/WDP):** Mixed with dry fillers with sticking agents but these dry powders can be mixed with water.
- iii) **Granules (G):** Dry formulations in which poisons are mixed with calcium or gypsum in granulated form. Main merit of this formulation is handling will be easy, it is not carried away by the wind and it is less toxic to plants.
- iv) **Liquid forms, Soluble Liquids (SL), Emulsifiable Concentrates (EC), and Soluble Concentrates (SC):** Liquid forms of pesticides. Since the pesticides are directly soluble in water, they are mixed with organic solvents, EC formulations disperse in water easily as they are mixed with emulsifiers.
- v) **Fumigants:** are the poisons in gas form. Normally it is used to fumigate godowns, grains, storage rooms and ships even for rat control.
- vi) **Poison baits:** Poisons mixed with food material. The latter acts as attractants. Baits are exclusively used to control rats. As the rats are more sensitive, pre baiting is necessary.

3.8. Types of chemicals

- Organochlorines, Organophosphates, Carbamates, Synthetic Pyrethroids are types of chemicals which were used before, but are not recommended now.
- New Molecules: Invention is a continuous process to identify more effective and less hazardous chemical search for better insect management. Examples include Nicotinamides, spinozids, triazoles (Hexaconazole, Propiconazole).

3.9. Sprayers/Dusters:

Types of applicators

Based on what to apply

- Sprayers are used to sprinkle the soluble chemicals.
- Dusters are used to spread the dust formulation of the pesticide.

Based on power source

- Manually operated sprayers/duster
- Power operated sprayers/duster
- Fuel operated
- Battery operated
- Solar panel powered operated
- Self propelled; i.e. they have their own power source for movement
- Normally 50 -100 litres of spray fluid are required for an acre. If we use manually operated sprayers 200-250 litres of spray fluid are required to cover an acre.
- There are a number of models with a variety of features available in the market. One can choose the model depending upon the requirement. Each instrument has got its own merits and demerits.
- Nozzle is the terminal part of the sprayer, which delivers the spray liquid to the plants. Different types of nozzles are available for different purpose.

Types of sprayer



Battery Operated Sprayer

Capacity 16 litres
 Battery 12V/8AH (Fuse:6A)
 Maintenance free Power Battery
 Charger: Input: 220V/50HZ
 Output: 12V/1000MA
 Nozzle: Single, Double



Rocker Sprayer:

A minimum of 3 persons are necessary. One person to use the lever to create pressure and other persons to spray.



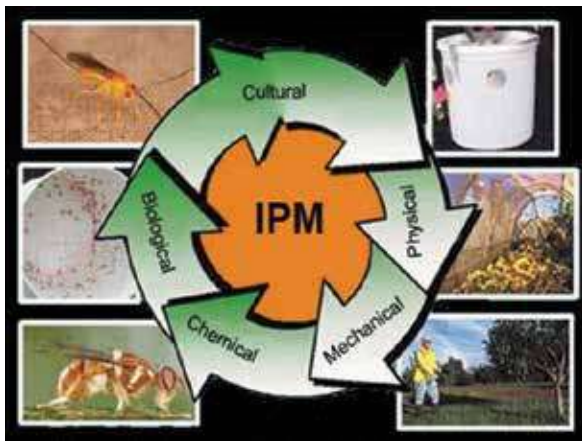
Motorized Power Sprayer is used for spraying of vegetable and ornamental crops in a large area.



Battery Operated Power Sprayer meant for use in the field.

3.10. Integrated Pest Management (IPM)

"IPM is a sustainable approach for managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks."



3.11. Some insecticidal materials for common household use

Kerosene emulsion

This is a contact insecticide useful against many sucking insects. Finely divide 500 g of ordinary bar soap and dissolve it in 4.5 litres of boiling water. Cool and add 9 litres of kerosene. The mixture is then vigorously agitated until the oil is completely emulsified. The stock solution can be diluted with 15-20 times of water before spraying.

Tobacco decoction

This is very effective for controlling aphids infesting vegetable crops. Tobacco decoction can be prepared by steaming 500 gm of tobacco in 4.5 litres of water for 24 hours. Then, 320 gm of ordinary sliced bar soap is dissolved separately in another vessel. The soap solution is added to tobacco decoction and the stock solution is diluted 6 - 7 times.

Neem seed suspension

This is very effective as a repellent against locusts and grasshoppers. Kernels of mature neem fruits should be crushed into a coarse powder. For obtaining 0.1% concentration, 1 g of powdered neem seed is required for a litre of water. The required quantity of the coarse powder should be put in a small bag of muslin cloth and dipped in water contained in a bucket and squeezed till the water becomes light brownish. This has to be sprayed on crops.

The latest registered chemicals are available in www.cibrc.nic.in or please verify with extension officer.

II. Disease Management

3.12. Disease

Disease is an impairment of the normal state of a plant that interrupts or modifies its vital functions. All species of plants, wild and cultivated alike are subject to disease. Although each species is susceptible to characteristic diseases, these are, in each case, relatively few in number. The occurrence and prevalence of plant diseases vary from season to season, depending on the presence of the pathogen, environmental conditions, and the crops and varieties grown. Some plant varieties are particularly subject to outbreaks of diseases.

Disease of crops and their importance

- Plant become diseased when it is continuously disturbed by some causal agent including an abnormal process that disrupts the plants.
- There are more than 80,000 plant diseases.
- Diseases reduce the yield of the crops and sometimes lead to disaster e.g. late blight of potato, Panama of banana, etc.
- Managing outbreak of diseases is challenge to the farmer.

Causes of plant disease

Infectious diseases: caused due to fungi, bacteria, viruses, nematodes, etc.

Non-infectious diseases: caused due to unfavourable extraneous condition such as scorching sunlight, high temperature, moisture stress or deficiency of micronutrients, pH, heavy metal toxicity, atmospheric pollution, etc.

3.13. The disease cycle

The main events of stages comprising the disease cycle include the following: production and dissemination of the primary inoculum, primary infection, growth and development of the pathogen, secondary infection and over wintering.

The primary inoculum is the part of the pathogen (that is, bacterial or fungal spores or fungal mycelium) that over winters (over-seasons) and causes the first infection of the season, known as primary infection. In general, the greater the amount of inoculum and the nearer it is to its host, the greater

the potential for a disease epidemic.

Dissemination refers to the spread or dispersal of the pathogen from an inoculum source to a host. Dissemination can occur by wind, splashing rain, insects, infested pruning tools, infected or infested transplants, and other means. Spread can occur over short distances within the tree canopy or from distant sources.

Primary infection occurs when the pathogen comes into contact with a susceptible host under favourable environmental conditions. Pathogens penetrate the surface of a plant directly or enter through wounds or natural openings.

Growth and development of a pathogen usually occurs on or within infected plant tissue.

Secondary infection results from spores or cells produced following primary infection or from other secondary infections. The secondary infection cycle can be repeated many times during the growing season. The number of cycles is dependent on the biology of the pathogen and its host and the duration of environmental conditions needed for infection.

Over wintering or over seasoning is the ability of a pathogen to survive from one growing season to the next. Pathogens of apple survive the winter in a number of different ways.

For a plant disease to occur, a susceptible host, a pathogen (casual agent), and favourable environmental conditions must be present and interact with one another. If any one of these requirements is not met, a plant disease will not occur. At present, our ability to manipulate the environment is limited to only a few practices such as pruning to promote drying, bedding to improve soil drainage, and scheduling of irrigation. Severe disease outbreaks can be prevented by manipulating the host - through the use of resistant cultivars - and the pathogen -- through cultural practices and fungicidal or bactericidal sprays.

3.14. Disease control measures of important crops

Crops	Disease	Symptoms	Control Measures
Banana	1. Sigatoka leaf spot	<p>On leaves small light yellow or brownish green narrow streaks appear. They enlarge in size becomes linear, oblong, brown to black spots with dark brown band and yellow halo.</p> <p>Black specks of fungal fructification appear in the affected leaves. Rapid drying and defoliation of the leaves.</p>	<p>Remove affected leaves and burn.</p> <p>Spray any one of the following fungicides commencing from November at monthly interval-difenoconazole (2ml/litre), azoxystrobin (2ml/litre), Copper oxychloride 2.5 g/lit.</p> <p>Alternation of fungicides for every spray prevents fungicidal resistance.</p> <p>Always add 5 ml of wetting agent like Sandovit, Triton AE, Teepol etc. per 10 lit of spray fluid.</p>
	2. Anthracnose	<p>The skin at the distal ends of the fingers turn black, shrivels.</p> <p>The fungus produces masses of conidia which form a pinkish coat.</p> <p>The entire fruit and bunch is affected in severe cases.</p> <p>Sometimes main stalk of bunch diseased. The bunch becomes black and rotten.</p> <p>Acervuli produces cylindrical conidiophores, hyaline, septate, branched. Conidia hyaline, non-septate, oval to elliptical.</p>	<p>Spray copper oxychloride 0.25% or Bordeaux mixture 1%.</p> <p>Post harvest dipping of fruits in difenoconazole (2ml/litre).</p>
	3. Bunchy-top	<p>Dark broken bands of green tissues on the veins, leaves and petioles.</p> <p>Plants are extremely stunted.</p> <p>Leaves are reduced in size marginal chlorosis and curling.</p> <p>Leaves upright and become brittle.</p> <p>Many leaves are crowded at the top. Branches size will very small. If infected earlier no bunch will be produced.</p> <p>The disease is transmitted primarily by infected suckers.</p> <p>Secondary spread is through the aphid vector.</p>	<p>Spray Methyl Demeton 2 ml/lit to control it. The sprays may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice.</p>

Crops	Disease	Symptoms	Control Measures
Banana cont...	4. Panama disease	<p>Yellowing of the lower most leaves starting from margin to midrib of the leaves.</p> <p>Yellowing extends upwards and finally heartleaf alone remains green for some time and it is also affected.</p> <p>The leaves break near the base and hang down around pseudostem.</p> <p>Longitudinal splitting of pseudostem. Discolouration of vascular vessels as red or brown streaks.</p> <p>The fungus spreads through use of infected rhizomes.</p> <p>Continuous cultivation results in build up of inoculum.</p>	<p>Uproot and destroy severely affected plants.</p> <p>Apply lime at 1 – 2 kg in the pits after removal of the affected plants. In the field, Panama wilt disease can be prevented by corm injection methods. A small portion of soil is removed to expose the upper portion of the corm.</p> <p>An oblique hole at 45° angle is made to a depth of 10 cm. Capsule application for 50 mg of <i>Pseudomonas fluoresces</i> is injected into the hole with the help of 'corm injector' on 2nd, 4th and 6th month after planting.</p>
Mango	1. Powdery mildew	<p>It attacks the leaves, flowers, stalks of panicle and fruits.</p> <p>Shedding of infected leaves occurs when the disease is severe.</p> <p>The affected fruits do not grow in size & may drop before attaining pea size.</p>	Application of Sulphur dust (350 mesh) in the early morning will protect new flush or spraying Wettable sulphur 0.2% will control powdery mildew.
	2. Anthracnose and stalk end-rot	<p>Produces leaf spots, blossom blight, wither tip, twigs blight and fruit rot.</p> <p>Small blister like spots develop on the leaves and twigs.</p> <p>Young leaves wither and dry Tender twigs wither and die back symptom appears.</p> <p>Affected branches ultimately dry up. Black spots appear on fruits.</p> <p>The fruit pulp becomes hard, crack and decay at ripening. Infected fruits drop.</p>	Pre-harvest spraying of Thiophanate methyl 1g/lit 3 times at 15 days interval will control anthracnose and stalk end-rot.
	3. Sooty mould	<p>The fungi produce mycelium which is superficial and dark. They row on sugary secretions of the plant hoppers. Black encrustation is formed which affect the photosynthetic activity.</p> <p>The fungus grows on the leaf surface on the sugary substances secreted by jassids, aphids and scale insects.</p>	<p>Spraying thiamethoxam @ 2 ml/ litre + Maida 5% (1 kg Maida or starch) boiled with 1 lit of water and diluted to 20 litres will control the incidence of sooty mould.</p> <p>Avoid spraying during cloudy weather.</p>

Crops	Disease	Symptoms	Control Measures
Mango cont...	4. Mango malformation	<p>The dark epicarp around the base of the pedicel.</p> <p>In the initial stage the affected area enlarges to form a circular, black patch.</p> <p>Under humid atmosphere extends rapidly and turns the whole fruit completely black within two or three days.</p> <p>The pulp becomes brown and somewhat softer.</p> <p>Dead twigs and bark of the trees, spread by rains.</p>	<p>Apply plant growth regulators (NAA/GA/Ethephon @ 50-200ppm) at Bud Inception stage.</p> <p>Harvest mangoes on clear dry day.</p> <p>Injury should be avoided to fruits at all stages of handling.</p>
Cotton	1. Seedling diseases (seed-rot, rootrot, and damping off	Seed-rot, root-rot, pre emergence and-post emergence damping-off.	Fungicide seed treatments help control seed rots and some pre emergence damping off. However, an additional soil treatment of fungicide must be used to control root-rots and most damping-off. In addition, producers must follow all other recommended cotton production practices to decrease seedling diseases. Some of these practices include use of correct planting equipment and date of planting, good seed bed preparation, correct use of herbicides and insecticides and use of high germinating seed.
	2. Fusarium wilt	Plants become stunted, yellowed, followed by defoliation. Yellowing first occurs around leaf edges and advances inward. Cross sections of infected stems usually reveals a brown Discoloration which is more intense in outer layers of tissue. Infected plants fruit earlier and produce smaller boll.	Reduce nematode population. Crop rotations. Use resistant varieties.
	3. Boll rot	<p>Boll rots usually first appear as water soaked spots. Later, as infection-spreads, bolls turn black and may be covered with a moldy fungus growth.</p> <p>Badly infected bolls may drop from-plant.</p>	<p>Avoid excessive rates of nitrogen.</p> <p>Practice skip-row planting. Timely defoliation will reduce boll rots. Reduce insects which injure bolls. Growth regulators such as Pix can be used effectively to reduce boll rots.</p>

Crops	Disease	Symptoms	Control Measures
Cotton cont...	4. Leaf spot	Various types of leaf spots and blights. Many spots occur on leaves toward maturity, but these are not usually damaging to the plant at this stage of growth.	Use fungicide seed treatments. Destroy crop residues. Use crop rotations and plant resistant varieties when available (esp. when Bacterial Blight is severe). Keep potash levels at least medium to high.
	5. Verticillium wilt	Seedlings may become infected and turn yellow, dry out and die. Plants that become infected later in the season are stunted and exhibit a yellow condition along leaf margins and between the major vein. Severely affected plants will shed their leaves. A brown Discoloration of the interior of the stem can usually be found later in the season. This discoloration is. Distributed evenly across the inside of the stem.	Plant resistant varieties when Verticillium Wilt is severe. A variety that matures very early may in some years escape injury from Verticillium Wilt.
Citrus	1. Root rot, foot rot and gummosis	Rotted roots, cracked bark, accompanied by gumming Water-soaked, reddish-brown to black bark at the soil line Discoloured tissue in the lower trunk; yellowing, sparse foliage and death of the tree.	Two sprays with drenching either by Fosetyl-Al (2.5g/L) or Metalaxyl MZ-72 (2.75g/l water covering the whole plant canopy and basin of affected plant at 40 days interval after onset of monsoon provided significant control. For the control of gummosis, scraping of the affected parts followed by application of Metalaxyl ² MZ-72 paste.
	2. Citrus canker	Disease affecting citrus species that is caused by the bacterial Infection causes lesions on the leaves, stems, and fruit of citrus trees. While not harmful to humans, canker significantly affects the vitality of citrus trees, causing leaves and fruit to drop prematurely.	Pruning and destruction of infected twigs followed by three to four sprays with copper oxychloride (COC) 0.3% + streptomycin 100 ppm at monthly intervals after the onset of monsoon.

Crops	Disease	Symptoms	Control Measures
Citrus cont...	3. Citrus decline	<p>Symptoms vary with the cause of the malady. The affected trees do not always die completely, but remain in a state for decadance and unproductive for a number of years.</p> <p>Some-times they may suddenly wilt and die in a day or two. In early stages, Symptoms are restricted to a few limbs, but eventually the whole tree is involved. Trees show sparse mottling leaves, stunted growth, sickly appearance. Midrib and lateral veins of old, mature leaves turn yellow with interveinal areas along the veins showing diffuse yellowing.</p> <p>Leaves may turn yellow and are shed with the onset of summer or autumn and the die-back of twigs starts. Dead shoots stand out prominently and may be found dead right down to the main trunk. The entire tree bears short twigs carrying narrow small leaves on their lower portion. Subsequent secondary growth consists of short, upright small, weak shoots showing a variety of discolouration of leaves. Often these leaves have green veins of green blotches. Occasionally, small, circular, green spots appear on yellow tissue on leaves. The die-back of weak shoots continues. There is excessive flowering, but the fruits are not carried to maturity. The fruits show distinct sun-blotching. The feeder root system becomes depleted, roots turn black and sometimes are covered with rotting bark. Either only a few trees or entire orchard may be affected.</p>	<p>Good cultural practices, improvement in soil fertility and drainage, control of insect pests, nematodes, etc. may be useful to minimize the incidence of decline. Use of resistant rootstocks and certified budwood for propagation is also useful.</p>

3.15 Concept of Seed Treatment

The concept of seed treatment is the use and application of biological and chemical agents that control or contain primary soil and seed borne infestation of insects and diseases which pose devastating consequences to crop production and improving crop safety leading to good establishment of healthy and vigorous plants resulting better yields.

The benefits of seed treatment are as follows:

- Increased germination
- Ensures uniform seedling emergence.
- Protect seeds or seedlings from early season diseases and insect pests improving crop emergence and its growth.
- Use of plant growth hormones may enhance crop performance during the growing season.
- Rhizobium inoculation enhances the nitrogen fixing capability of legume crops, and their productivity.
- Improved plant population and thus higher productivity.

Pest/Disease	Seed Treatment	Remarks
Root rot, wilt	Trichoderma spp. 4-6 gm/kg. seed.	For seed dressing metal seed dresser / earthen pots or polythene bags are used.
Root rot disease	Trichoderma 5-10 gm/kg. seed (before transplanting).	-do-
Bacterial sheath blight	Pseudomonas fluorescens 0.5% W.P. 10 gm/kg.	-do-
White tip nematode	Seed soaking in 0.2% solution.	-do-
Anthracnose spp. Damping off	Seed treatment with Trichoderma viride 4g/kg.	-do-
Soil borne infection of fungal disease	Trichoderma viride @ 2 gm/kg. seed and Pseudomonas fluorescens, @ 10gm/kg. Captan 75 WS @ 1.5 to 2.5 gm a.i./litre for soil drenching.	-do-
Jassid, aphid, thrips	Imidacloprid 70 WS @ 10-15 gm a.i./kg seed (To be used in proper doses under guidance of an agriculture expert).	-do-
Wilt, blight and root rot	Trichoderma spp. @ 4 gm/kg. seed.	For seed dressing metal seed dresser/earthen pots or polythene bags are used.
Root knot nematode	Paecilomyces lilacinus and Pseudomonas fluorescens @ 10 gm/kg as seed dresser.	- do-
Soil borne infection of fungal disease Early blight Damping off Wilt	T. viride @ 2 gm/100gm seed. Captan 75 WS @ 1.5 to 2.0 gm a.i./litre for soil drenching. Pseudomonas fluorescens and V. chlamydosporium @ 10gm/kg as seed dresser	For seed dressing metal seed dresser/earthen pots or polythene bags are used.

Bacterial wilt	Pseudomonas fluorescens @ 10gm/kg.	-do-
Pest/Disease	Seed Treatment	Remarks
Seed rot	Trichoderma viride @ 6 gm/kg seed.	-do-
Jassids, whitefly	Thiamethoxam (0.2gm/litre of water)	
Termite	Treat the seed before sowing with any one of the following insecticides. i) Chlorpyrifos @ 4 ml/kg seed (Best available option and use with caution).	For seed dressing metal seed dresser / earthen pots or polythene bags are used.
Bunt/false smut/ loose smut/covered smut	Carboxin 75 % WP. Tebuconazole 2 DS @ 1.5 to 1.87 gm a.i. per kg seed. T. viride 1.15 % WP @ 4 gm/kg.	
Wilt and damping off	Seed treatment with Trichoderma viridi 1% WP @ 9 gm/kg seeds.	
Soil and tuber borne diseases	Seed treatment with boric acid 3% for 20 minuts before storage.	

3.16. Nematode management

Nematodes are thread-like roundworms invisible to the naked eye. Species parasitic on plants attack roots and other plant parts, causing stunting and yield reduction. Nematode-infected plants are not only weakened but their root systems are more susceptible to secondary infections by fungi or bacteria.

Correct identification is the first step when a nematode problem is suspected. The second step is to determine whether populations are high enough to threaten the crop. Root knot nematodes, the most common pathogenic nematodes in vegetables, cannot penetrate roots when soil temperatures are below 50 degrees F, and will not reproduce when soil temperatures are below 58 degrees F. Their reproductive rate is slower at cooler temperatures, so

populations build up more slowly. Thus, cool season crops are less likely to be damaged. E.g., early spring potatoes, are rarely damaged by nematodes.

Nematode management practices

Isolation: Once a nematode problem is confirmed, affected areas and plants should be isolated because transplants, machinery and irrigation water can all spread nematode infections. From initially small-infested areas, nematodes can spread across a field at a rate of 3 feet per year.

Crop rotation and cover crops: Crops susceptible to root knot nematodes include all cole crop species, beans, cucumber, muskmelon, watermelon, bendi, potato, sweet potato and tomato. All potatoes are susceptible to nematodes except for a few cultivars resistant to the golden nematode.

Rotation to non-host crops such as corn, cucurbits, potatoes and tomatoes is an effective control for the cyst nematode. But is less likely to control the root knot nematode because of its wider host range. All species of *Meloidogyne* are called 'root knot' nematode but each species has a different host range, causing confusion over which crops or cultivars are resistant or tolerant to which species of root knot nematode. Rotations to non-host crops for more than a year reduce populations below damaging levels but will not eliminate them.

Cover crops: significantly reduce subsequent damage to crop.

Increasing Soil Organic Matter: Higher soil organic matter content protects plants against nematodes by increasing soil water-holding capacity and enhancing the activity of naturally-occurring biological organisms that compete with nematodes in the soil.

Fallow Period: A fallow period of two years with no susceptible plants in the field decreases nematode populations. *Marigold* as a rotation crop suppress nematodes.

Plant resistance: Nematode resistant cultivars may be used to reduce the incidence of nematodes

Symptoms

- Understanding symptom and description of disease will help in identification at field level.



Alternaria leaf spot of redgram



Wilt affected redgram plant



Red rot in sugarcane



Ratoon stunting in sugarcane



Blast infected leaf of paddy



Anthracnose in cotton



Bacterial blight of paddy



Gray mould in cotton

3.17. Control measures - Tips for the farmers

- Correct identification of disease in your farm is essential for effective control of disease.
- With little experience, you can identify the disease. However you can contact agricultural officers of your area along with disease specimen and seek their help in identifying the disease.
- You can also give disease-affected plant parts to the Agri clinics for clinical test before undertaking control measures.
- Follow Integrated Diseases Management such as host plant resistance, agronomic practices, judicious use of fungicides, pesticides for vector control, bio-pesticides for pathogen control etc., as indicated below.

3.18. Integrated disease management practices in the field

- Select varieties and hybrids resistant to the most common or economically important diseases in consultation with agricultural officers of your area.

For example:

Diseases of Cotton	Resistant Variety/Hybrid
Verticillium Wilt	MCU 5 VT, Surabhi, Savitha (Hybrid)
Bacterial Leaf Blight	MCU 10, L 604, L 389

- Plant only good quality, disease-free seed having good germination. E.g. Cotton seed having above 80% germination will have vigorous growth and will not suffer from infection of soil borne diseases
- Use seed-treatment with fungicides to control diseases.
- Plant when soil temperature and moisture are most favourable for specific crop. E.g: If the farmers take up sowing of cotton during the warmer temperature (>65 F), there will be better germination and growth.

- Avoid planting the same crop in a field year after year. E.g.:
I) Growing paddy in the Verticillium wilt infested field will reduce the incidence of microbial population in the soil.
II) Growing Chrysanthemum will inhibit the growth of the Verticillium in the soil.
- Incorporate the crop residues of the previous crop by tilling well before planting season. E.g. Disease affected plants should be burnt immediately.
- Choose right sowing time and maintain appropriate plant population by adopting recommended spacing.
- Apply a balanced fertilizers based on a soil test. E.g.: Potassium deficiency leads to susceptibility of Alternaria leaf spot.
- Apply recommended amount of Farmyard Manures/compost at regular intervals and maintain soil-organic matter content. E.g.: Over dose of chemical fertilisers lead to more vegetative growth and more disease.
- Enrich soil with beneficial micro-organisms like Trichoderma.
- Keep the land weed free. Weeds can serve as alternate hosts for pathogens and helps disease development.
- Timing and duration of irrigation should match the crop and water requirement without allowing for excess water. E.g.: Excessive irrigation favour soil borne pathogen
- Maintain insect population below ETL to reduce the incident of disease transfer by insects.
- Regular crop monitoring is essential for effective disease management.
- Use bio-pesticide as far as possible to control disease. Chemical may be used only as last resort.

III. Weed Management

3.19. Weed and its relevance in crop production

- Weeds are the plants, which grow where they are not wanted
- Weeds compete with crops for water, soil nutrients, light and space
- Weeds reduce crop yields to the extent of up to 50 percent
- Critical period of weed competition is approximately 1/3rd of the duration of the crop

Characteristics of weeds: “One year seeding, seven years weeding”

- Produces larger number of seeds compared to crops. E.g.: *Amaranthus retroflexus* produces 1,96,405 seeds/plant, whereas wheat & rice produces only 90 to 100 seeds/plant
- Most of the weed seeds are small in size
- Easy and diverse means of seed dispersion
- Seeds germinate earlier and grow faster
- Flower earlier and mature ahead of the crop
- Germinate under tough conditions, season bound
- Seeds are dormant for long period and germinate during suitable season
- Good viability for years
- Tolerate moisture stress
- Possess stronger and deeper root system

Effect of weed competition on crop growth and yield

- Crop suffers from nutritional deficiency
- Growth is reduced
- Water requirement will be more
- Lowers the input response
- Pest and disease incidence will be more
- Yield is affected
- Cost of production will increase

3.20. Critical period of weed competition for important crops

Crops	Days from sowing
Rice (lowland)	35
Rice (upland)	60
Sorghum	30
Maize	30
Cotton	35
Sugarcane	90
Groundnut	45
Soybean	45
Onion	60
Tomato	30

3.21. Different types of common weeds

GRASSY WEEDS

*Acrachne racemosa**Aristida funiculata**Avena ludoviciana**Brachiaria reptans**Chloris inflata*
Syn: *Chloris barbata**Cynodon dactylon**Dactyloctenium aegyptium**Digitaria bicornis**Digitaria longiflora**Dinebra arabica**Dinebra retroflexa**Dinebra**Echinochloa colona**E. crus-galli**Echinocloa glabrescens*

BROAD LEAVED WEEDS



Abutilon hirtum



Abutilon indicum



Acalypha ciliata



Acalypha indica



Acanthospermum hispidum



Achyranthes aspera



Aerva lanata



Aerva tomentosa



Aeschynomene indica



Ageratum conyzoides



Alternanthera



Alternanthera paranychioides



Alternanthera sessilis



Alternanthera pungens



Allmania nodiflora

SEDGES



Cyperus castaneus



Cyperus compressus



Cyperus difformis



Cyperus digitatus



Cyperus halpan



Cyperus iria



Cyperus nutans



Cyperus polystachyos
Syn: *P. odoratus*



Cyperus rotundus



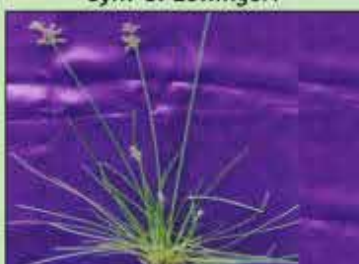
Cyperus tenuiculmis
Syn: *C. zollingeri*



Fimbristylis aestivalis



Fimbristylis argentea



Fimbristylis complanata



Fimbristylis milliacea



Fimbristylis woodrowii

Source: Directorate of Weed Science Research, Jabalpur

3.22. Control measures of weeds

Principles of weed control

- Prevention
- Eradication
- Control
- Management

a) Preventive weed control

- Avoid using crop that are infested with weed seeds for sowing
- Avoid adding weeds to the manure pits
- Nursery or planting material should be free from weeds
- Keep irrigation channels, fence-lines and uncropped areas clean
- Constantly look for weed, destroy the weeds then and there
- Use good quality certified seeds, which are free from weed seeds
- Use pre-emergence herbicides to prevent germination of weeds

b) Eradication (complete removal): Weeds are killed or completely removed from a given area, will not reappear unless it is introduced again. However,

- It is very difficult
- Involves high cost
- Can be used in green houses and nurseries

c) Control: Weeds growth is restricted and killed when necessary so that it does not affect crop growth.

d) Weed management: Managing the population of weeds using all possible methods.

(i) Mechanical method:

- **Tillage:** Using plough or disc, weeds are removed from soil and exposed to sunlight.
- **Hoeing:** Using hand hoe, annual and biennials are completely removed.
- **Hand weeding:** Either by physical removal or pulling out of weeds by hand or using some implements.
- **Digging:** Advisable in the case of perennial weeds.
- **Using sickle:** Top portion of weeds are removed using sickle, thereby weeds seed production is controlled.
- **Burning:** Burning is often an economical and practical means of controlling weeds but not

always possible in crop production field.

- **Flooding:** Kills weeds by reducing oxygen to plant growth. This is possible only under garden land or wetland condition.

Merits of mechanical method

- Oldest and effective method
- Safe method for environment
- High skill is not necessary
- Weeding is possible in between plants
- Deep rooted weeds can be controlled effectively

Demerits of mechanical method

- Labour and time consuming
- Possibility of crop damage
- Requires ideal moisture
- Costly

ii) Cultural weed control

- **Summer ploughing:** Is done immediately after summer showers. This exposes weeds to hot sun.
- **Field preparation:** Makes the field weed free by constant removal.
- **Select crop** that can compete better with weeds like cowpea, sudan grass, sorghum are good competitors. Fast growing crops suppresses the weed effectively.
- **Maintenance of optimum plant population:** Adequate plant population covers the land and, hence, growth of the weed will be difficult. Close row crops are better than wide row.
- **Crop rotation:** Minimize the dominance of particular weed in the cropping system.
- **Growing of intercrops:** Inter cropping covers the land quickly and reduce growth of the weeds. E.g.: Growing crop such as cowpea/ soybean, etc. in wide spaced crops like maize/pigeon pea/sugar cane, etc.
- **Mulching:** Mulch is a protective covering of material maintained on soil surface. It has smothering effect and reduces the weed growth. Mulching can be done through degradable farm waste or through plastic sheets. In case of plastic, black is the most popular colour used in commercial horticulture crop production, especially for weed control.
- **Solarisation:** Done by covering the pre soaked field with transparent polythene cover, which increases the temperature by 5 – 10 °C.

- **Stale seedbed:** Weeds are allowed to germinate and non-residual herbicide is sprayed to kill the young weed seedlings.
- **Blind tillage:** Ploughing after sowing of the crop and before plants emerge. Normally seed drills are used under rainfed condition for this purpose.
- **Crop management practices:** Vigorous and fast growing crop varieties for better competition with weeds.

Merits of cultural method

- Low cost
- Easy to adopt
- Less technical skill is sufficient
- No damage to crops
- Effective weed control

Demerits of cultural method

- Time taking and difficult
- Perennial and problematic weeds can not be controlled

iii) Biological weed control: Natural enemy of a weed plant is used to control the weed

Examples:

- *Zygogramma biolorata* for control of *Parthenium*
- Hirsch – *Manniella spinicaudata* is a rice root nematode to control most upland rice weeds
- *Azolla* in rice

Advantages

- Eco friendly
- Easy
- Low cost

Disadvantages

- They may have alternate host or switching over to alternate host
- Multiplication of bio agent in many cases is difficult

iv) Chemical Weed Control: Herbicides are chemicals used to control weeds.

Merits

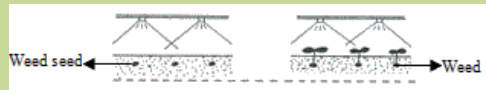
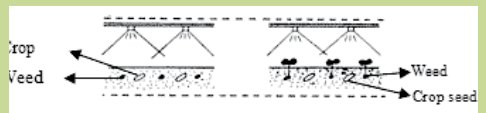
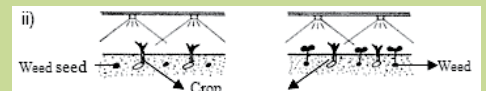
- Recommended for adverse soil and climatic conditions
- Applied even before weeds emerge and make the environment weed free
- Suitable for all types of crops

- Controls the targeted weeds only
- Controls many perennial weed species
- **Cost effective** compared to labour

Demerits

- Pollutes the environment
- Affects the soil
- Herbicide drift affects adjoining field
- Requires minimum technical knowledge
- Leaves residual effects
- Some herbicides are costly
- No suitable herbicides are available for mixed and inter-cropping system

3.23. Classification of herbicides

Method of application	Soil herbicides; e.g. Fluchloralin Foliar herbicide: e.g. Glyphosate
Mode of action	Selective herbicide: Kills only weeds. Non selective herbicide: Kills the entire vegetation.
Mobility	Contact herbicide; Kills when comes in contact with plant. Translocated herbicide: poison moves from treated parts to untreated part: Eg. Glyphosate
Time of application	Pre-plant: Before sowing or along sowing Eg. Glyphosate for Hariyali, Basalin for groundnut  Pre emergence: Before weeds germinate; Eg. Thiobencarb  Post emergence: applied after weeds germinate i) Eg. Bispyribac Sodium. ii) 

Formulations	<p>Emulsifiable Concentrate (EC): Liquid form.</p> <p>Wettable powders: Poisons mixed with inert carrier.</p> <p>Granules (G) poisons are mixed with granular forms.</p> <p>Water Soluble Concentrates (WSC) forms are also available</p>
---------------------	---

3.24. Methods of application

- Spraying
- Broadcasting

Foliar application

Blanket spray: Both crop and weed is sprayed with weedicide.



Blanket Spray

Directed spray: Application of herbicides on weeds only avoiding crop using hood.

Eg: Spraying glyphosate¹ in between rows of tapioca using hood to control Hariyali.

Protected spray: Crops are covered and herbicides are sprayed on weeds. This method is expensive.

Spot treatment: Applied only where weeds are present.

3.25. Control of parthenium (perennial weed)

- Manual removal and destruction of Parthenium plants before flowering using hand glouse/ machineries (or)
- Uniform spraying of sodium chloride 200g + 2 ml soap oil/litre of water (or)
- Spraying of 2,4-D sodium salt 8 g or glyphosate 10 ml + 20g ammonium sulphate + 2 ml soap solution/litre of water before flowering (or)
- Post-emergence application of metribuzin 3 g / litre of water under non-crop situation.
- Raising competitive plants like Cassia serecea and Abutilon indicum on fallow lands to replace Parthenium (or)
- Biological control by Mexican beetle, fungal pathogen and nematodes

3.26. Control of perennial weeds in orchards

Perennial weeds like *Cyperus rotundus*, *cynodon dactylon*, etc. in orchards can be controlled effectively by spraying glyphosate¹ at 2.5 to 5.0 L ha⁻¹ dissolved in 500 liters of water. Falling of the spray fluid on young fruit plant foliage should be avoided. Second spray is required when there is re-growth of weed. (Cost Rs.700/- to 1400 ha).

3.27. Precautions while spraying the herbicides

- Select right kind of herbicide for right kind of crop and spray. Any mistake in choosing the herbicide may result in loss of total crop.
- Dosage should be accurate and good quality of water should be used.
- Use always correct nozzle for spraying. Spraying should be done from front to backwards. (We should not step into the sprayed field for a minimum of 3 days).
- The soil should have sufficient moisture for effective control.
- For paddy, a thin film of water should be maintained for 3 days and it should not be drained.

3.28. List of Herbicides for different crops

★ There may be slight variation in doses. Please consult local Agricultural Extension Officer/Scientists from KVK or read carefully the leaflet attached along with the herbicide:

Crop	Herbicide	Dose (kg ai/ha)	Trade name and formulation	Time of application
Rice	Thiobencarb	1.25	Machete 50% EC Delchlor 50% EC	Pre-emergence
	Anilophos	0.40	Thunder 50% EC Saturn 50% EC	Pre-emergence
	Pendimethalin	0.90	Arozin 30% EC Aniloguard 30% EC	Pre-emergence
Finger millet	Pendimethalin	0.90	Stomp 30% EC	Pre-emergence
	2,4-D Na salt	1.00	Fernoxone 80% SS	Post-emergence
Maize	Pendimethalin	0.75	Stomp 30% EC	Pre-emergence
Cotton	Metolachlor	1.00	Dual 50% EC	Pre-emergence
	Pendimethalin	1.00	Stomp 30% EC	Pre-emergence
Groundnut	Metolachlor	1.00	Dual 50% EC	Pre-emergence
	Pendimethalin	0.90	Stomp 30% EC	Pre-emergence
Vegetables	Pendimethalin	1.00	Stomp 30% EC	Pre-emergence
Pulses	Pendimethalin	0.60	Stomp 30% EC	Pre-emergence
Wheat	Isoproturon	0.60	Arelon 75% WP	Pre-emergence
Citrus	Glyphosate 4	4 Kg/ha		Post-emergence

3.29. Herbicide mixtures

Sometimes involves mixing of two or more herbicides used for effective and economical weed control at reduced dosage.

Two types of mixtures available are:

1. Tank mixtures made with the desired proportion of herbicides before application. eg: Anilophos + Bispyribac Sodium – Rice
2. Ready mix – formulated by the manufacturer. Ready mix available in the world market eg: Bispyribac Sodium+Glyphosate.

Mixing Ammonium sulphate with glyphosate increases the efficiency where nitrogen increases the translocation.

3.30. Integrated Weed Management (IWM)

Combination of two or more weed control methods at low input levels to reduce weed composition in a given cropping system below the economic threshold level. It:

- Aims to minimize the residue problems
- Minimize the effect on the ecosystem

3.31. Beneficial Effects of Weeds or Economic Uses of Weeds

Several weeds have been put to certain economic uses since ages. Some of the examples are:

- Typha and Saccharum sp is used for making ropes and thatch boards.
- Chicory Cichorium intybus roots are used for adding flavor to coffee powder.
- Amaranthus viridis, Chenopodium album and Portulaca sp. are used as leafy vegetable.
- Hariyali grass (Cynodon dactylon) and Cenchrus Ciliaris, Dichanthium Annulatum and Eclipta alba weeds of grass land serve as food for animals.
- Weeds act as alternate host for predators and parasites of insect pests, which feed on the weeds. For example, Trichogramma chilonis feed upon eggs of castor semi looper, which damage the castor plants. E.g. Commelina sp (Copper), Eichornia crassipes (Copper Zinc, lead and cadmium in water bodies).
- Several species of weeds like Tephrosia purpurea and Croton sparsiflora in South India are used as green manures, whereas Eichornia crassipes and Pistia stratiotes are used for composting.
- Argemone Mexicana is used for reclamation of alkali soils.
- Some weeds have medicinal properties and used to cure snake bite (Leucas aspera), gastric troubles (Calotropis procera), skin disorders (Argemone mexicana) and jaundice (Phyllanthus niruri) and Striga Orobanchoideae to control diabetes.
- Agarbathi (Cyperus rotundus), aromatic oils, (Andropogon sp & Simbopogon sp) are prepared from weeds.
- Air pollution determined by wild mustard and chickweed respectively.
- Aquatic weeds are useful in paper, pulp and fiber industry.
- Chenopodium album is used as mulch to reduce evaporation losses, whereas Agropyron repens (quack grass) is used to control soil erosion because of its prolific root system.
- Weeds like Lantana camara, Amaranthus viridis, Chenopodium Album and Eichhornia crassipes are used for beautification.

- Agropyron repense are used for soil conservation, whereas Dichanthium Annulatum are used as stabilizing field bunds.
- Opuntia Dellini is used as biological fence.

3.34. Lessons Learnt

1. Not all insects are harmful. Farmers need to identify beneficial and harmful insects.
2. Summer ploughing, growing trap crops, adopting mixed cropping, intercropping, crop rotation and keeping the field clean are the important agronomical practices farmers need to follow for effective pest management.
3. Farmers need to understand the Economic Threshold level of major pest of the crops grown.
4. Biological control methods results in sustainable pest control.
5. Farmers are advised to harvest the fruits and vegetables after the waiting period to minimize the residual effect.
6. Seed treatment prevents soil and seed borne infestation of insects and diseases
7. Select varieties and hybrids resistant to most common and economically important diseases.
8. One year seeding, seven years weeding. Hence, prevent spreading of seeds of weeds.

Categories of Pesticides and Precautions

Insecticide	Group	Label of Toxicity	Precaution
Flubendiamide	Diamide	Category D	To be used with Caution.
Emamectin Benzoate	Macrocyctic Lactone - Avermectin	Category D	To be used with Caution.
Spinosad	Macrocyctic Lactone – Spinosyn	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Acetamiprid	Neonicotinoids	Category D	To be used with Caution.
Imidacloprid	Neonicotinoids	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Thiamethoxam	Neonicotinoids	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Chlorpyrifos	Organothiophosphate	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Profenophos	Organothiophosphate	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Fenazaquin	Unclassified	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.

Fungicide	Group	Label of Toxicity	Precaution
Thiophanate methyl	Benzimidazole precursor	Category B	To be used with great caution (since highly hazardous for human health and/or environment) and under the guidance of an Agriculture Expert.
Carboxin	Carboxamide/ oxathin	Category D	To be used with Caution.
Copper oxychloride	Inorganic copper	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Fosetyl	organophosphorus	Category D	To be used with Caution.
Captan	Phthalimide	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Metalaxyl	phenylamide	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Azoxystrobin	Strobilurins	Category D	To be used with Caution.

Difenoconazole	Triazoles	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Triadimefon	Triazoles	Category B	To be used with great caution and under the guidance of an Agriculture Expert.
Tebuconazole	Triazoles	Category C	To be used with caution and under the guidance of an Agriculture Expert.

Herbicide	Group	Label of Toxicity	Precaution
2,4-D	Chlorophenoxy acid or ester	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Butachlor	Chloroacetanilide	Category B	To be used with great caution and under the guidance of an Agriculture Expert.
Metolachlor	Chloroacetanilide	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Fluchloralin	Dinitroaniline	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Pendimethalin	Dinitroaniline	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Anilophos	Organophosphorus	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Diuron	Phenylurea	Category B	To be used with great caution, since probably carcinogenic, and under the guidance of an Agriculture Expert.
Isoproturon	Phenylurea	Category C	To be used with caution and under the guidance of an Agriculture Expert.
Glyphosate	Phosphonoglycine	Category B	To be used with great caution, since probably carcinogenic, and under the guidance of an Agriculture Expert.
Atrazine	Triazines	Category B	To be used with great caution and under the guidance of an Agriculture Expert.
Thiobencarb	Thiocarbamate	Category B	To be used with great caution (since toxic to bees etc.) and under the guidance of an Agriculture Expert.
Metribuzin	Triazinone	Category B	To be used with great caution and under the guidance of an Agriculture Expert.

4. Farm Management

4.1. Objectives of the session

- To equip the farmer to take advantage of improved technologies and market opportunities to increase income.
- To assist the farmer to make proper plan and adopts his production to assure food security for the family.
- To empower the farmer for professional negotiations with buyers, input dealers and credit institutions.
- To educate the farmer to make profitable decisions considering available resources and anticipate risks including market fluctuations.

4.2. What we know at the end of the session

- Importance of farm management
- Basic information which support better farm management decision
- Market driven enterprises
- Matching resources with calendar of activities
- Selection of cropping pattern
- Understanding of cost benefit analysis
- Risk analysis in agriculture

Module 1: Is farming a business?

What is a farm?

Farm is a socio economic unit. It is composed of farm family, farm enterprises and structures. Farmer is a grower cum manager. The farmer has to decide how much land, labour, capital and type of technology to use to produce in a given season. Ultimately, the farmer has to earn a profit to support his livelihood.

What will the farmer do in farm management?

The farmer would efficiently use the available resources to increase profits through deciding among the best alternatives available.

Some basic functions of farm management

The farmer performs following basic functions to effectively manage the farm:

Diagnosis: Analysis of past performance of farm, its weakness/strengths.

Planning: Planning for the future crops/animals considering the opportunities and threats.

Implementation: Efficient implementation with least cost.

Monitoring: Reduce the losses and increase the profits by reducing the costs and choosing better technologies based on the observed opportunities.

Evaluation: Evaluating the actions for repeating the successes in future.

What will happen if the farmer does not do farm management?

In the absence of good farm management, the farmer may experience losses in farming for the following the reasons:

- There is continuous changes in supply and price of agri inputs like seeds, fertilizers, irrigation, power etc.
- There is continuous change in prices of the produce (outputs) in the market due to demand and supply changes.
- There is continuous change in the farm technologies.

Therefore the objectives of farming as a business are:

- How to choose best variety/crop/cropping pattern
- How to minimise input cost by judicious use
- How to increase the production and productivity
- How to enhance the quality
- How to plan market driven production
- Choosing the better source of finance and better avenues for investment
- Efficient risk management

For better farm management, the farmer should have thorough knowledge of the following aspects:

- Farm map
- Soil slope and topography
- Soil type (physical and chemical properties)
- Soil colour such as red soil or black soil
- Weather parameter such as rainfall, temperature, relative humidity, etc.
- Vegetative cover such as trees, weeds, etc.
- Irrigation potential from borewell/tubewell/nala/channels
- Drainage facilities - whether water gets logged or not
- Technology available and whether the farmer can access them easily
- Risk factors like hand loans and high rate of interest
- Market facilities - whether they are near to his farm or far off
- Communication facilities like cell phone and internet connectivity
- Physical and infrastructure facilities such as godowns, roads for transport, vehicles, custom hiring centers, etc.
- Whether a farmer can afford the crop/animal he/she wishes to grow or rear considering the above conditions
- Supporting programmes and schemes/subsidies

Farmers should maintain farm records to have a holistic knowledge of their production system

For example: If a farmer maintains a record for all the cost of production such as inputs, labour, etc. for the entire crop cycle along with yield and income obtained from selling the produce, he/she can compare with the next crop cycle to understand whether his/her profit increased or decreased. The records also provides information on activities which contributed for his/her profit or loss so that, the farmer can take alternative decisions to enhance his/her net income.

Farm Resources: To make good farm management decisions, farmers need some basic knowledge on farm resources such as the extent of land available for cultivation, source of irrigation, family labour, availability of labour, skill level of labours, livestock, availability of fodder, availability of farm machinery, availability of inputs such as seeds and fertilizers, credit requirement and availability, source of credit, market demand for produce, infrastructure such as cold storage and godowns. etc. For example, regarding manpower and livestock the farmers have to understand following issue:

Man Power

- **Skill:** Is the labour employed is skilled, e.g. cotton picking skill?
- **Knowledge:** Does the farmer/labour have a thorough knowledge of the package of practices of the crop?
- **Attitude:** Does he/she have a positive attitude towards the technology?

Live Stock

- **Breed:** Selection of a suitable breed
- **Production capacity:** For instance, milk production, meat production and egg laying capacity.
- **Adaptability:** Does the selected breed adapt to the local situation?
- **Drafting capacity:** Knowledge on the draught capacity of animal.
- **Resistance:** Is the foreign breeds resistant to local Indian conditions. E.g. the Holstein Fresian is highly sensitive to high temperatures.
- **Feeding habit:** Are the upgrade breeds or imported breeds capable of feeding on locally available feed materials

Module 2: Know your farm resources

Inputs	Tools and equipment	Labour	Money	Land
Seeds Fertiliser Insecticide Fungicide	Plough, hoe, sprayer, thresher, Tractors	Family and Paid workers	Self finance and credit	Own / Rented land Share-cropping

What does one need to know about the market if one wants to do good business?

The market for agricultural produce	The market for inputs and equipment
The location of the market	The locations of sale
Who is the buyer?	Who sells the inputs and equipments?
The quality of product that is demanded by the market	The quality of inputs and equipment
The price of the product compared to other markets	The price of sale of the inputs and equipments
When to sell	When to buy

How does the price of agricultural products change?

The price of agriculture products change according to the season of the year	The price of agriculture products change between years
At times of abundance, the prices are lowest	The price of a product that is needed by more and more people will rise from one year to the next
At times of scarcity, the prices are highest	The price a product that is produced in greater abundance will fall from one year to the next
The quality of inputs and equipment	
The price of sale of the inputs and equipments	
When to buy	

Important Lesson

To DO successful farm business, the farmer must be well aware of prices (of inputs and produce) at different markets. This allows the farmer to plan production as well as make decisions on the purchase of inputs and the sale of produce.

Module 3: Manage your farm for enough income to sustain yourself

FARM PLANNING: Farm planning is to help the farmers to move to a higher level of production and income, starting from where he/she is now with the resource available to him/her. In this process, the farmer has to consider different types of enterprises like:

- Land based (agril. production activities, pisciculture, plantation, seed production, etc.)








- Animal component based (diary, poultry, goatery, piggery, duckery, etc.)
- Nursery/orchard
- Non-land based (mushroom, apiculture, vermiculture, etc.)

In the present example, three crops namely paddy, cotton and maize have been taken into comparison

for one season. With these three crops, farmers can grow the following combinations in a year:

- Paddy – Paddy (Kharif followed by Rabi)
- Paddy – Maize (Kharif followed by Rabi)
- Cotton – Maize (Kharif followed by Rabi)
- Maize – Maize (Kharif followed by Rabi)

Exercise 1: Agricultural Calendar of Operations to Plan the Production of Paddy.

The times of work...													
Of the main season are shown by a square													
Of the off-season are shown by a circle													
The tasks of the farmer		January	Feb.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
	Prepare the field												
	Plough the field												
	Purchase seeds												
	Sow												
	Fertilizer application												
	Weeding												
	Apply insecticide												
	Harvest and store												

Important Lesson:

For a good yield, the farmer plans to do the necessary work in the field and apply the inputs at the right time based on the calendar of operations throughout the year

Here we will see how to determine if farm business was good or bad. We will calculate the “Income” and “Expenditure” from different produce. Master Trainers may give the following exercise sheet to the farmers to work out the details for the respective crops by changing the relevant package of practices as applicable to local situations.

Exercise Sheet 2: Paddy

Blank sheet to be filled by Farmer based on worked solution given below.

Steps:

- Multiply the quantity with the price in each line
- Add the money spent (“Expenditure”) on inputs and labour
- Multiply the yield by the price of sale (“Income”)
- Subtract the sum of “money-out” from the “Income”
- Determine if there was a gain or a loss

Activity	Unit	Quantity	Price	Total (Rs.)
Preparatory cultivation				
a) Machine / labour	No of hours			
b) Animal / labour	Days			
Sub Total				
Seeds and sowing				
a) Cost of seed	Kgs			
b) Cost of seed treatment				
c) Cost of sowing (Human Labour)	Days			
d) Cost of thinning/gap filling	Days			
Sub-Total				
Manures and Fertilizers				
a) Cost of organic & Green Manuring (In-situ ploughing)				
b) Application cost				
c) Cost of fertilizer	Kgs	N		
		P		
		K		
d) Application cost (Human Labour Male)	Days			
Sub-Total				
Weed control				
a) Cost of Manual weeding	Labour			
b) Cost of herbicide if any (butachlor)	Litre			
Sub-Total				
Plant Protection				
a) Cost of bio-agents				
b) Cost of pesticides (Thiamethoxam/pro-fenophos)	Litres			

Activity	Unit	Quantity	Price	Total (Rs.)
Furadon-3G	Kg			
c) Cost of Application	Labour			
Sub-Total				
Irrigation cost if any	Power	month		
Sub-Total				
Cost of harvest				
a) Combined harvester	Hours			
Post harvest charges				
b) Cleaning and bagging (Human Labor)	days			
Sub total				
Total cost of cultivation				
Yield Kgs/Ha. and returns				
a) Qty. produced Qtls. per ha	qtls			
b) Gross returns received per ha (Rs.)				
c) Total cost involved per Ha (Rs.)				
d) Net returns per Ha (Rs.)				
e) Cost benefit ratio (Gross Returns divided by Total Cost)				








Solution to exercise 2 – Paddy

Cost of Cultivation of Paddy (per hectare)

Activity	Unit	Quantity	Price	Total (Rs.)
Preparatory cultivation				
a) Machine / labour	No of hours	8	800	6400
b) Animal / labour	Days	6	600	3600
Sub Total				10000
Seeds and sowing				
a) Cost of seed	Kgs	50 kgs	20	1000
b) Cost of seed treatment				50
c) Cost of sowing (Human Labour)	Days	25	200	5000
d) Cost of thinning/gap filling	Days	5	200	1000
Sub-Total				7050
Manures and Fertilizers				
a) Cost of organic & Green Manuring (In-situ ploughing)				350
b) Application cost				100

Activity	Unit	Quantity	Price	Total (Rs.)
c) Cost of fertilizer	Kgs	120 N	12	1440
		60 P	50	3000
		40 K	28	1120
d) Application cost (Human Labour Male)	Days	3	200	600
Sub-Total				6610
Weed control				
a) Cost of Manual weeding	Labour	30	200	6000
b) Cost of herbicide if any (butachlor)	Litre	2.5	200	500
Sub-Total				6500
Plant Protection				
a) Cost of bio-agents				
b) Cost of pesticides (Thiamethoxam/pro-fenophos)	Litres	5	350	1750
Furadon-3G	Kg	15	60	900
c) Cost of Application	Labour	6	200	1200
Sub-Total				3850
Irrigation cost if any	Power	5 months	500	2500
Sub-Total				2500
Cost of harvest				
a) Combined harvester	Hours	4.5	1700	7650
Post harvest charges				
b) Cleaning and bagging (Human Labor)	days	10	200	2000
Sub total				9650
Total cost of cultivation				46160
Yield Kgs/Ha. and returns				
a) Qty. produced Qtls. per ha	qtls	50	1500	75000
b) Gross returns received per ha (Rs.)	Cart load	8	800	6400
c) Total cost involved per Ha (Rs.)				81400
d) Net returns per Ha (Rs.)				46160
e) Cost benefit ratio (Gross Returns divided by Total Cost)				35240
e) Cost benefit ratio				1:1.76

Exercise 1: Agricultural Calendar of Operations to Plan the Production of Maize

The times of work...													
Of the main season are shown by a square													
Of the off-season are shown by a circle													
The tasks of the farmer		January	Feb.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
	Prepare the field												
	Plough the field												
	Purchase seeds												
	Sow												
	Fertilizer application												
	Weeding												
	Apply insecticide												
	Harvest and store												

Important Lesson:

For a good yield, the farmer plans to do the necessary work in the field and apply the inputs at the right time based on the calendar of operations throughout the year.

Here we will see how to determine if farm business was good or bad. We will calculate the “Income” and “Expenditure” from different produce. Master Trainer may give the following exercise sheet to the farmers to work out the details for the respective crops by changing the relevant package of practices as applicable to local situations.

Exercise Sheet - 2 (Maize – Blank sheet to be filled by Farmer based on worked solution given below.

Steps:

- Multiply the quantity with the price in each line
- Add the money spent (“Expenditure”) on inputs and labour
- Multiply the yield by the price of sale (“Income”)
- Subtract the sum of “money-out” from the “Income”
- Determine if there was a gain or a loss

Activity	Unit	Quantity	Price	Total (Rs.)
Preparatory cultivation				
a) Machine / labour	No of hours			
b) Animal / labour	Days			
Sub Total				
Seeds and sowing				
a) Cost of seed	Kgs			
b) Cost of seed treatment				
c) Cost of sowing (Human Labour)	Days			
d) Cost of thinning/gap filling	Days			
Sub-Total				
Manures and Fertilizers				
c) Cost of fertilizer	Kgs	N		
		P		
		K		
d) Application cost (Human Labour Male)	Days			
Sub-Total				
Weed control				
a) Cost of Manual weeding	Labour			
b) Cost of herbicide if any (butachlor)	Days			
Sub-Total				
Plant Protection				
a) Cost of bio-agents				
b) Cost of pesticides (Thiamethoxam/pro-fenophos)	Litres			
Furadon-3G	Kg			
c) Cost of Application	Labour			
Sub-Total				

Activity	Unit	Quantity	Price	Total (Rs.)
Irrigation cost if any	Power	month		
Sub-Total				
Cost of harvest				
a) Combined harvester	Hours			
Post harvest charges				
b) Cleaning and bagging (Human Labor)	days			
Sub total				
Total cost of cultivation				
Yield Kgs/Ha. and returns				
a) Qty. produced Qtls. per ha	qtls			
b) Gross returns received per ha (Rs.)				
c) Total cost involved per Ha (Rs.)				
d) Net returns per Ha (Rs.)				
e) Cost benefit ratio (Gross Returns divided by Total Cost)				


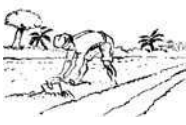





Solution to exercise 2 - Maize

Cost of Cultivation of Maize (per hectare)

Activity	Unit	Quantity	Price	Total (Rs.)
Preparatory cultivation				
a) Machine / labour	No of hours	5	650	3250
b) Animal / labour	Days	5	500	2500
Sub Total				3750
Seeds and sowing				
a) Cost of seed	Kgs	20	81.25	1625
b) Cost of seed treatment				
c) Cost of sowing (Human Labour)	Days	5	200	1000
d) Cost of thinning/gap filling	Days	5	200	1000
Sub-Total				2625
Manures and Fertilizers				
c) Cost of fertilizer	Kgs	150 N	12	1800
		60 P	50	3000
		50 K	28	1400
d) Application cost (Human Labour Male)	Days	10	150	1500
Sub-Total				7700
Weed control				

Activity	Unit	Quantity	Price	Total (Rs.)
a) Cost of Manual weeding	Labour	20	150	3000
b) Cost of herbicide if any (butachlor)	Days	4	500	2000
Sub-Total				5000
Plant Protection				
a) Cost of bio-agents				
b) Cost of pesticides	Litres	5	300	1500
Furadon-3G	Kg	10	60	600
c) Cost of Application	Labour	4	200	8
Sub-Total				2900
Irrigation cost if any	Power	4	500	2000
Sub-Total				2000
Cost of harvest				
a) human labour	days	20	200	4000
b) Threshing (machine)	quintals	40	60	2400
Post harvest charges				
b) Cleaning and bagging (Human Labor)	days	15	200	3000
Sub total				7400
Total cost of cultivation				31375
Yield Kgs/Ha. and returns				
a) Qty. produced Qtls. per ha	qtls	40	1000	40000
b) Gross returns received per ha (Rs.)	Cart load	4	500	2000
c) Total cost involved per Ha (Rs.)				42000
d) Net returns per Ha (Rs.)				31375
e) Cost benefit ratio (Gross Returns divided by Total Cost)				10625
e) Cost benefit ratio				1:1.34

Exercise 1: Agricultural Calendar - Operations to Plan the Production of Cotton

The times of work...												
Of the main season are shown by a square												
Of the off-season are shown by a circle												
The tasks of the farmer	January	Feb.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
 Prepare the field												
 Plough the field												
 Purchase seeds												
 Sow												
 Fertilizer application												
 Weeding												
Apply insecticide												
 Harvest and store												

Important Lesson:

For a good yield, the farmer plans to do the necessary work in the field and apply the inputs at the right time based on the calendar of operations through out the year.

Here we will see how to determine if firm business was good or bad. We will calculate the “Income” and “Expenditure” from different produce. Master Trainer may give the following exercise sheet to the farmers to work out the details for the respective crops by changing the relevant package of practices as applicable to local situations.

Exercise Sheet - 2 (Cotton - Bt Cotton) – Blank sheet to be filled by Farmer based on worked solution given below.

Steps:

- Multiply the quantity with the price in each line.
- Add the money spent (“Expenditure”) on inputs and labour
- Multiply the yield by the price of sale (“Income”)
- Subtract the sum of “money-out” from the “Income”
- Determine if there was a gain or a loss

Cost of Cultivation Cotton (per hectare)

Activity	Unit	Quantity	Price	Total (Rs.)
Preparatory cultivation				
a) Machine / labour	No of hours			
b) Animal / labour	Days			
Sub Total				
Seeds and sowing				
a) Cost of seed	Kgs			
b) Cost of seed treatment				
c) Cost of sowing (Human Labour)	Days			
d) Cost of thinning/gap filling	Days			
Sub-Total				
Manures and Fertilizers				
c) Cost of fertilizer	Kgs	N		
		P		
		K		
d) Application cost (Human Labour Male)	Days			
Sub-Total				
Weed control				
a) Cost of Manual weeding	Labour			
b) Cost of herbicide if any (butachlor)	Days			
Sub-Total				
Plant Protection				
a) Cost of bio-agents				
b) Cost of pesticides (Imidacloprid/Thia-methoxam/profenophos)	Litres			
Furadon-3G	Kg			
c) Cost of Application	Labour			
Sub-Total				

Activity	Unit	Quantity	Price	Total (Rs.)
Irrigation cost if any	Power			
Sub-Total				
Cost of harvest				
a) Picking	Kgs			
Sub total				
Total cost of cultivation				
Yield Kgs/Ha. and returns				
a) Qty. produced Qtls. per ha	qtls			
b) Gross returns received per ha (Rs.)				
c) Total cost involved per Ha (Rs.)				
d) Net returns per Ha (Rs.)				
e) Cost benefit ratio (Gross Returns divided by Total Cost)				

Solution to exercise 3 – Cotton

Cost of Cultivation of Cotton (per hectare)

Activity	Unit	Quantity	Price	Total (Rs.)
Preparatory cultivation				
a) Machine / labour	No of hours	5	650	3250
b) Animal / labour	Days	5	500	2500
Sub Total				5750
Seeds and sowing				
a) Cost of seed	Kgs	0.9	1860	1674
b) Cost of seed treatment				
c) Cost of sowing (Human Labour)	Days	8	200	1600
d) Cost of thinning/gap filling	Days	2	200	400
Sub-Total				3674
Manures and Fertilizers				
c) Cost of fertilizer	Kgs	150 N	12	1800
		60 P	50	3000
		60 K	28	1680
d) Application cost (Human Labour Male)	Days	30	150	4500
Sub-Total				10,980
Weed control				
a) Cost of Manual weeding	Labour	75	150	11250

Activity	Unit	Quantity	Price	Total (Rs.)
b) Cost of herbicide if any (butachlor)	Days			
Sub-Total				11250
Plant Protection				
a) Cost of bio-agents				
b) Cost of pesticides (Imidacloprid/ Thia-methoxam/profenophos)	Litres	10	350	3500
Furadon-3G	Kg			
c) Cost of Application	Labour	20	200	4000
Sub-Total				7500
Irrigation cost if any	Power	6	500	3000
Sub-Total				3000
Cost of harvest				
a) Picking	Kgs	2500	6	15000
Sub total				15000
Total cost of cultivation				57154
Yield Kgs/Ha. and returns				
a) Qty. produced Qtls. per ha	qtls	25		
b) Gross returns received per ha (Rs.)			3600	90000
c) Total cost involved per Ha (Rs.)				57154
d) Net returns per Ha (Rs.)				32846
e) Cost benefit ratio (Gross Returns divided by Total Cost)				1:1.57

Note: The fixed cost and recurring cost like the interest, depreciation, opportunity cost, etc have not been taken into calculation in the three crops above. Therefore, other things remaining constant, Only the variable cost and returns have been used for the exercise.

Module 4: Income and expenditure statement

Comparing results to know whether you are doing successful farm business

Please tell what is good and what is bad business and indicate the reasons.

Crop	Unit	1 ha of Paddy	1 ha maize	1 ha Cotton
Production	Quintal	50 q	Main product = 40 q By Product (stover/ Straw) = 4 cart load	25 q
Income	Rs/ha	81400	42000	90000
Expenditure	Rs/ha	46160	31375	57154
Profit or Loss?	Rs/ha	+ 35240	+ 10625	+ 32846
		Profit	Profit	Profit
Rank		I	III	II

* It proves that Paddy after Paddy realises the highest profit throughout the year followed by Cotton – Maize. Paddy – Cotton is not feasible.

Remember: Even if Paddy after Paddy promises the highest profit throughout the year, farmer should avoid continuous monocropping to ensure soil fertility through crop diversification and rotation to realize sustained profitability of their farm.

Main Lessons

- To know if you are doing successful business with a crop, you need to know the “Income” and “Expenditure” accurately.
- The farmer records the inputs & labour used in a field, and calculates the “Income” and “Expenditure”
- From the “Income” the farmer subtracts the Expenditure. The result indicates whether farm is making profit or loss.
- The farmer makes a **PROFIT** or **GOOD BUSINESS** if the “Income” is greater than the “Expenditure.”
- It is a **LOSS**, if the “Expenditure” is greater than the “Income.” In that case it is **BAD BUSINESS**.
- A loss is illustrated by the the minus (dash) and a profit by the plus in front of the number.
- A good farmer will abandon loss making crop or use a better technique to make a profit.
- To ensure a profit, the farmer needs to visualise Income and Expenditure before production.
- The Difference between Income and Expenditure indicates whether we are making a loss or profit from the use of the land.
- The Unit Cost of a crop indicates if it can compete with the same crop produced elsewhere. In the case of food crops, the Unit Cost indicates if it is preferable to buy the produce in the market.
- The good farmer calculates well ahead of the season to decide what to produce and which techniques to use.
- During the production season the good farmer keeps records on money spent for farm operations and inputs.
- After the harvest, the good farmer evaluates the profit and identifies what changes are needed to improve the planning and profit for the next production season

What are Fixed Costs?

Certain costs are called fixed costs. These are costs for equipment and tools that the farmer owns and are used for various crops over several years, such as sprayers, irrigation pumps, buildings etc. The Fixed Costs do not vary with the size of the field.

Blank Exercise sheet of Income and Expenditure Statement: Comparing Results to know whether you are doing successful Farm Business

After, all the calculations farmers will determine the opportunities to increase revenues. By looking at the money on this page farmers will learn

- How to make investment decisions and determine the best opportunities by using Gross Margin, Labour Productivity and Capital Productivity.
- Rank crops based on Profit or Loss
- What crops and techniques to choose?
- Make a choice based on this ranking

	Unit	Paddy	1 ha maize	1 ha Cotton
Surface Area	Ha	1	1	1
1. Money-Out (Variable Costs) Rs/ha	Rs/ha			
Cost of Inputs	Rs/ha			
Labour Costs	Rs/ha			
2. Income (Gross revenue)	Rs/ha			
Production	Kg			
Price	Rs/kg			
Yield x Price of Sale	Rs/ha			
Value of Produce (Gross Income)	Rs/ha			
Expenditure	Rs/ha			
Profit or Loss?				
Rank				

Module 5: Manage your Money throughout the Year

Bad management of money

- How does one know if the money is managed badly?
- What are the causes?
- What must one do to manage money well during the year?

One must plan! The person, who fails to plan, plans to fail!

First Step: Please look at Income and Expenditure for different crops on the farm and also look at household expenditures. Below are the expenditures of a Household of 5 persons (1 child not yet in school, 1 child in primary school, 1 old parent along with husband and wife). We discuss if we can predict all these expenditures.

Money Needs	Expenditures (Rs)	Period	Can be foreseen
Provisions (food, fuel and household items for an average family size of 5 members)	36,000 (3000 X12)	Each month	Yes
School fees			
Free education for primary school children			
Clothing			
School uniforms for 1 child	1,000	June	Yes
Clothing /year	5,000	April	Yes
Happy events			
Diwali /dussehra	1000	November	Yes
Baisakhi/Ugadi	1000	January	Yes
Unexpected events	3600	Each month @ Rs 300	No
Health expenditure	2400	Per year	No
Total expenditure	50000		

Second Step:

- Let us put these numbers into a financial calendar. On the next page you will see the numbers calculated in Module 5.
- How much money is left at the end of each month?
- How much money is left at the end of the year?

The trainer explains how to do it.

Case 1: Paddy – Paddy financial calendar based on a farm using current practices (Rs) – Exercise

Expenditure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Paddy (1 ha) - Kharif												
Cost of Inputs including labour						6550	18610	7400	3450	8150	2000	
Paddy(1 ha) - Summer												
Cost of Inputs including labour	18610	7400	3450	8150	2000							6550
Household	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
School fees and material												
Happy events				1000							1000	
Clothing				5000		1000						
Unexpected events	300	300	300	300	300	300	300	300	300	300	300	300
Total per month	21910	10700	6750	17450	5300	14850	21910	10700	6750	11450	6300	9850
Expenditure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Paddy (81 Paddy (81400) Summer					81400							
Paddy (81400) - Kharif											81400	
Total per month					81400						81400	
Expenditure	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Expenditure per Month	21910	10700	6750	17450	5300	14850	21910	10700	6750	11450	6300	9850
Total Expenditure for the Year	142320 (Total expenditure per year = 46160 (Cost of Cultivation for Paddy per season) X2 seasons + 50000 (Family Expenditure per year)											
Total balance per year	Income = (81400 X 2 = 162800 - 142320 = 20480 (Net balance)											

* As the income is realised only during May and November, the monthly balance is shown as negative which indicates that the farmers raises a hand loan/personal loan or shall keep the gross income (Rs 81,400 X 2 = 162,800) and spend through out the year based on the need.

Note: In this example all produce from the farm is sold as per the prevailing market rates. The profit of the farmer depends on the price for the produce i.e., whether the Minimum Support Price (MSP) or market rates are prevailing - which are both fluctuating.

Third Step:

Fill the second financial calendar. The expenditures for inputs and labour are those from the exercise Sheets in Module 5 – using improved practices.

Fourth Step:

Discuss the differences and which situation is preferable. What changes are necessary?

Main Lessons

- In the agricultural enterprise, expenditure for the farm and the household are incurred every month. But the revenue comes only after sale of produce. Therefore there are months of the year where the expenditures are greater than the revenues. These months are called “deficit months.”
- For this reason, the good farmer makes a financial calendar. The farmer plans expenditures for production and household needs in consultation with his spouse.
- To be able to cover the expenditures in deficit months, the good farmer saves money from the sales of produce (“surplus months”).
- Improved techniques may contribute to improve the revenues of the farmer.
- The needs for inputs can be identified with calculations of gross margin and the financial calendar. This information can be used to make savings in a targeted way or to solicit credit for production.
- The above calculations are done for a farmer with one hectare for Paddy – Paddy combination in Kharif and Rabi for one year. The same exercise should be repeated for taking farm management decisions for the combinations such as
 - Cotton – Maize (Kharif – Rabi)
 - Paddy – Maize (Kharif – Rabi)
 - Maize – Maize (Kharif – Rabi)

Risk in Agriculture

The farmer does not like risks because they are difficult to predict. However, he/she can determine the risk during the planning so that the impact on revenues could be minimised. For example, Module 4 indicates income and expenditure of paddy, maize and cotton. With available data, Paddy - Paddy is the best preferred cropping pattern. However, the farmer can make a judicious decision taking prevailing and anticipated risks into considerations. The anticipated risks and possible decisions are as follows:

Anticipated Risks	Remarks
Reduction in Paddy Market price by 10%	Cotton – Maize is preferred
Inadequate water due to drought for Paddy - Paddy	Cotton – Maize is preferred followed by Maize - Maize. Quantity of water available decides the cropping pattern.

Anticipated Risks	Remarks
Lack of capital for investment for Paddy – Paddy or Cotton - Maize	Paddy and Maize is preferred followed by Maize - Maize
Serious pest problems in Cotton	Paddy – Paddy is preferred

Main Lessons

- Comparing the gross margins of different crops and the production techniques, helps to make decisions on using the land to maximise revenue. This comparison is important to all agricultural entrepreneurs.
- Comparing the labour productivity helps to identify the crops and techniques that make best use of labour (family or wage labour). It also indicates if it is profitable to work on your own farm.
- Comparing the capital productivity indicates which crops or production techniques make best use of money invested.
- Production decisions are based on these comparisons.
- The good agricultural entrepreneur knows that a fluctuation in prices constitutes a risk and revenues. Risks are concern for traditional as well as improved varieties and techniques.
- To evaluate the impact of this market risk, the entrepreneur calculates estimated the gross margin with a much lower price (pessimistic) than the current price (or last season's price). If the pessimistic gross margin estimate can still satisfy the revenue objectives, then the risk is acceptable.
- To evaluate the impact of production risks, the agricultural entrepreneurs calculates a gross margin using a yield lower (pessimistic) than expected. If the pessimistic gross margin estimate can still satisfy the revenue objectives, then the risk is acceptable.

5. Occupational Health and Safety of Farmers

5.1. Objectives of the session

- To create an awareness about causes of health hazards, risks and fatalities in agriculture.
- To impart the knowledge on preventive measures of health hazards in agriculture.
- To enlighten the farmers on use of first aid in emergencies.

5.2. What we know at the end of the session

- Important occupational health hazards in agriculture
- Factors responsible for increasing risk of injury or illness for farmers
- Safe handling of agro chemicals
- Colour coding of pesticides
- First aid measures for pesticide poisoning
- Care in use of pesticides by farmers
- Safety tips to reduce the risk of injuries and fatalities while handling machineries
- First aid for accidents

In agriculture, farmers work under open condition in natural environment, which expose them to various occupational hazards, especially more caused due to handling of chemicals and machineries. Besides, natural hazards are caused due to snakebite, wild animal attack, etc. Knowledge on preventive and curative aspects of these occupational hazards would reduce risks and ensure the safety to the farmers.

5.3. Important occupational health hazards in agriculture

Exposure	Health Effect	Specificity to Agriculture
Hot Weather	Dehydration, heat cramps, heat exhaustion, heat stroke, skin cancer	Most agricultural operations are performed outdoors
Snakes, insects	Fatal or injurious bites and stings	Close proximity results in high incidence
Sharp tools	Injuries ranging from cuts to fatalities	Most farm situations require a wide variety of skill levels for which workers have little knowledge
Physical labour, carrying loads	Back pain and body pain	Agricultural work involves uncomfortable conditions and sustained carrying of excessive loads
Pesticides	Acute poisoning or chronic poisoning	Pesticides can be hazardous and must be used with Personal Protective Equipment (PPE)
Dusts, fumes	Irritation of the eyes and respiratory tract	Agricultural workers are exposed to a wide range of dusts and gases during plant protection with few exposure controls and limited use of PPE

Gases, pathogen	<ul style="list-style-type: none"> • Skin diseases such as fungal infections and allergic reactions • Parasitic diseases such as malaria, sleeping sickness and hookworm • Animal related diseases such as anthrax, bovine tuberculosis and rabies (at least 40 of the 250 animal related diseases are occupational diseases in agriculture) • Cancers 	<ul style="list-style-type: none"> • Workers are in direct contact with environmental pathogens, fungi, infected animals, and allergenic plants • Workers have intimate contact with parasites in soil, waste water/sewage, dirty tools and unhygienic housing • Workers have ongoing, close contact with animals through raising and sheltering • Agricultural workers are exposed to a mix of biological agents, pesticides, and diesel fumes, all linked with cancer
Others	<ul style="list-style-type: none"> • Electricity shocks, fire, road accidents, livestock and wild animal attacks, falling into wells, lightening, psychological depression, suicides, etc. 	<ul style="list-style-type: none"> • Loss of life and injuries and suffering to the dependents

Adapted from IFPRI, 2006

5.5. Factors that may increase risk of injury or illness for farm workers

Age: Injury rates are highest under 15 and over 65 years of age.

Equipment and machinery: Most farm accidents and fatalities involve machinery. Proper machine guarding and regular equipment maintenance according to manufacturers' recommendations can help prevent accidents.

Non-availability of protective equipments: Using protective equipment, such as seat belts on tractors and personal protective equipment (such as safety gloves, coveralls, boots, hats, aprons, goggles and face shields) could significantly reduce farming injuries.

Lack of medical care: Hospitals and emergency medical care are typically not readily accessible in rural areas near farms. However, the farmers may utilize for example 108 mobile medical emergency services during emergencies.

Socio - economic risks

- There are dangers due to indiscriminate pesticide/weedicide application to soil, water, air, food chain, natural enemies of pest, resistance of pest, etc.
- Pesticides are hazardous, so there will be associated risk and impact of risk on social system

including economic damage. So there should be a proper understanding on hazards of pesticides.

Effects on human beings

- Pesticides accumulate in fatty tissues and reproductive cells lead to birth defects, abnormalities, abortions, premature deliveries, etc.
- Farm workers who regularly spray pesticides are susceptible to impaired eyesight.
- The liver is particularly susceptible to damage by chlorinated hydrocarbons, which can lead to higher risk of serious infection.

Environmental exposures lead to

- Air pollution
- Soil and water pollution
- Food contamination

Looking into the implications of pesticides on socio-economic dimensions, use of pesticides should be judiciously planned only in critical situations with utmost care. Management of pest below Economic Threshold Level (ETL) is most desirable.

5.6. Safe handling of agro chemicals

Agro chemicals are widely used in agriculture, which are major source of health hazards to farmers. Important tips to farmers for safe use of agro chemicals are as follows:

Buying pesticides

Before buying think over this

- Which pest is to be controlled?
- Is damage crossing threshold level requiring pesticide use?
- Have you observed any predators that check pest attack?
- What is the recommendation for the observed problem?
- Which is the least toxic and low persistent chemical among recommendations?

While buying

- Buy from a reputed and licensed store.
- Buy only required quantity and not to go for bulk purchase.
- Do not buy leaky containers.
- See the expiry date.
- Buy only ISI / BIS marked products.
- Don't buy banned and restricted chemicals.

Transportation

- Do not transport/carry pesticides along with food products.
- Do not spill or allow leakage while transporting.
- If leakage is observed clean the vehicle.

Storage

- Don't keep chemicals in kitchen or with animal feed.
- Keep out of reach of children.
- Keep under lock and key.
- Keep in well ventilated separate room.
- Avoid cross contamination of different chemicals.
- Do not keep with human or animal medicine.
- Properly reseal before storing again.

Application

- Read the label and follow the instructions.
- Don't work alone while handling and applying.
- Don't allow children and animals near mixing and application site.
- Use long wooden stick for mixing.
- Mix only the quantity that you need for the next application.
- Avoid excessive spraying and unintended site application.
- Read the label and instructions carefully before opening the pack.

- Never eat and drink while applying.
- Use Personal Protective Equipment (PPE), particularly long shirt and pants, closed shoes as well as protection mask and gloves.
- Avoid application during rainy period.
- Never blow out clogged nozzles or hoses with your mouth, use pin or fine wire for cleaning.
- Avoid windy conditions and do not spray against wind direction.

After application

- Immediately after application take bath and change cloths.
- All clothes must be washed after spraying/dusting and wash them separately.
- Never leave residues of pesticide in sprayers and dusters.
- While cleaning see that water used for cleaning should not enter the drinking water stream/wells.
- Do not go into the treated field until the recommended safety period has passed.
- Do not harvest produce before safe period.

Safe container disposal

- Bury the containers in the field after use.
- Don't use for food and feed storage.
- Do not sell empty container.
- Do not wash the used containers in community water sources.

Colour Coding of pesticides:

The colour band on the pesticide container indicates the hazard level of pesticides. While handling pesticides farmers should take colour band into consideration.

- Red – Very toxic to toxic
- Yellow – Harmful
- Blue - Moderately hazardous
- Green - Acute hazard unlikely in normal use

5.7. First aid measures for pesticide poisoning

- In case of skin contact, remove contaminant contacts and wash with clean water.
- In case of inhalation, remove from site and provide good clean air site, keep the head and shoulder upright.
- In case of unconscious and breathing stops, provide artificial respiration.
- If pesticide is swallowed, induce vomiting by giving 2-3 liters salt water. Give milk after that.

- Take the patient to doctor at the earliest.
- Take the container along with patient to consult doctor.

Snake and other animal bites or attacks and precautions





Snakebite is a routinely occurring life threatening emergency in India. The mortality and morbidity associated with the diverse presentation of snakebites can be decreased if a proper history of the patient's background and habits combined with a thorough knowledge of the specific features of the regional snakes are kept in mind.







Physical and mental drudgery







To reduce drudgery related to hard work in different agricultural operations, several technologies for land preparation, weeding, pesticide application and various other farm works have been developed including farm machinery which need to be used by the farmers to keep themselves fit and healthy. Farmers are advised to contact local extension functionaries and scientists to obtain information on such drudgery reducing farm machineries.

5.8. Care in use of pesticides by farmers

Useful tips for safe use of pesticides by farmers are:

	<ul style="list-style-type: none"> • Identify the pest and ascertain the damage done. • Use pesticide only if it has exceeded the economical injury level. • Use only the recommended pesticide, which is the least toxic.
	<ul style="list-style-type: none"> • Read instructions manual of the pesticide and equipment. • Check the spraying equipment and accessories, which are to be used.
	<ul style="list-style-type: none"> • Ascertain that all components are clean, especially filling and suction, strainer, sprayer tank, cut off device and nozzle • Replace worn out parts such as 'O' ring, seal, gasket, worn out nozzle tip, hose clamps and valves. • Test the sprayer and ascertain whether it pumps the required output at rated pressure. Check the nozzle spray pattern and discharge rate.
	<ul style="list-style-type: none"> • Calibrate the sprayer. Set sprayer speed and nozzle swath by adjusting spray height and nozzle spacing.

	<ul style="list-style-type: none"> • Make sure that appropriate protective clothing is available and is used • Train all concerned with the application and also understand the recommendations. Ensure that soap, towel and plenty of water is available.
	<ul style="list-style-type: none"> • Pesticide should be kept in dry and locked store.
During spraying	
	<ul style="list-style-type: none"> • Take only sufficient pesticide for the day's application from the store to the site. • DO NOT transfer pesticides from original container and packing into the containers. • Recheck the use instructions of pesticide and equipment. • Make sure pesticides are mixed in the correct quantities.
	<ul style="list-style-type: none"> • Wear appropriate clothing. • Avoid contamination of the skin especially eyes and mouth. • Liquid formulation should be poured carefully to avoid splashing.
	<ul style="list-style-type: none"> • Never eat, drink or smoke when mixing or applying pesticides. NEVER blow out clogged nozzles or hoses with your mouth.
	<ul style="list-style-type: none"> • Follow correct spray technique. Spray plant crop thoroughly by operating sprayer at correct speed and correct pressure.

	<ul style="list-style-type: none"> Follow correct spray technique. Spray plant crop thoroughly by operating sprayer at correct speed and correct pressure.
	<ul style="list-style-type: none"> Never allow children or their unauthorized persons to be nearby during mixing. Never leave pesticides unattended in the field. Never spray if the wind is blowing towards grazing livestock or pastures regularly used. Spraying should be done in the direction of Wind.
After spraying	
	<ul style="list-style-type: none"> Remaining pesticides left in the tank after spraying should be emptied and disposed off in pits dug on wasteland. Never empty the tank into irrigation canals or ponds.
	<ul style="list-style-type: none"> Never leave unused pesticides in sprayers. Always clean equipment properly. After use, oil it and then keep away in storeroom.
	<ul style="list-style-type: none"> Do not use empty pesticide containers for any purpose. Crush and bury the containers preferably in a land filled dump.
	<ul style="list-style-type: none"> Clean buckets, sticks, measuring jars etc used in preparing the spray solution.



- Remove and wash protective clothing and footwear.
- Wash yourself well and put on clean clothing.



- Keep an accurate record of pesticide usage.
- Prevent persons from entering treated areas until it is safe to do so.
- Mark the sprayed plots with a flag.

Source : tnauagriportal

5.9 Basic Measures to Manage Weeds, Diseases and Pest Problems

- Prevention is better than cure, hence follow the preventive measures discussed above
- Keep pest below ETL using preventive techniques
- Give more attention to pest warnings by Agriculture Department officials and experts
- Be watch full on weather forecast by ICAR and IMD
- Consult KVK or Scientist in early stages
- Discuss the problems with fellow farmers, you may get many traditional tips
- Understand the scientific rationale behind each pest management ITKs
- Have regular contact with local Research and Development wings of agriculture and allied sectors to get a recent development.

5.10. Safety tips to reduce the risk of injuries and fatalities while handling machineries

Contrary to the popular image of fresh air and peaceful surroundings, a farm is not a hazard free work setting. Every year, thousands of farm workers are injured and hundreds die in farming accidents. Safety in agriculture is one of the main concern, especially when handling with farm tools and machinery. Many accidents in agriculture go

unnoticed because they will not be reported. So learning from mistakes will be less. Safety tips to reduce the risk of injuries and fatalities while handling machineries are as follows:

- Safety can be improved on farm by increasing awareness of farming hazards and making a conscious effort to prepare for emergency situations including fires, vehicle accidents, electrical shocks from equipment and wires and chemical exposures.
- Be especially alert to hazards that may affect children and the elderly.
- Minimize hazards by carefully selecting the products to ensure safety.
- Always use seat belts when operating tractors.
- Read and follow instructions in equipment operator's manuals and on product labels.
- Inspect equipment routinely for problems that may cause accidents.
- Discuss safety hazards and emergency procedures with all concerned.
- Take precautions to prevent entrapment and suffocation caused by unstable surfaces of grain storage bins and silos. Never "walk on the grain."
- Be aware that methane gas, carbon dioxide, ammonia and hydrogen sulfide can form in unventilated grain silos and manure pits and can suffocate or poison farmers or explode.
- Wear clothing that fits well and is not loose fitting to avoid being caught in pinch points.

- Never reach over or work near unguarded rotating parts.
- Turn off machinery to attend to repairs.
- Always replace shields that were removed for maintenance.
- Plug unused or failed borewell pits
- Check all equipment for potential wrap points (e.g. where clothing or hair could be wrapped around a shaft) and if possible, shield those points.
- Replace any damaged manufacturer installed warning labels and place warnings on equipment parts not previously labeled (consider painting them with a bright color, perhaps with a wide stripe).
- Stay alert and warn others when working with shear and cutting points (e.g. objects with blades or hard edges used to cut). Some shear and cutting points cannot be guarded, which can result in severe cuts, lost limbs or injuries from objects thrown by the cutting type equipment.
- Wait until a tractor has stopped completely before stepping into the hitching position.
- Never touch free-wheeling parts (i.e. parts that continue to spin after the power is shut off) until they have stopped moving. This could take 2-2½ minutes.
- Be aware of burn points: mufflers, manifolds and even gear cases.
- Hydraulic systems contain fluid under extreme pressure. Before loosening, tightening, removing or otherwise working with any fittings or parts, relieve this pressure (shut off the hydraulic pump, lower implements and follow instructions in the operator's manual).
- Keep equipment in good repair and safety features up to date.
- "Proper machine inspection and maintenance can help prevent accidents".
- When it comes to machinery maintenance, a shield and guard to cover spinning parts or blades should be kept in place.
- Follow the one seat, one rider rule. If there is only one seat on the equipment, there should only be one rider – an adult.
- Don't allow children to play or ride on equipment or in areas where machinery is used or stored.
- Under aged children should not operate 2, 3, and 4 wheeled vehicles.
- Do not allow riders or passengers in the back of pickup trucks.
- Before starting machinery, all operators should know where kids are located. You may be unable to hear or see children, especially behind large wheels or in blind spots.
- All equipment should be parked and locked with the keys removed when not in use.
- Keep hand tools out of reach of children, especially those with sharp or hot parts.

Better safety and health practices reduce farmer fatalities, injuries and illnesses as well as associated costs such as workers' compensation insurance premiums, lost production and medical expenses. A safer and more healthy workplace improves morale and productivity.

First aid for accidents: The farmers injured should be given first aid at the earliest in order to reduce the damage caused by the injuries. Important tips are as follows:

- The treatment should be given from a person trained in basic first aid, using supplies from a first-aid kit.
- Medical treatment and care given at the site of any medical emergency or while transporting any victim to a medical facility.
- Make sure that first-aid trained personnel are available to provide quick and effective first-aid. Alternatively, one of the family members should be trained.
- Make sure first-aid supplies at your workplace are appropriate to your occupational setting. The response time of your emergency medical services is very important.
- Good knowledge about locally available antidotes or medicinal plants, which can be used.
- Keep the first aid kit(s) in the work place.
- Keep clean water in the work place.
- Keep mobile numbers of trained person on first aid, ambulances, local hospital, local doctors and vehicle owners in the near by vicinity.

5.11. Suggested items for your first-aid kit

- Sterile adhesive bandages
- Small roll of absorbent cotton pads of different sizes
- Adhesive tape

- Triangular and roller bandages
- Cotton (1 roll)
- Band-aids (Plasters)
- Scissors
- Pen torch
- Latex gloves (2 pair)
- Tweezers
- Needle
- Moistened towels and clean dry cloth pieces.
- Antiseptic (Savlon or dettol)



First Aid Kit

5.12. Lessons Learnt

1. Awareness on occupational health and safety issues is must for every farmer.
2. Majority of the health hazards in Agriculture are preventive in nature provided farmers are aware about.
3. Farmers should handle the agro chemicals safely. Little negligence may cost the life of human beings and livestock.
4. Dispose the pesticide containers safely.
5. First aid knowledge and skills saves the lives.
6. Keep away children from farm machineries.

- Thermometer
- Tube of petroleum jelly or other lubricant
- Assorted sizes of safety pins
- Cleansing agent/soap

Non-prescription drugs

- Aspirin or paracetamol pain relievers
- Antidiarrhea medication
- Antihistamine cream for Bee Stings.
- Antacid (for stomach upset)
- Laxative

Kits should be checked at least weekly to ensure adequate number of needed items is available. Kits may be kept in the work place.

Make sure that first-aid supplies are:

- Easily accessible to all farmers.
- Stored in containers that protect them from damage, deterioration or contamination.
- Containers must be clearly marked, not locked, and may be sealed.
- Able to be moved to the location of an injured or acutely ill worker.
- Make sure emergency washing facilities are functional and readily accessible.

6. Farmers' Access to Services

6.1. Objectives of the session

- To enhance awareness about source of extension, information and services among farmers.
- To expose farmers to public and private extension services.
- To encourage farmers to avail extension services through ICT means.
- To enhance farmers knowledge on agricultural credit, insurance and legal aspects.

6.2. What we know at the end of the session

Sources of extension and nature of services provided by following extension service providers:

- Public extension services
- Private extension services
- Institutional sources
- ICT sources
- Agricultural credit
- Agricultural insurance
- Legal aspects

Farmers' Access to Services

6.3. Important services required for farmers

- Information
- Inputs (seed, fertilizer, pesticide, machinery, etc.)
- Infrastructure (cold storage, godown, feed mixing unit, etc.)
- Market (market yard, market intelligence, transport, etc.)
- Developmental schemes/programmes
- Credit and insurance, etc.

The above services are needed with dimensions of accessibility, quality, cost effectiveness and timeliness.

Information is the critical input required for the farmers to bring about changes starting from selection of crops till the marketing.

Past experience: The most important source of information to the farmers is his/her past experience itself. However before acting upon information based on past experience, he/she needs to cross check the relevance to the present context.

Progressive farmers: are the small segment of rural

life who are socially, economically and technologically advanced compared to other farmers. They go in search of advanced technologies proactively, adopt and harvest the benefit of technologies. They are the nearest and easiest source of agricultural information to other farmers. For example, contact farmers, award winning farmers, Block Farmers Advisory Committee (BFAC) members, District Farmers Advisory Committee (DFAC) members, State Farmers Advisory Committee (SFAC) members, farmers running farm school, etc.

Input Dealers: are mostly village level businessmen who sell seeds, fertilizers, pesticides and machineries to the farmers. Also provides extension advisories by their strength of proximity to the farmers. However maximum precautions has to be exercised for accessing the advisory services as they are not professionally qualified extension functionaries. However, some input dealers are trained through various programme like Diploma in Agricultural Extension Service for Input Dealers (DAESI) who can provide quality agricultural information. In other cases, advisory from local public extension functionaries and inputs based on the advisory from input dealers can be accessed.

Cooperative Societies: District Central Cooperative

banks and Primary Societies

- Extend agriculture credits under priority sector
- Implement NABARD schemes
- Implement Government schemes
- Implement social security schemes
- Extends crop loans

Land (Agriculture & Rural) Development Banks

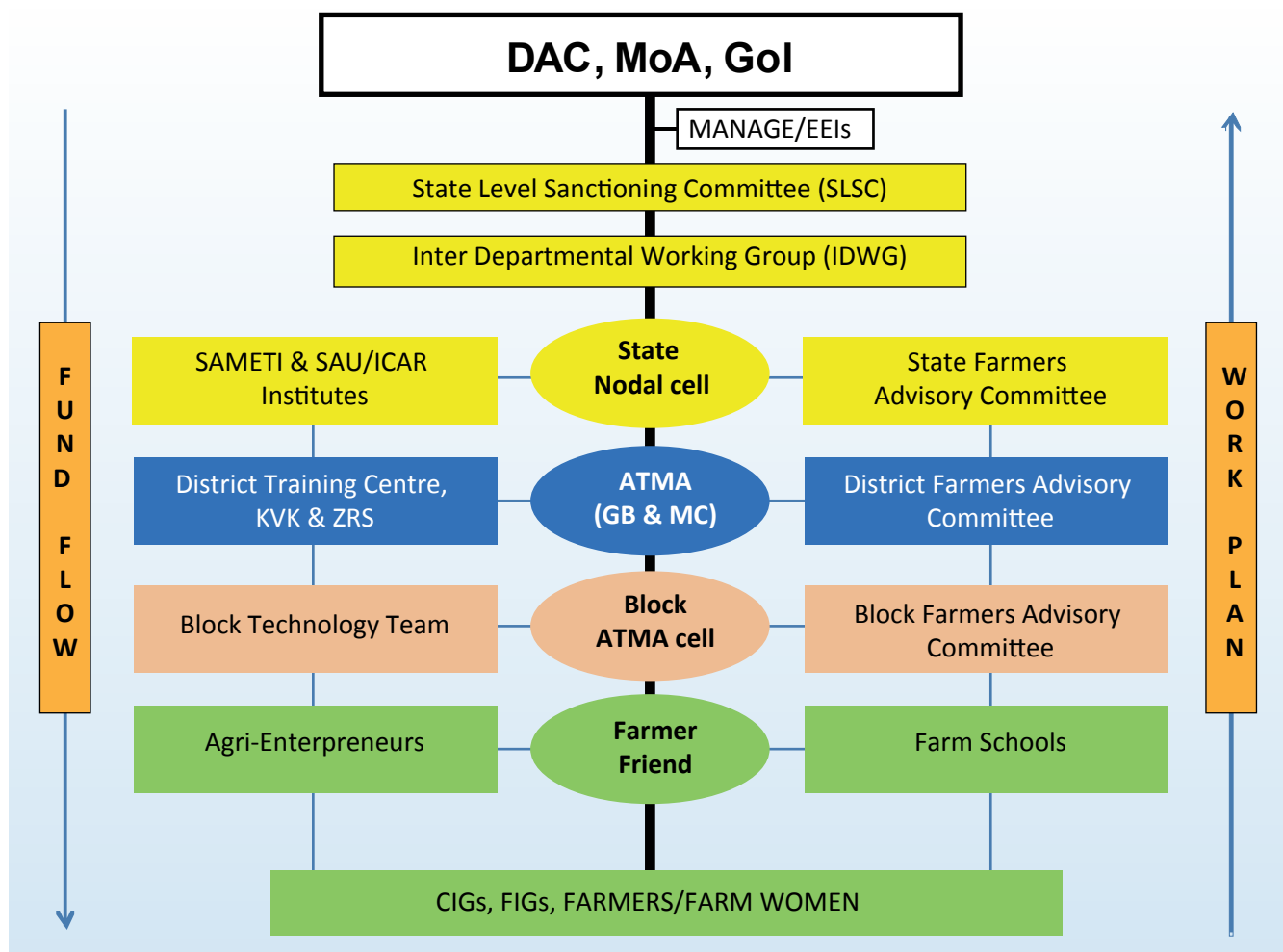
- Extend medium and long term credit to agriculture
- Implement government schemes

Public sector extension: Represented mainly by the State Agriculture and allied departments continues to be the most important source of information for the majority of farmers. Each department such as Agriculture, Horticulture, Sericulture, Animal Husbandry, Marketing, etc. have their own extension manpower and delivery mechanism to

reach the farmers. The focus is on transfer of technology and undertaking agricultural development programmes of state and central Governments.

Agricultural Technology Management Agency (ATMA):

An agency undertaking agricultural development programmes at district level in which agriculture and allied departments along with private sectors work together. At village level farmer friend, at block level Block Technology Manager and Subject Matter Specialists provide agricultural information and benefits of schemes/programmes to the farmers. ATMA organize various extension activities like field visits, trainings, demonstrations, field days, farmers – Scientists interactions, exhibitions, exposure visits, campaign, etc. Publish extension information through print and electronic media, Provide alerts to farmers on agriculture operations and precautions.



Commodity Interest Groups of Farmers (CIGs):

A group of farmers growing same crop/enterprise, share common problems and benefits. Matured CIGs can collectively access information, inputs, infrastructure, credit and market linkages. Some CIGs have independent setup for research,

extension, credit and marketing purpose. E.g. Amul for dairy farmers, Maha Grapes for Grape farmers.

Kisan Call Center (KCC):

An online agricultural advisory service provided by Government to farmers. Farmers can access information on crops,

livestock, fisheries, inputs, credit, government scheme benefits, through toll free number **1800 180 1551 OR 1551** from 6 A.M. to 10 P.M. except on Sundays and Gazetted holidays. Beyond these hours the calls are attended in the IVRS mode. Qualified professional in local language provides the advisory.

Krishi Vigyan Kendra (KVK): A district scientific organizations that works on technology generation, refinement and dissemination. KVK consists of qualified multidisciplinary experts focusing mainly on locally relevant agricultural issues. KVKs organize front line demonstrations, exposure visits, training programmes, exhibitions, field days and provide agricultural literature to the farmers. Some of the KVKs do provide input support for farmers.

Agriculture university extension system

- Maintains supportive extension service to line departments.
- Supplements efforts of line departments for service through their extension units, research stations and through teaching campuses.
- Develop innovative extension strategies.
- Provide technical knowledge to line departments.
- Organize front line demonstration of their technologies.
- Disseminate technologies through public- private partnerships.

Indian Council of Agriculture Research (ICAR)

- Generates agricultural technologies.
- Provides extension support through its research institutes and KVKs.
- Develops innovative extension strategies.
- Provides technical knowledge to line departments.
- Organizes front line demonstration of their technologies.
- Disseminate technologies through public-private partnerships.

Commodity Boards and National Institutes:

Commodity Boards like Coffee Board, Rubber Board, Spice Board, Tea Board, Coconut Development Board, Tobacco Board, Silk Board, Cotton Corporation of India, National institutes like National Institute of Agricultural Extension Management (MANAGE), Central Food and Technology Research Institute (CFTRI), Defence Research and Development Organisation (DRDO), National Institute of Plant Health Management (NIPHM), National Institute of Agricultural Marketing (NIAM), National Horticulture Mission (NHM), National Horticulture Board (NHB). etc., provide extension advisory services to their respective clientele group.

International institution: International institution namely International Center for Research in Semi Arid and Tropics (ICRISAT) in Hyderabad is also serving farmers on crops in semiarid and tropics.

Agriclinics and agribusiness centers

- Agriclinics and Agribusiness Centers are advisory and business centers managed by agricultural professionals in rural areas.
- They provide client specific advisory services free/payment basis.
- Details on Agripreneurs are available at www.agriclinics.net.

Agribusiness companies

- Almost all the Agribusiness Companies provide extension advisory services to farmers in their specialized crops/inputs.
- Contract farming assures extension, input, management and market access to farmers by agribusiness companies. Credit is also provided in few cases.
- Few agribusiness companies are providing different services to farmers through farmers one stop shop concept.

Non-Governmental Organisation (NGOs)

Many NGOs are working in various aspects of agricultural development such as farm advisory, input supply, infrastructures, processing, marketing, community mobilization, micro finance, livelihood development, etc. Farmers can take the advantages of such NGOs wherever available.

Mass Media

- Rapidly expanding mass media ensures easy access to information to farmers on real time basis.
- Agricultural magazines, newspapers provide updated information on agriculture to farmers regularly.
- Community radio, radio, and television provides updated information to the farmers.
- Mobile is also widely used as channel for reaching farmers by many organizations.

Internet opens worldwide information to the doorstep of farmers. Some of the important agri portals useful to the farmers along with key information available are as follows:

- www.icar.org: Research institutes and major technologies
- www.indiaagristat.com: Agricultural related statistics
- www.isapindia.org: Query Redress Services (QRS)
- www.indiaagronet.com: Agricultural jobs, buy and sell and exhibitions
- www.agriwatch.com: Market prices of agricultural commodities
- www.indiancommodities.com: Forecasts of prices of commodities, online trade and warehousing
- www.krishiworld.com: Multilingual portal, organic farming, crop specific information, disease and pest, market watch and home gardening
- www.agriculture-industry-india.com: Export – import directory, agro trade leads, and agro Trade events
- www.agricoop.nic.in: central sector schemes and policies
- www.apeda.com: Export and import procedure and schemes
- www.fert.nic.in: Fertiliser details
- www.mofpi.nic.in: Food processing technologies and schemes
- www.agmarknet.nic.in: Prices of commodities and trends
- www.icrisat.org: Technologies for semi arid tropics
- www.ikisan.com: Agro informatics, software services and education
- www.uttamkrishi.com: Hindi website and toll free help line
- www.nafed-india.com: Cooperative market-

ing of agricultural produce

- www.agritech.tnau.ac.in: Technologies, special technologies, schemes and services
- www.nhm.nic.in: Horticultural technologies and schemes

6.4. Accessing financial services – sources

- Self Help Groups (Micro Finance Institutions)
- Nationalized and other private banks
- Cooperative banks and societies
- Subsidy schemes of State/Central Governments

Important types of credits and savings

Kisan Credit Card Scheme (KCC) aims at providing adequate and timely support from the banking system to the farmers for their short-term credit needs for cultivation of crops. This mainly helps farmers for purchase of inputs during the cropping season. Credit card scheme proposed to introduce flexibility to the system and improve cost efficiency.

Benefits of KCC

- Simplifies disbursement procedures.
- Removes rigidity regarding cash and kind.
- No need to apply for a loan for every crop and every season.
- Assured availability of credit at any time enabling reduced interest burden for the farmer.
- Helps to buy seeds, fertilizers at farmer's convenience and choice.
- Helps to buy on cash-avail discount from dealers.
- Credit facility for 3 years – no need for seasonal appraisal.
- Maximum credit limit based on agriculture income.
- Any number of withdrawals permitted subject to credit limit.
- Repayment only after harvest.
- Rate of interest as applicable to agriculture advance.
- Security, margin and documentation norms as applicable to agricultural advance.

How to get Kisan credit cards

- Approach nearest public sector bank and get the details.
- Eligible farmers will get a Kisan Credit Card and a passbook. It contains details like name,

address, particulars of land holding, borrowing limit, validity period, a passport size photograph of holder which may serve both as an identity card and facilitate recording of transactions on an ongoing basis.

- Borrower is required to produce the card cum pass book whenever he/she operates the account.

Banks implementing KCC

- Allahabad Bank - Kisan Credit Card (KCC)
- Andhra Bank - AB Kisan Green Card
- Bank of Baroda – BKCC
- Bank of India - Kisan Samadhan Card
- Canara Bank – KCC
- Corporation Bank – KCC
- Dena Bank - Kisan Gold Credit Card
- Oriental Bank of Commerce -Oriental Green Card (OGC)
- Punjab National bank - PNB Krishi Card
- State Bank of Hyderabad –KCC
- State Bank of India –KCC
- Syndicate Bank –SKCC
- Vijaya Bank -Vijaya Kisan Card
- Personal Accident Insurance Package” is provided to the Kisan Credit Card (KCC) holders.

Salient features of the scheme

- This scheme covers all the Kisan Credit Card Holders against death or permanent disability within the country.
- All KCC holders up to the age of 70 years are eligible.

The benefits under the scheme are as under

- Death due to accident caused by outward, violent and visible means: Rs.50,000/-
- Permanent total disability: Rs.50,000/-
- Loss of two limbs or two eyes or one limb and one eye: Rs.50,000/-
- Loss of one limb or one eye: Rs.25,000/-
- Period of Master Policy - Valid for a period of 3 years.
- **Period of Insurance** - Insurance cover will be in force for a period of one year from the date of receipt of premium from the participating Banks in cases where annual premium is paid. In case of three year cover, the period of insurance would be for three years from the date of receipt of premium.
- **Premium** - Out of the Annual premium of

Rs.15/- per KCC holder, Bank has to pay Rs.10/- and Rs.5/- has to be recovered from KCC holder.

- **Claims Procedure** - In case of death, disablement claims & death due to drowning: Claim administration will be done by the designated office of the Insurance Companies. Separate procedure is to be followed.

Credit support from nationalized banks

- Extend agriculture credits under priority sector, implement NABARD Schemes, Government schemes and social security schemes
- Extend crop and agriculture investment/term loans

Extension of Bank-SHG Linkage Programme to Agricultural Purposes

- The loans extended under both the SHG linkage programme and Primary Agriculture Co-operative Societies (PACS) originate from joint efforts of people and financial institutions.
- The microfinance (through SHGs- Bank linkage) meets both consumption and production needs of the people compared to the conventional system that caters only to the production needs.

Commodity Boards Finance

- Give crop loans and subsidies
- Crop pledge loan
- Market loan

6.5. Agricultural insurance

Insurance coverage is given to farmers mainly by Agricultural Insurance Corporation Ltd (AIC) and many other private agencies. All loanee farmers automatically eligible for agricultural insurance coverage. Non loanee farmers can also avail this benefit by payment of nominal premium. Some of the important agricultural insurance schemes available at present are as follows.

- National Agricultural Insurance Scheme
- WBCIS - Weather Based Crop Insurance Scheme
- MNAIS - Modified National Agricultural Insurance Scheme
- RISC - Rainfall Insurance Scheme for Coffee

(Coffee Insurance)

- Rubber Insurance
- Coconut Insurance
- Varsha Bima/Rainfall Insurance
- Rabi Weather Insurance
- Wheat Insurance (Weather & Biomass)
- Potato Insurance
- Bio-Fuel Tree/Plant Insurance
- Pulpwood Tree Insurance
- Cardamom Plant & Yield Insurance

6.6 . Legal aspects

It is important for farmers to know the legal aspects of important inputs namely seeds, fertilizers, pesticides, etc.

The Seeds Act 1966 deals with regulations related to production, certification, quality control, sales, seed analysis, seed inspection, export and import, penalty, exemptions and amendment. The details are available under <http://agricoop.nic.in/seedsact.htm>

The Fertiliser (Control) order 1985 deals with regulations related to fertilizer Price control, control on distribution, registration of dealers, manufacture of fertilizers, mixtures, restrictions on manufacturing, import, sale, enforcement authorities, analysis of samples, specifications and penalty. The details are available under www.agricoop.nic.in/sublegi/FertilizerControlOrder.htm

Insecticides Act, 1968: An act to regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals and for matters connected. The details are available under http://cibrc.nic.in/insecticides_act.htm

For more information, farmers may contact nearest banks, agricultural department or Kisan Call Centers.

5.12. Lessons Learnt

1. Important extension sources to farmers are progressive farmers, input dealers, Cooperative Society, ATMA, Kissan Call Center (Toll Free No. 1800 180 1551), Krishi Vigyan Kendra, Agricultural Universities, ICAR Institutions, Commodity Boards, National Institutes, Interantional Institutes, Agriclincs and Agribusiness Centers, NGOs, Radio, TV, Newspapers, Agricultural Magazines and agricultural related websites.
2. Important sources of finance to farmers are banks, cooperatives and SHGs.
3. Kissan Credit Cards provides adequate and timely financial support from the banking system to the farmers.
4. Non loanee farmers are advised to take the benefits of agricultural insurance coverage by paying nominal premium, maintain close liaison with extension, credit and insurance providers regularly.

WORKSHEET

[illegible]

WORKSHEET

[illegible]

WORKSHEET

[illegible]

WORKSHEET

[illegible]

WORKSHEET

[illegible]

WORKSHEET

[illegible]

WORKSHEET

[illegible]

WORKSHEET

[illegible]

**For further information,
contact:**

Dr. P. Chandra Shekara

National Institute of Agricultural
Extension Management
(MANAGE)
Ministry of Agriculture
Government of India
Hyderabad, Andhra Pradesh
India

Mrs. Sabine Preuss

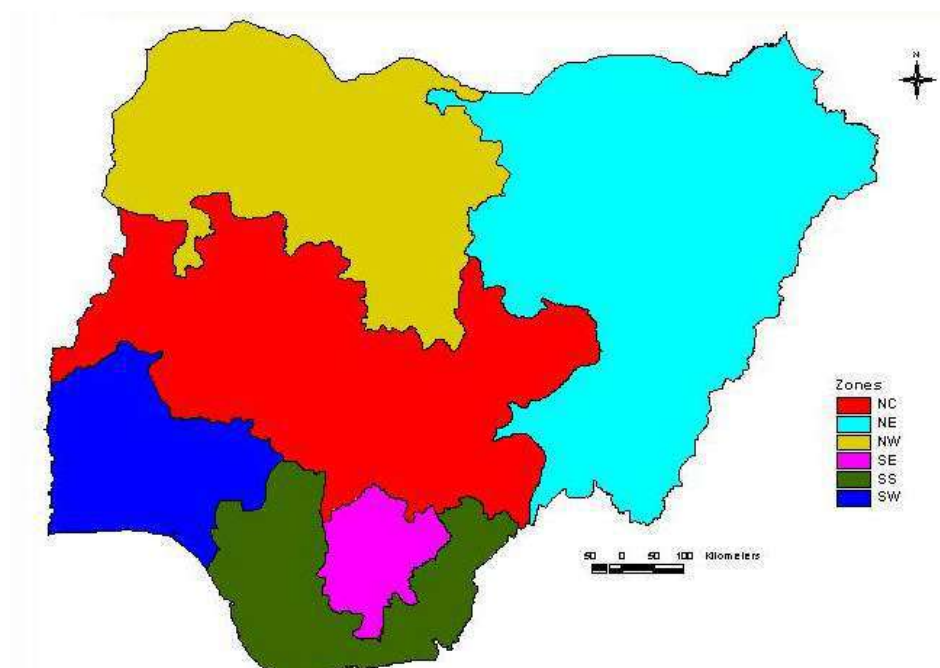
Programme Director
Natural Resource Management
Deutsche Gesellschaft für
Internationale Zusammenarbeit
(GIZ) GmbH
A2/18, Safdurjung Enclave
2nd floor, New Delhi - 110029
India

Mr. Rajiv Ahuja

Technical Expert
Natural Resource Management
Programme
Deutsche Gesellschaft für
Internationale Zusammenarbeit
(GIZ) GmbH
A2/18 Safdurjung Enclave
2nd floor, New Delhi, 110029
India

AGRICULTURE IN NIGERIA:

Identifying Opportunities for Increased Commercialization and Investment



Main Report

By

Manyong, V.M., A. Ikpi, J.K. Olayemi, S. A. Yusuf, R. Omonona, and F.S. Idachaba

From



International Institute of
Tropical Agriculture



And

University of Ibadan

For



USAID/NIGERIA

AGRICULTURE IN NIGERIA:

Identifying Opportunities for Increased Commercialization and Investment

Main Report

By
Manyong, V.M., A. Ikpi, J.K. Olayemi, S. A. Yusuf, R. Omonona, and F.S. Idachaba

This Research was funded by USAID/Nigeria.

Implementation was by
International Institute of Tropical Agriculture (IITA),

In collaboration with
University of Ibadan (UI)

November, 2003

**AGRICULTURE IN NIGERIA STUDY:
IMPLEMENTATION COMMITTEE (IC) MEMBERS**

1. Prof. F. Idachaba, Agriculture in Nigeria Study /IC Chairman, University of Ibadan
2. Dr. V.M. Manyong –IC Secretary, Agriculture in Nigeria Study Coordinator, IITA
3. Prof. J.O. Olayemi, University of Ibadan
4. Prof. A. Ikpi, Head, Department of Agric. Economics, University of Ibadan

Assisted by Drs. S. A. Yusuf, R. Omonona, and V. Okoruwa (University of Ibadan) and Miss B. Koleosho (Project Administrative Assistant, Agriculture in Nigeria Study, IITA)

AGRICULTURE IN NIGERIA STUDY:

STEERING COMMITTEE (SC) MEMBERS

1. Federal Ministry of Agriculture and Rural Development, FMARD
2. Nigerian Association of Chamber of Commerce, Industry, Mines and Agriculture, NACCIMA
3. Nigerian Institute for Social and Economic Research, NISER
4. Farmers' Association and Development Union, FADU
5. Central Bank of Nigeria, CBN
6. Union Bank of Nigeria PLC, UBN
7. International Fertilizer Development Corporation, IFDC/DAIMINA
8. United States Agency for International Development, USAID/Nigeria
9. Department for International Development, DFID/Nigeria
10. Department of Agricultural Economics, University of Ibadan, UI
11. International Institute of Tropical Agriculture, IITA

AGRICULTURE IN NIGERIA STUDY:

Field Technical Teams

- Team 1:** Southwest Zone: Dr. (Mrs.) Akanji B. (NISER) and Dr. Okoruwa V. (UI)
- Team 2:** Southeast Zone: Dr. Yusuf S. A. and Mr. Samuel Awoniyi (UI)
- Team 3:** South-south Zone: Dr. Omonona (UI) and Dr. Udoh E. (Univ. of Uyo)
- Team 4:** North-central Zone: Dr. Ayoola G. (Univ. of Makurdi)
- Team 5:** Northwest Zone: Dr. Ahmed B. and Dr. (Mrs.) Sanni (ABU)
- Team 6:** Northeast: Dr. Amaza P. (Univ. of Maiduguri) & Femi Agboola (UI)

AGRICULTURE IN NIGERIA STUDY:

COLLABORATING INSTITUTIONS

1. International Institute of Tropical Agriculture (IITA)
2. University of Ibadan (UI)
3. University of Uyo (UNUYO)
4. Ahmadu Bello University, Zaria (ABU)
5. University of Maiduguri, UNIMAID
6. Federal University of Agriculture, Makurdi
7. Nigerian Institute for Social and Economic Research (NISER)

TABLE OF CONTENTS

TABLE OF CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF APPENDICES	xi
EXECUTIVE SUMMARY	xii
CHAPTER ONE: INTRODUCTION	1
1.1 Socio-economic and Development Challenges in Nigeria's Agriculture	1
1.2 Focus of Nigeria's Agricultural Development Priorities	1
1.3 Scope and Objectives of the Study	2
1.4 The Interface among the study, IEHA and USAID/Nigeria Strategic Objectives	2
1.5 Plan of the Report	3
CHAPTER TWO: CONCEPTUAL FRAMEWORK AND METHODOLOGY	6
2.1 Conceptual Framework	6
2.2 Defining Development Domains of Nigeria	11
2.3 Sources of Data and Methods of Data Collection	12
2.4 Methods of Analysis	14
CHAPTER THREE: THE PERFORMANCE OF NIGERIA'S AGRICULTURE.....	18
3.1 Evidence from Literature	18
3.2 Stakeholders' Perception of the Performance of Nigeria's Agriculture	24
CHAPTER FOUR: A REVIEW OF AGRICULTURAL POLICY IN NIGERIA	26
4.1 Past Government Policies in Agriculture	26
4.2 Constraints to Effectiveness of Past Agricultural Policy	35
4.3 The New Nigerian Agricultural Policy	35
4.4 Key Agricultural Development, Supportive and Service Delivery Programs of the Federal Government.....	38
4.5 Other Policies, Institutions and Legal Framework.....	40
4.6 Stakeholders' Perspective on the Effectiveness of Policies, Regulations and Institutions on Nigerian's Agriculture	42
CHAPTER FIVE: ASSESSMENT OF INVESTMENT IN NIGERIA'S AGRICULTURE.....	44
5.1 Past Investment Trends in Nigeria's Economy	44
5.2 Levels and Trends of Investment in Nigeria's Agriculture	45
5.3 Determinants of Investment in Nigeria	48
CHAPTER SIX: CONSTRAINTS TO PRIVATE SECTOR INVESTMENT IN NIGERIA'S AGRICULTURE	53
6.1 Evidence from Literature	53
6.2 Stakeholders' Assessment of Nigeria's Economic Climate for Private Investment in Agriculture	53
6.3 Stakeholders' Perspectives on Constraints to Private Sector Investment in Nigeria's Agriculture	55
6.4 The Persistence of Constraints to Investment in Nigeria's Agriculture	64
6.5 Effects of Constraints on Commercialization and Investment in Nigeria's Agriculture	69
CHAPTER SEVEN: INVESTMENT OPTIONS IN NIGERIA'S AGRICULTURE.....	76
7.1. Attractiveness of Agricultural Enterprises to Private Investors.....	76
7.2 Priority Commodities for Investment in Nigeria's Agriculture	79
7.3. Evaluations of Agricultural Investment Options: Partial Equilibrium Approach.....	81
CHAPTER EIGHT: RECOMMENDED INTERVENTION STRATEGIES	95
8.1 Strategies for Accelerated Investment in Nigeria's Agriculture	95
8.2 Strategies for Increased Commercialization.....	96
8.3 Strategies for Mitigating Negative Impacts of Commercialization on Gender and Equity	98
8.4 Strategies for Enhanced Food Security	98
8.5 Strategies for Sustainable Environmental Management.....	99

8.6	Sectoral Policies for Specific Priority Commodities	100
8.7.	Regional Development Hubs	100
8.8.	Recommended Future Studies.....	100
REFERENCES.....		103
APPENDICES		106

LIST OF TABLES

Table 1.1: Analysis of Study Objectives.....	4
Table 2.1: Number of Instruments Administered in the Different Zones of the Country.....	14
Table 3.1: Indicators of Agricultural Sector Performance (in Mean Annual Values).....	18
Table 3.2: Mean Annual Percentage Growth Rates of Agricultural Sector Performance Indicators	20
Table 3.3: Variability in Agricultural Sector Performance Indicators (Coefficients of Variation in Percentage).....	22
Table 3.4: Performance Indicators in Recent Years (1996-2000)	22
Table 3.5: Performance of Nigeria's Agriculture by Development Zones since 1999.....	25
Table 3.6: Factors enhancing the Performance of Enterprises in Nigeria in order of importance.....	25
Table 4.1: Effectiveness of Policies, Regulations and Institutions on Nigeria Agriculture	42
Table 5.1: Real Domestic Public Investment (N'million).....	45
Table 5.2: Summary of Direction of Foreign and Domestic Investment Flows to Agriculture by Zone*.....	47
Table 5.3: Augmented Dickey Fuller (ADF) Unit Root Test for the Variables Used in Regression Analysis	49
Table 5.4: Cointegration Test of the Dependent Variable	49
Table 5.5: Determinants of Domestic Private Investment.....	51
Table 5.6: Determinants of Foreign Direct Investment.....	51
Table 6.1: Assessment of Nigeria's Economic Climate for Foreign Private Investment in Agriculture and Agro- Allied Industries	54
Table 6.2: Assessment of Nigeria's Economic Climate for Domestic Private Investment in Agriculture and Agro- Allied Industries	55
Table 7.1. Attractiveness of Agricultural Enterprises to Foreign and Domestic Private Investors by Zones	78
Table 7.2. Agricultural Commodities in which Development Domains have Comparative Advantage in the Domestic, Regional or World Market by zones	79
Table 7.3. Factors Accounting for Development Domains' Comparative Advantage in the Domestic, Regional or World Market	80
Table 7.4: Commodities with Comparative Advantage for Investments as Ranked by Stakeholders in Each Development Domain	83
Table 7.5: Technology parameters and adoption for the ex-ante assessment of returns to investments in research and development (R&D) in Nigeria	84
Table 7.6. Commodity Ranking by Total Benefit in each Development Domain of Nigeria.....	88

LIST OF FIGURES

Figure 2.1: A flow chart of Investment and Sustainable Livelihood	8
Figure 2.2: Flow Chart of the Constraints to Investment and Commercialization in Agriculture	10
Figure 2.3. Development Domains of Nigeria	12
Figure 6.1. Relative Frequency Distribution of Constraints to Foreign and Domestic Investment in Nigeria's Agriculture (Percentage of responses by institutions surveyed).....	56
Figure 6.2. Intensity of Constraint to Foreign and Domestic Investments across Development Domains of Nigeria (% of Responses by Domain).....	56
Figure 6.3. Intensity of Technical Constraint Affecting Agriculture by Development Domains of Nigeria	57
Figure 6.4. Intensity of Infrastructural Constraint Affecting Agriculture by Development Domains of Nigeria	58
Figure 6.5. Intensity of Economic Constraint Affecting Agriculture by Development Domains of Nigeria	58
Figure 6.6. Intensity of Financial Constraint Affecting Agriculture by Development Domains of Nigeria	59
Figure 6.7. Intensity of Political Constraint Affecting Agriculture by Development Domains of Nigeria	59
Figure 6.8. Intensity of Socio-cultural Constraint Affecting Agriculture by Development Domains of Nigeria	60
Figure 6.9. Intensity of Health Constraint Affecting Agriculture by Development Domains of Nigeria	60
Figure 6.10. Intensity of Macroeconomic Policy Constraint Affecting Agriculture by Development Domains of Nigeria	61
Figure 6.11. Intensity of Microeconomic Policy Constraint Affecting Agriculture by Development Domains of Nigeria	62
Figure 6.12. Intensity of Institutional Constraint Affecting Agriculture by Development Domains of Nigeria.....	62
Figure 6.13. Intensity of Environmental Constraint Affecting Agriculture by Development Domains of Nigeria	63
Figure 6.14. Intensity of Land Tenure Constraint Affecting Agriculture by Development Domains of Nigeria	64
Figure 6.15. Intensity of Labour Constraint Affecting Agriculture by Development Domains of Nigeria	64
Figure 7.1: From DREAM analysis: identifying for investments in research and development in Nigeria – based on streams of benefits to producers and consumers by 2015 as a result of existing portfolio of technologies.....	86
Figure 7.2: From DREAM analysis: identifying for investments in research and development in Nigeria – based on streams of benefits to producers and consumers by 2015 as a result of a one time 1% increase in productivity (IFPRI 2003).....	87
Figure 7.3: Ranking of Development Domains for Root and Tuber Crops.....	89
Figure 7.4: Ranking Development Domains for Cereals	90
Figure 7.5: Ranking of Development Domains for Grain Legumes	91
Figure 7.6: Ranking of Development Domains for Vegetables.....	92
Figure 7.7: Ranking of Development Domains for Tree Crops.....	93
Figure 7.8: Ranking of Development Domains for Livestock Products	94

LIST OF APPENDICES

Appendix 4.1: Agricultural Sector Policies.....	107
Appendix 6.1: Summary of Investment Constraints.....	119
Appendix 6.2: Causes of Persistence of Constraints in the Different Zones of Nigeria	123
Appendix 6.3: Gainers from Persistence of Constraints and Nature of Gains.....	127
Appendix 6.4: Losers from Persistence of Constraints and Nature of losses	130
Appendix 6.5 Effects of Constraints to Investment in Nigeria’s Agriculture	133
Appendix 7.1: Reasons for Attractiveness of Enterprises to Foreign Investors by Zones	137
Appendix 7.2: Reasons for Attractiveness of Enterprises to Domestic Investors by Zones	139
Appendix 7.3: Priority Primary Commodities for Investment Across Zones in Nigeria	142
Appendix 7.4: Investment Priorities in Downstream Agricultural Activities.....	144

EXECUTIVE SUMMARY

1. The USAID/Nigeria Mission contracted the International Institute Tropical Agriculture (IITA) to conduct a study on identifying opportunities for increased commercialization and investment in Nigeria's agriculture. IITA teamed up with the University of Ibadan to implement the study. The primary purpose of the Agriculture in Nigeria (AIN) study was to provide USAID/Nigeria with the analytical basis for the Mission to design its new Agricultural Policy Strategy that contributes to unlocking constraints to commercialisation and investment in the Nigerian agricultural sector for a sustained economic growth; enhanced food security; increased competitiveness of products in the domestic, regional, and international markets; sustainable environmental management; and poverty alleviation.

2. The key issue in the study was the identification of constraints to investment in the agriculture sector and the involvement of strategies and priority areas for intervention by USAID/Nigeria, other donors, the home governments and private sectors for the purpose of providing catalytic support for the flow of investment into the agricultural sector.

3. The AIN study is in line with both the strategic five pillars (science and technology, improved agricultural trade and market systems, building human capital, infrastructure and institutional capacity, promoting sustainable environmental management, and supporting community organizations) of the US President Initiative to End Hunger in Africa (IEHA) and the long-term USAID/Nigeria new strategic directions for a sustainable agricultural and diversified economic growth.

4. The country was divided in six development domains on the basis of differences in agro-ecology, population density, market opportunities, farming systems, and geo-political division of the country.

5. In this study, *investment* is defined as additions to stock of capital that are the sources of future income streams, while *commercialization* should be understood to be the movement from a subsistence production system to a market-based system. The importance of investment derives from the fact that agricultural growth requires increasing doses of investible fund. This fund translates into capital, which, in turn, transforms various developmental variables to create the ultimate impact, which is economic growth and development (see Figures 2.1 and 2.2. for schematic representations of the conceptual framework).

6. The focus of analysis in the study was on constraints taxonomy, constraints domain characterization, constraints cause identification, constraints function transformation, constraints range characterization, constraints impact analysis, constraints persistence analysis, identification of gainers and losers from constraint persistence, policies, regulations and institutions analysis, investment priority determination, comparative advantage analysis, recommendation of new policies, regulations and institutions for enhancing comparative advantage and for improving investment climate, determination of strategic options for supporting IEHA interventions in Nigeria, and identification of areas of intervention to promote priority commodities in different zones of the country.

7. With respect to sources of data and methods of collection and analysis, both primary and secondary data were used in this study. Primary data were collected from selected respondents, using prepared questionnaires. Secondary data were collected from local and international publications and reports. The methods adopted in the collection of primary data involved the use of two survey instruments (questionnaires), one addressed to policy makers and implementers and the other addressed to the private sector and other stakeholders in agriculture, like associations and individual investors.

8. The defined development domains plus Abuja Federal Capital Territory (FCT) were adopted as the primary frame for data collection. Two states were then selected per domain for the survey, in addition to the Abuja FCT. The respondents were purposively selected to cover a wide range of stakeholders in each zone. The combination of field survey methods employed included in-depth interviews, focus group discussions, individual completion of questionnaires and taped interviews. Methods of analysis included descriptive statistical analysis, constraints mapping, development domain mapping, regression analysis, and partial equilibrium models.

9. The assessment of agricultural policy and investment in Nigeria presented in this study covers an assessment of the performance of Nigeria's agriculture sector, a review of past policies affecting agriculture, an assessment of investment processes in Nigerian agriculture, an analysis of constraints to private sector investment in Nigerian agriculture, and an evaluation of investment options.

10. The results of performance analysis show a mixed performance. The share of agriculture in both aggregate GDP and non-oil GDP increased only marginally in the 1981-2000 period covered. The share of total bank credit going

into the agricultural sector first increased rapidly between the 1981-85 and 1991-95 sub-periods and then declined in the 1996-2000 period. The share of federal government's total capital expenditure going to the agricultural sector declined almost persistently over the period. Finally, the share of total labor force employed in the agricultural sector also declined over the period. Generally, there was a lack of consistency in the growth performance of the agricultural sector in the 1981 to 2000 period, with some evidence of unstable or fluctuating trends, probably due to policy instability and inconsistencies in policies and policy implementation.

11. Factors constraining agricultural performance in the country include those relating to technical constraints, resource constraints, socio-economic constraints and organizational constraints.

12. A review of past government policies in agriculture shows that in the pre-structural adjustment period, sector-specific agricultural policies were designed to facilitate agricultural marketing, reduce agricultural production cost and enhance agricultural product prices as incentives for increased agricultural production. Major policy instruments included those targeted to agricultural commodity marketing and pricing, input supply and distribution, input price subsidy, land resources use, agricultural research, agricultural extension and technology transfer, agricultural mechanization, agricultural cooperatives, and agricultural water resource and irrigation development.

13. Macro and institutional policies as well as legal frameworks complemented sector-specific policies. The structural adjustment period was governed largely by structural adjustment policies. Broadly, structural adjustment policies in Nigeria covered public expenditure-reducing or demand management policies, expenditure switching policies, market liberalization policies and institutional or structural policies. Like in the pre-structural adjustment period, there were microeconomic, macroeconomic, institutional and legal framework policy instruments put in place to address these issues. But, there was much more emphasis on macroeconomic and institutional policies in this latter period than before.

14. Constraints to agricultural policy effectiveness are identified to include those of policy instability, policy inconsistencies, narrow base of policy formulation, poor policy implementation and weak institutional framework for policy coordination.

15. The objectives of the new agricultural policy are (i) the achievement of food self-sufficiency and food security, (ii) increased production of raw materials for industries, (iii) increased production and processing of export crops, (iv) generation of gainful employment, (v) rational utilization of agricultural resources, (vi) promotion of increased application of agricultural technology, and (viii) improvement in the quality of rural life.

16. The key features of the new policy include (i) the evolution of strategies for achieving food self-sufficiency and improved technical and economic efficiency in food production, (ii) reduction of risks and uncertainties in agriculture, (iii) a unified national agricultural extension system under the ADPs, (iv) promotion of agro-allied industries, and (v) provision of agricultural incentives.

17. The new policy direction involves (i) creating a conducive macro-environment for private sector investment in agriculture, (ii) rationalizing the roles of tiers of government and the private sector, (iii) reorganizing the institutional framework in the agricultural sector, (iv) implementing integrated rural development programs, (v) increasing budgetary allocation to agriculture, and (vi) rectifying import tariff anomalies in respect of agricultural products.

18. Agricultural commercialization calls for increased investment and capital formation for more intensive production. Hence, the level of commercialization and the size of investment are positively correlated. A review of past investment trends in the Nigerian economy reveals that both domestic and foreign flow of private investment into the Nigerian economy as a whole suffered a declining trend between 1970 and 1985. Gross investment in the economy expressed as a percentage of the GDP first increased from about 17 percent in 1970 to about 26 percent in 1975, but declined to about 24 percent in 1980 and to 12 percent in 1985. The patterns of domestic and foreign private investment over this period were highly correlated with the changing states of political and policy instability.

19. In the post-1985 period, gross domestic investment increased consistently between 1987 and 1997, but declined in 1998 and 1999. Similarly, cumulative foreign investment increased consistently between 1990 and 1998, but declined in 1999. Real foreign net private investment flow into the Nigeria's agriculture sector increased between 1981-85 and 1991-95 sub-periods and then declined in the 1996-2000 sub-period. However, agriculture's share of total foreign net private investment was very low, being on the average, less than of 4 percent in the entire 1981 to 2000 period. There were negative flows (i.e. actual outflow) of foreign investment into agriculture in 1980, 1995, 1987 and 1994.

20. Agriculture's share of cumulative foreign investment declined almost consistently in the 1981-2000 period, from about 2 percent in the 1981-85 sub-period to about 1 percent in the 1996-2000 sub-period. The pattern of both domestic and foreign investment in Nigeria in the period under review tended to be volatile, displaying highly variable growth rates and high degrees of instability. This pattern was a direct reflection of the generally unstable investment climate in the country in the period. A comprehensive summary of the economic, social, political, institutional, legal/regulatory and external environmental determinants of private investment flow into the agricultural sector is provided in the report.

21. Levels and trends of investment in Nigeria's agriculture show that gross fixed capital formation was used as a proxy for gross domestic investment. In this regard, gross fixed capital formation's share of the gross domestic product declined consistently over the 1981-2000 period. However, agricultural sector's share of aggregate gross fixed capital formation increased consistently over the 1981-2000 period, implying that the sector performed better than the economy as a whole in terms of gross fixed capital formation.

22. Thirteen categories of constraints to investment in the agriculture sector are identified from both literature search and stakeholders' perspectives. Infrastructural constraints (bad or poor state of roads, poor processing facilities and marketing outlets, epileptic power supply, poor state of telecommunication facilities, etc.) were ranked first by more than 90% of respondents throughout the Federation. It was followed, in decreasing order of importance, by financial, technical, and economic constraints (>80% of respondents); macro-economic policy and socio-cultural constraints (>70%); labor, environmental, and political constraints (>50%); micro-economic policy, institutional, health, and land tenure constraints (<50%).

23. The severity of constraints was varied among development domains except for infrastructural constraints. For example the technical constraints were assessed very high (>75% of respondents) in the far northern zones while environmental constraints were very high in Southeast Domain. The intensity of the economic constraints (high cost of production, low returns to investments, or low income, etc.) was very high in Northeast Domain. Socio-cultural constraints were found everywhere such as corruption, insecurity, high crime rates, and ethnic strife/crisis. Religious strife for northern domains and availability of mineral resources especially crude oil were found to be elements of ethnic strife.

24. The causes and source of constraints were investigated for each constraint. For example poor credit policy coupled with ineffective policy implementation, high rate of interest and unstable exchange rate were the main causes of the persistence of financial constraints to investment in agriculture. Poor leadership, political instability, poor governance, and non-participatory governance were sources of political constraints. An example of technical constraints is on inconsistencies in agricultural input policies that constrained producers, including small-scale farmers to acquire modern farm inputs.

25. Gainers and nature of gains from the persistence of constraints were identified. Within Nigeria, gainers include government officials (political appointees, policy makers, policy implementers, and lower cadre civil servants). They derive benefits ranging from hard currency, receipt of financial kickbacks from suppliers and contractors. At the foreign level, the main gainers from the persistence of above constraints in Nigeria are some of the foreign investors, technical partners, and foreigners who take advantage of the precarious situation. This group of gainers imports all sorts of goods to derive/make non-deserved maximum benefits.

26. Losers include a long range of stakeholders. Entrepreneurs, marketers and processors are affected in the area of low capacity utilization, high cost of power generation, and reduced output. Bankers, lenders are also affected by the persistence of financial constraints. The nature of these losses includes high transaction costs, low investment, lack of investible capital, and loss of employment. Farmers and women are among the vulnerable groups of the society. Farmers' losses include low access to modern inputs, reduced outputs, low income, and high poverty incidence.

27. About 33 types of effects of constraints to commercialization were identified along the food chain.

28. There are 13 areas in which investors (foreign and domestic investors) are willing to put their money in attractive enterprises. These are: input production and supply enterprises, livestock production, fisheries, forestry, and commodity processing and storage enterprises. Others are commodity marketing, agro-industry manufacturing, agricultural commodity export, and agricultural support services. The general inference is that agricultural enterprises in Nigeria are fairly attractive to domestic investors while they are less attractive to foreign investors. Nine out of the thirteen enterprises are hardly attractive to foreign investors while three were fairly attractive.

29. The study identified 32 commodities in which the Development Domains are perceived to have a comparative advantage in the domestic, regional, or world market. The identified commodities were grouped into five categories namely staple crops (9 commodities), industrial crops (12 commodities), livestock (5 commodities), fishery (3), and forestry (5). Reasons for the attractiveness to private sector investment were given for each commodity.

30. Ex-ante evaluation of returns to investment was completed for 26 commodities for which data were readily available (for example all the forestry commodities did not enter the partial equilibrium DREAM model because of lack of data). Given the current level of the technology portfolio available for each commodity, cassava emerged as commodity 1 to invest on for estimated gross returns of \$570 m per year over the period of 17 years from 1999 to 2015. The next nine ranked commodities are yam, maize, millet, groundnut, rice, sorghum, poultry, leafy vegetables, and cowpea. The second group of priority commodities includes pepper, beef, oil palm, fish, melon, tomato, soybean, onion, rubber, and cocoa. The lower ranked commodities include ginger, pork, goat, mutton, benniseed, and cashew nut. The above results compare favourably with results from a similar analysis by IFPRI in West Africa. The first ten ranked commodities were yams, rice, cassava, vegetables, beef, millet, groundnut, sorghum, cotton, and maize in decreasing order of importance.

31. Major regional differences were recorded in the returns to investments. For root and tubers, cassava gives highest returns in North-central, Southsouth, Southeast, and Southwest in decreasing order of returns. Yams stand high in North-central, followed by South-south. Patterns are uneven for cereals: rice is exclusive in Northcentral; maize is better promoted in Northwest, Northcentral, and Southwest. Millet is profitable only in Northwest and Northeast. Sorghum and benniseed are crops for the three northern Domains. Grain legumes (groundnut, soybean, and cowpea) give high returns in the three northern Domains. The patterns for grain legumes were observed for the group of vegetables except for leafy vegetables that grow well throughout the country. As expected, tree crops such as oil palm (South-south and Southeast), cocoa (Southwest), and rubber (Southsouth) produce better in the humid domains of the country. In contrast, cashew nut and ginger are commodities for Northcentral and Northwest. Livestock also indicates a specialization across Development Domains. Ruminants (cattle, mutton, and sheep) are important in the three northern Domains though goat has a smaller but significant presence in the southern Domains. Pork and fish are important in South-south. As expected, poultry is found everywhere with a major presence in South-south.

32. In addition to investments in commodities with high returns to investments, other strategies for increased commercialization include the adoption of a development model that links producers to processors and consumers along the continuum. Four possible models are suggested in this paper.

33. Strategies for mitigating negative impacts of commercialization on gender and equity include but not limited to promoting the facilitation of women' involvement in downstream activities, better education for girls, and empowerment of women through income-generating activities and the creation of marketing lobbies for women.

34. Strategies for enhanced food security include increasing the agricultural productivity, reducing post-harvest losses, promoting a database for early warning systems, and building capacity of government officials in monitoring the status of food security in the country.

35. Increased commercialization in the agriculture sector is likely to pose threat to environment through land degradation, pollution of the ecosystem, or the extension in the use of other agricultural resources.

36. Sectoral policies for specific priority commodities would be needed to attract investment towards a commodity through the promotion and creation of lobbying groups, design and adoption of grades and standards that favor the utilisation of the commodities, and the creation of an enabling macro-policy environment in the country.

37. Three regional development hubs are being recommended to USAID for consideration for their investments: the northern development hub, the central development hub, and the southern development hub. These regional hubs are made to integrate the designed strategies for increased investment and commercialization in Nigeria's agriculture. The regional development hubs would be centred on a group of priority commodities and would aim at integrating the objectives of wealth creation, food security, sustainable development, equity, and gender.

38. Finally, three studies are recommended in order to move forward in the implementation of the above strategies namely a subsector concentration analysis, a downstream agricultural activities study, and an integrated monitoring and evaluation program design.

CHAPTER ONE

INTRODUCTION

1.1 Socio-economic and Development Challenges in Nigeria's Agriculture

Nigeria is one of the largest countries in Africa, with a total geographical area of 923,768 square kilometres and an estimated population of about 126 million (2003 estimate). It lies wholly within the tropics along the Gulf of Guinea on the western coast of Africa. Nigeria has a highly diversified agro-ecological condition, which makes possible the production of a wide range of agricultural products. Hence, agriculture constitutes one of the most important sectors of the economy. The sector is particularly important in terms of its employment generation and its contribution to Gross Domestic Product (GDP) and export revenue earnings.

Despite Nigeria's rich agricultural resource endowment, however, the agricultural sector has been growing at a very low rate. Less than 50 percent of the country's cultivable agricultural land is under cultivation. Even then, smallholder and traditional farmers who use rudimentary production techniques, with resultant low yields, cultivate most of this land. The smallholder farmers are constrained by many problems, including those of poor access to modern inputs and credit, poor infrastructure, inadequate access to markets, land and environmental degradation, inadequate research and extension services and so on.

Since the collapse of the oil boom of the 1970s, there has been a dramatic increase in the incidence and severity of poverty in Nigeria, arising in part from the dwindling performance of the agricultural sector where a preponderant majority of the poor are employed. Furthermore, poverty in Nigeria has been assuming wider dimensions, including household income poverty food poverty/insecurity, poor access to public services and infrastructure, unsanitary environment, illiteracy and ignorance, insecurity of life and property, poor governance and so on (NPC and UNICEF, 2001). In response to the dwindling performance of agriculture in the country, governments have, over the decades, initiated numerous policies and programs aimed at restoring the agricultural sector to its pride of place in the economy. But, as will be evident from analyses in subsequent chapters, no significant success has been achieved, due to the several persistent constraints inhibiting the performance of the sector.

From the perspective of sustainable agricultural growth and development in Nigeria, the most fundamental constraint is the peasant nature of the production system, with its low productivity, poor response to technology adoption strategies and poor returns on investment. It is recognized that agricultural commercialization and investment are the key strategies for promoting accelerated modernization, sustainable growth and development and, hence, poverty reduction in the sector. However, to attract investment into agriculture, it is imperative that those constraints inhibiting the performance of the sector are first identified with a view to unlocking them and creating a conducive investment climate in the sector. The development challenges of Nigeria's agriculture are, therefore, those of properly identifying and classifying the growth and development constraints of the sector, unlocking them and then evolving appropriate strategies for promoting accelerated commercialization and investment in the sector such that, in the final analysis, agriculture will become one of the most important growth points in the economy.

1.2 Focus of Nigeria's Agricultural Development Priorities

In spite of the existence of a well-articulated agricultural policy document for Nigeria since 1988, the country has never established a systematic focus in her agricultural planning history that shows a conscious effort to purposely prioritise her agricultural development based on the generally identified components that constitute modern agriculture. Normally, in terms of concentrating on the development of the various parts of the agriculture continuum, the government of Nigeria (GON) should have adopted a prioritization scheme in which, for some specified time periods, it would consciously emphasize on one or more of the areas of commodity production, commodity processing (to add some value), commodity marketing (for either internal commercialization or external trade or both), and institutional support services for agro-industry.

What has happened instead is that, over the years, there has been the development and adoption of programs that tended to generally support only increased production of commodities in the country. Such programs have included among others the following key ones:

- *Farm settlement schemes (FSS)* in the early-to-mid 1950s for creating farmsteads of the Israeli Moshav-type agriculture intended to increase commodity output and create employment for young school leavers;

- *River basin development authorities (RBDAs)* for the purpose of harnessing water resources for farmers throughout the country;
- *Green revolution scheme (GRS)* that encouraged all Nigerians in both urban and rural areas to go into agriculture for both commerce and provision of food for home consumption; and
- *Agricultural development programs (ADPs)* in all States of the federation to help organize farmers into more productive agriculture through the provision of modern inputs.

Each of these programs/schemes succeeded in momentarily increasing food production only. There were no inbuilt components that purposely catered for the processing and/or commercialization of the food output. Thus, understandably, they failed as efforts aimed at developing the agriculture sector.

Recent attempts that have recognized agriculture's current level of performance and the fact that every aspect of Nigeria's agriculture sector needs attention have only listed specified areas that require attention. For example, the *2001 Rural Development Sector Strategy* identifies the following areas for immediate attention if agriculture and rural development in Nigeria are to make the desired impact on the lives of the people:

- Institutional restructuring and role reassignment in the agricultural extension sub-sector;
- Agricultural technology development and natural resources management;
- Physical and social infrastructural development;
- Public intervention in specified areas of rural agriculture to measure effectiveness; and
- Human capacity building in the agriculture sector.

Similarly, the *2002 Agricultural Policy* document that has listed the new directions that agricultural development in the country should take has also only listed the various components of the agriculture sector without any attempt at prioritising the components. So, in both cases, there is no directed effort at specifying which areas should be the priorities and for what periods so that efforts in developing the agriculture sector can be programmed in a systematic manner, indicating desired impact indices that must be attained within such periods. One of the key recommendations in the investment strategies that are suggested in this report deals with the order of priorities that efforts in developing Nigeria's agriculture must take if there must be positive felt changes in the sector. The key issues involved in such prioritization are highlighted and discussed in detail in various sections of this report based on field data and information analysis from the six geopolitical zones of the country.

1.3 Scope and Objectives of the Study

The primary purpose of the study is to provide USAID/Nigeria with the analytical basis for the Mission to design its new Agricultural Policy Strategy that contributes to unlocking constraints to commercialization and investment in the Nigerian agricultural sector for a sustained economic growth; enhanced food security; increased competitiveness of products in the domestic, regional, and international markets; sustainable environmental management; and poverty alleviation. The study addresses the immediate needs of the Mission of identifying key investment options in various geographic areas of Nigeria. In this respect, the study provides short- and long-term strategic support to USAID/Nigeria that enables the Mission to plan, monitor and evaluate its agriculture portfolio. It provides an analytical basis for identifying key investment options and also monitoring and evaluating the impacts of such investments.

The specific objectives of the study are, therefore, to:

- (i) Review previous studies on constraints to commercialization and investment in Nigeria's agriculture;
- (ii) Define development domains within the Nigerian political economy framework;
- (iii) Identify technical, infrastructural, economic, political, social, policy, and institutional constraints to commercialization and investment in Nigeria's agriculture;
- (iv) Explain the persistence and assess the effects of the identified constraints to commercialization and investment in Nigeria's agriculture over time and from regime to regime within a political economy framework; and
- (v) Assess the investment options and design appropriate short- and long-term strategies for mitigating the effects of the identified constraints.

The implications, data required, etc. of the above objectives are summarized in Table 1.1.

1.4 The Interface among the study, IEHA and USAID/Nigeria Strategic Objectives

The study is in line with both the new US President Initiative to End Hunger in Africa (IEHA) and the Mission Strategic Objectives for years 2004-2005. Recently, the UN adopted the Millennium Development Goals (MDG) that aim at cutting hunger and poverty in half by 2015. IEHA is being launched to contribute to MDG of halving

hunger by 2015 in Sub-Saharan Africa (SSA). The IEHA focus is on smallholder-based agriculture because only the small farmers can contribute to ending hunger in SSA. However, the IEHA approach is to ignite an economic growth of the agricultural sector to rapidly raise rural incomes and consequently reducing poverty and hunger. Its programmatic concentration is on six focal areas (science and technology, market and trade, producer organisations, human and institutional capacity and infrastructure, vulnerable groups, and environment). IEHA intends to capitalise on regional dynamism and synergism. Therefore, IEHA has selected a few focal countries with potentials for spillover effects in their respective sub-regions. In these focal countries, investments will be based on a rigorous analysis of agricultural investment options. The rigorous analysis requires the development of a strategic and knowledge support system that could guide IEHA investments in Africa and that could help monitoring and evaluation of IEHA projects in a sub-regional context (e.g. East Africa, Southern Africa, and West and Central Africa).

The USAID Mission in Nigeria has just adopted a concept paper about the long-term development strategy for Nigeria. This concept note describes four strategic objectives (SOs) that would guide its intervention in Nigeria namely good governance through transparency, participation, and conflict management (SO5), sustainable agricultural and diversified economic growth (SO6), improved social sector service delivery (SO7), expanded response to HIV/AIDS prevention (SO8). SO6 is in particular directly relevant to. The new program framework for SO6 intends to improve the performance of the agricultural sector in the areas of (1) production and productivity, (2) commercialization, and (3) environmental sustainability. In addition to agriculture, the other sectors of a paramount importance for SO6 are increasing the private sector's access to critical financial services and improving the environment for private sector growth.

The AIN study, as described in its above scope and objectives, is in line with both IEHA and the long-term USAID/Nigeria new strategic directions for a sustainable agricultural and diversified economic growth. The focus of the study is on agriculture that is dominated by smallscale farmers. The study will be based on a rigorous analysis that also gives voice to stakeholders. The study team will combine the art of science and technology and the field experience of stakeholders, including producer organisations to implement the study. Its outcomes will contribute to improving our understanding of constraints that mitigate against increased commercialisation and investment in Nigeria's agriculture. Therefore, the study will provide a strategic information for the USAID/Mission and IEHA to design programs and projects that would contribute significantly to the achievements of objectives of wealth generation, poverty elimination, and ending of hunger in Nigeria.

1.5 Plan of the Report

Following chapter one, chapter two discusses the conceptual framework and methodology of the study. Chapter three examines the performance of Nigeria's agriculture. Chapter four is on the review of agriculture policy. Chapter five focuses on the assessment of investment in Nigeria's agriculture. Chapter six examines constraints to private sector investment in Nigeria. Chapter seven identifies investment options in Nigeria's agriculture. Finally, chapter eight contains recommendations that arise from the study.

Table 1.1: Analysis of Study Objectives

Objectives		Implications	Data Required	Analytical technique	Sources of data	Expected output
1.	Review previous studies on constraints to commercialization and investment in Nigeria agriculture ↓	To critically examine past studies in order to identify gaps in the understanding of constraints to commercialization and investments in Nigeria agriculture.	Literature	Narrative descriptive	Library search	Identifica-tion of gaps in knowledge
2.	Define development domains within Nigeria political-economic framework	To classify Nigeria on the basis of biophysical, socioeconomic and political considerations.	(i) States in Nigeria (ii) agro-ecology and climate (iii) market access (iv) population (v) agricultural practices	GIS and descriptive statistics	IITA, FOS, FMARD, Library search	Maps of development domains
3.	Identify technical, infrastructural, economic, political, social, policy, gender, and institutional constraints to commercialization, and investment in Nigeria agriculture.	To recognize and prioritize the different constraints	Different constraints identified by sources, types, and domains	Descriptive analysis	Library search, Field survey	List of prioritized constraints
4.	Explain the persistence and assess the effect of the identified constraints to commercialization and investment in Nigeria agriculture over time and from regime to regime within political economic framework.	(1) To understand the nature, extent and dynamics of these constraints to commercialization, and investment in Nigeria agriculture (ii)To analyze the effects of the identified constraints on commercialization, and investment in Nigeria agriculture.	Level of investment by product, extent of commercialization by product, origin of constraints, extent of the constraints i.e. how bad is the situation e.g. telecommunication, road network (quantity and quality), markets, and their facilities, health care facilities, educational facilities etc. Both <i>cross-sectional and time series data will be required</i>	Descriptive statistics, regression, input-output analysis, scoring/ranking mapping	Field survey, CBN reports, FOS, infrastructure survey, MAN, NACCIMA, ADP, National Data Bank, Input-output table	1. Output of political framework indicating the inventories of gainers and losers. 2. factors that has perpetuated the constraints 3. Maps of relative inventory of constraints.
5.	Assess the investment options.	(i) To identify the investment options in each development domain (ii) To analyze the effects of	List of commodities, prices, production, consumption, elasticities of production and demand,	DREAM, descriptive statistics, regression	Primary data, survey, secondary data from FOS,	Returns to items of priority commodities in each development

		each investment option on welfare in each development domain. (iii) On the basis of analysis, rank the investment options.	amount to be spent on each investment option.	analysis and ranking/ scoring	CBN, IITA and other past studies for elasticities.	domain.
6.	Design appropriate short and long term strategies for mitigating the effects of the identified constraints	(i) Identify and rank short and long term strategies for mitigating constraints.	Findings of the study from items 1-5.	Narrative	Reports from 1-5	List of short and long term strategies.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND METHODOLOGY

2.1 Conceptual Framework

The challenge facing Nigeria is to eradicate poverty, attain food security, agricultural competitiveness and the sustainable management of the environment through accelerated commercialization and investment in Nigeria's agriculture. The approach is to rely on marketed oriented agriculture that relies primarily on the private sector for the needed investment and commercialization of agriculture.

Investment in this study is defined as additions to stocks of capital that are the sources of future income streams. This study takes a generalized approach to capital that includes real tangible physical capital such as dams, irrigation structures, grain silos, farm machinery and implements, hoes, machetes, and rural roads. It also includes social capital such as human capital through education and health, and on-the-job training through intergenerational transfer of farming skills. This generalized approach to capital formation and investments also includes institutional capital accumulated through investments in organizations and the regulatory environment. Investment can be gross, including investments to replace depreciated capital " stock, or it can be net, to include only net additions to the capital stock. It can be referred to as net capital formation as with expenditures on new farm machinery, irrigation infrastructure, storage facilities, etc over and above the requirements for the replacement of existing capital, which are used in the production of goods and services for future use as opposed to present consumption. From a broader perspective, investment can be viewed as sacrificing certain present values of consumption for future consumption. It is the commitment of money in order to earn future benefits. . Fixed investment is defined as purchases by firms of newly produced capital goods such as production machinery, newly built structures, office equipment etc. Inventory investment on the other hand is the change in stock of finished products and raw materials firms keep in their warehouses. Replacement investment is investment made to replace worn out capital goods resulting from their use in the production process. It is also known as disposable investment. In this study investment can be from public (government), and/or the private sectors, which can be foreign and/or domestic.

Commercialization, on the other hand, is the movement from a subsistence production to a market-based system of production. It involves raising the cash earnings of small-scale agricultural-related enterprises. Commercialization can be brought about by increasing the unit of output, raising the value added or both, and producing for domestic and foreign markets.

Commercialization is, however, contingent upon the availability of both input and output markets. This assumes inter-sectoral linkages within the economy as the inputs needed for commercialization are obtained from the different sectors of the economy or from abroad while the outputs from commercialization are also distributed to the different sectors of the economy or to abroad.

In a fundamental sense, a conceptual framework provides a guide to the organization of ideas and issues in a study. It acts as a filing cabinet for sorting ideas and issues into neat compartments - As such, a conceptual framework must derive its validity from the objectives of a study while it, in turn, guides the study towards the achievement of its objectives.

In its broad perspective, the overarching research issue in this study is the dynamics of investment flow for the development of the agricultural sector of the economy. The importance attached to investment flow for agricultural development derives from the theoretically and historically valid assumption that the sector requires an increasing

dosage of investible capital from all feasible sources. This capital translates into investment, which, in turn, transforms various developmental variables in and outside the agricultural sector to create the ultimate impact, which is economic growth and sustainable development. The relationships among the variables are very complex. But in order to capture the essential highlights of these relationships, a schematic representation of the patterns of interactions among major variables is depicted in Figure 2.1.

As shown in Figure 2.1 investible capital kick-starts the process that ultimately leads to agricultural growth and overall sustainable livelihood of households operating in the agricultural sector. The process, as depicted in the chart is as follows.

1. Investible capital, which is made up of both private and public capital, flows in from foreign private and public sources as well as from domestic private and public sources.
2. This capital from various sources creates investment that, in turn, creates increasing commercialization and employment and generates increasing outputs of various kinds as driven by the pattern of demands. Agricultural outputs come from corporate business organizations as well as from individuals or groups of producers,
3. Corporate outputs generate corporate profits that are distributed in various ways. Part of the profits is ploughed back into further investment; part goes to households say, as dividends; part constitutes a leakage from the economy, say, as profit repatriation from the country by investors; and part goes in the form of income transfers for the welfare of vulnerable groups and the poor as well as for other welfare interventions like environmental management and repairs of environmental damage done in the course of production.
4. Households earn their incomes from four main sources, namely share of corporate earnings, income from their own production, wage earnings by household members and net income transfers to the household.
5. Households distribute their incomes to finance consumption, to finance further investment and to support vulnerable members or other outside groups.
6. The net impact of these complex processes is sustainable livelihood of households, meaning that there is sustained economic growth, declining poverty, increasing food security and enhanced environmental sustainability. The process is dynamic and involves various lags between stimuli and responses in the economic system.
7. The major purpose of this study is to evolve strategies and identify areas of intervention by the USAID, other donors, the home governments and the domestic private sector to provide a catalytic support for an increasing flow of agricultural investment, leading to the positive socio-economic impact outlined above. But as far as the USAID is concerned, the five pillars of U.S.A. support for this process are, as outlined in Figure 2.1:
 - (i) Technological support
 - (ii) Improving agricultural trade and market systems
 - (iii) Building human capital, infrastructure and institutional capacity
 - (iv) Promoting sustainable environmental management, and
 - (v) Supporting community organizations

These five forms of catalytic support are encapsulated in a U.S.A. initiative known as the Initiative to End Hunger in Africa (IEHA). An important purpose of this study is, therefore, to identify strategies for the successful implementation of this initiative.

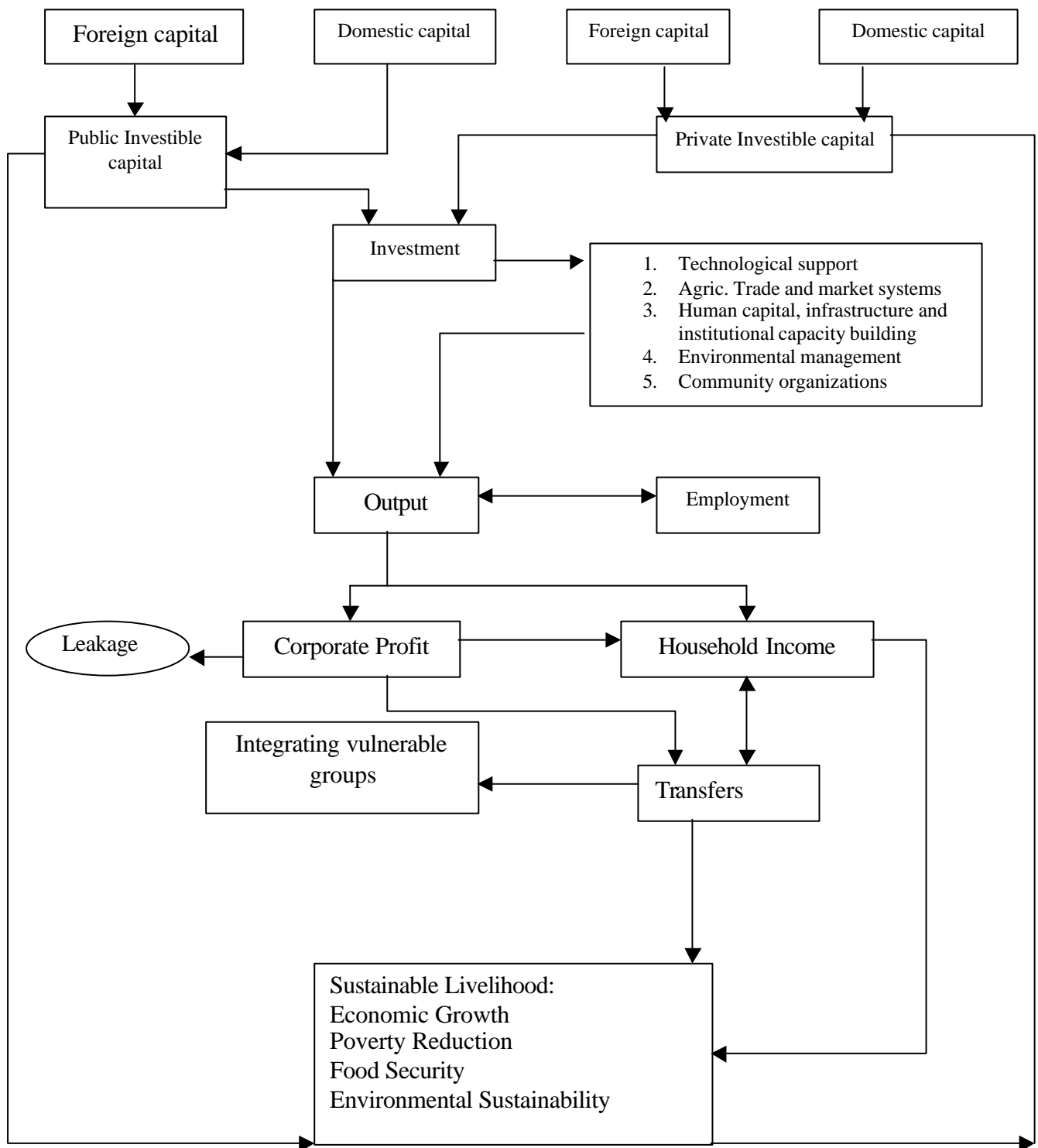


Figure 2.1: A flow chart of Investment and Sustainable Livelihood

It is easy to observe that the pattern of inter-relationships among the economic variables represented in figure 2.1 is complex and elaborate. It is, therefore, impossible to cover the entire breadth and depth of all the inter-relationships in this phase of the study, given time and other constraints. In the event, a simpler, narrower subset has been carved out for research attention at this stage. The study will cover the identification and mapping of key constraints to investment and commercialization in agriculture, but with particular reference to the various development domains in Nigeria, explain the persistence and assess the characteristics, sources and effects of the constraints, design strategies for the mitigation of the constraints and establish the linkage between the designed strategies and IEHA and Nigeria's agricultural investment priorities.

For this short-term phase of the study, a schematic representation of key variables of research interest and their inter-relationships is shown in figure 2.2 as already mentioned is a sub-set of Figure 2.1. The link between commercialization and investment is bi-directional as shown in Figure 2.2. For example, investment in agriculture can or will lead to commercialization of the agricultural sector while commercialization, on the other hand, can also spur investment. Investment and commercialization are key to sustained economic growth, enhanced food security, increased competitiveness of products, poverty reduction and sustainable environmental management.

Constraints to the inflow of private sector investment and commercialization in Nigeria's agriculture include technical, infrastructural, economic, financial, political and social. Others are policy constraints, institutional constraints, environmental constraints, external constraints, land tenure constraints, and agricultural labor market and wage constraints. Unlocking these constraints will promote investment and commercialization in the agricultural sector. This study is, therefore aimed at analyzing the constraints to private sector investment and commercialization in Nigeria's agriculture. The study will prioritize the strategic areas of intervention by USAID in order to remove the bottlenecks to investment and commercialization in Nigeria (see Figure 2.2)

The key questions to address in this study are:

- What are the elements of the constraint domain?
- What are the characteristics or features of elements of the constraint domain?
- What are the causes of each element of the constraint domain?
- What are the consequences of each element of the constraint domain? The consequences form the elements of the constraint range, that is, the end results of the transformation of the elements of the constraint domain into consequences.
- What are the effects of the identified constraints on investment and commercialization of Nigeria's agriculture? What is the ranking (quantitative or qualitative) of these constraints as measured by the relative magnitude of their adverse effects on investments and commercialization, and how might these guide the prioritization of intervention strategies for unlocking these constraints?
- Why have the identified constraints persisted over time and from one regime to the next? Who are the gainers and losers from the existence of these constraints, that is, from the elements of the constraint domain? Who are the gainers and losers from the consequences of the constraints; that is, who are the gainers and losers from the elements of the constraints range? Why have the gainers prevailed over the losers from the continued existence of these constraints? What are the explanatory variables for the persistence of these constraints and how might an interventionist strategy tackle these within a political economy framework?
- What policies, regulations and institutions have promoted or inhibited agricultural investment and commercialization?
- What are the investment priorities in different zones of the country and what are the determinants of these priorities?
- In what crops, livestock products, fishery, forestry, agro-industries, etc, does Nigeria have comparative advantage and high degree of competitiveness in the world market?
- What specific policies, regulations and institutions can be adopted to enhance this comparative advantage?
- What new policies, regulations and institutions can be adopted to improve the investment climate in Nigeria's agricultural sector?
- What strategic options are available for supporting IEHA interventions in Nigeria?
- What are the primary interventions required for promoting the identified priority commodities in the zones?

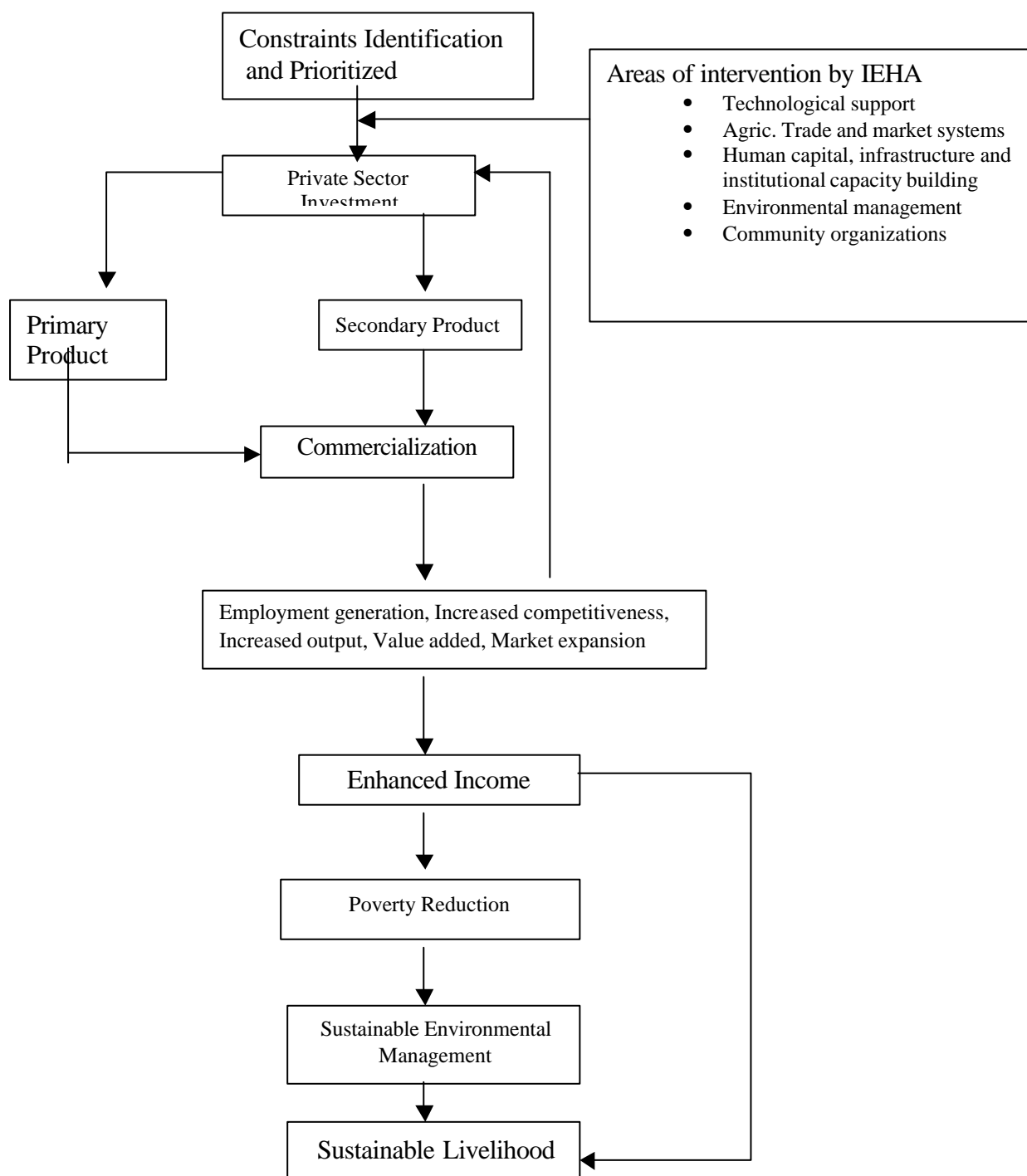


Figure 2.2: Flow Chart of the Constraints to Investment and Commercialization in Agriculture

The study recognizes the challenges and opportunities inherent in Nigeria's diverse agro-ecologies, resource endowment and agricultural production systems, hence the study will focus critically on Nigeria's diverse agricultural zones as development domains. In principle, the demarcation of development domains is based on a composite set of factors which includes market access, population density, ecology, agricultural production systems and geo-political considerations. But due to a number of important considerations, this study will adopt Nigeria's six geo-political zones (simply referred to as development domains) in this study. These geo-political zones, incidentally, largely reflect the geo-ecological and other diversities of the country.

Development domain mapping will be carried out in this study to indicate the agricultural production and investment priorities in the various development domains. Finally, appropriate strategies or strategic options will be identified for facilitating the process of agricultural investment flow and commercialization in the development domains.

The selection of priority commodities and technology options for the development domains often involves the use of a complex set of criteria that will include the following:

- (i) Commodities that have large markets and high future demand opportunities in the domains, in other domains within the country or in the export market.
- (ii) Commodities that constitute predominant sources of household income.
- (iii) Commodities that enjoy comparative advantage of high competitive advantage in domestic and export markets.
- (iv) Commodities that are already being produced in large quantities with familiar technologies.
- (v) Commodities that have high actual or potential growth rates in production and productivity.
- (vi) Commodities that have potential for high value added and spillover benefits through agro-processing and other downstream transformations either within the domain or in other domains within the country.
- (vii) Commodities, the production of which has minimal adverse effects on the environment or enhance environmental management.
- (viii) Commodities, the production of which largely benefits smallholder farmers, the poor and the vulnerable groups in and outside the domains.

In this study, commodities selection was based on one or a combination of the criteria above except 3 and 7.

2.2 Defining Development Domains of Nigeria

The first task is to define zones that could form the basis for investments into agriculture for the highest economic returns. Defining development zones of Nigeria would be based on such factors as agro-ecology, population density, market opportunities, infrastructure, farming systems, incidence of poverty and malnutrition, soils, political factor, etc. For the study, four factors were first combined on the basis of available geo-referenced data, namely the ecology (potentials for agricultural production), population density and road density (potentials for agricultural intensification and diversification and commercialization of both inputs and outputs) and farming systems (potentials for conversion of natural resources into crop products). A fifth factor about the geo-political division of the country that is the basis for the overall guidance of investment and political decisions in Nigeria. Overlaying maps of the above features resulted in the definition of six development domains for Nigeria. These are the North-West Zone (NW), North-East Zone (NE), North-Central Zone (NC), South-West Zone (SW), South-East Zone (SE), and South-South Zone (SS) (Figure 2.3). These development domains match very well with the so-called six geo-political zones of Nigeria.

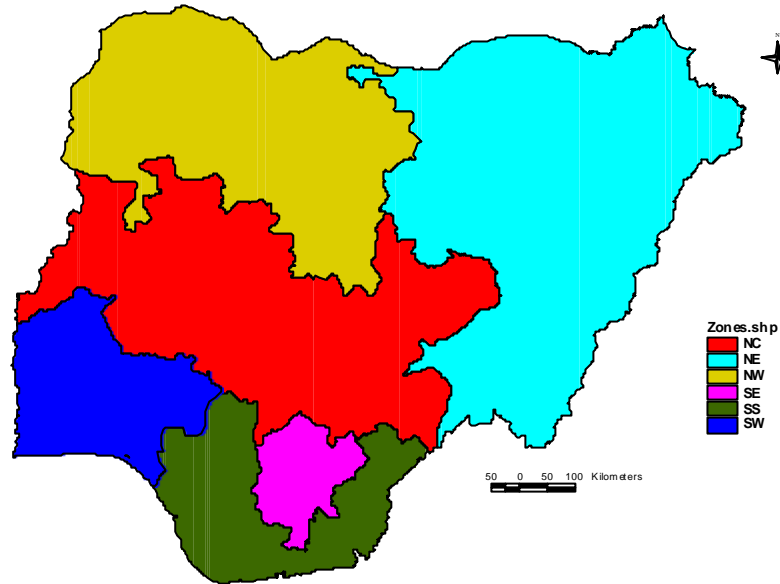


Figure 2.3. Development Domains of Nigeria

2.3 Sources of Data and Methods of Data Collection

2.3.1 Sources of Data

The data for this study were derived from both primary and secondary sources. The data needs were identified on the basis of the objectives of the study. The data needs are already presented in chapter one (Table 1.1). Each data source and the method of collection adopted are explained as follows.

The secondary data used for this study were obtained from publications of local and international agencies. The local agencies included the Federal Office of Statistics (FOS), the Central Bank of Nigeria (CBN), the Federal Ministry of Agriculture and Rural Development (FMARD), the Projects Coordinating Unit (PCU), State-wide Agricultural Development Programs (ADPs) and the National Data Bank (NDB). The international sources of secondary data included the World Bank, and the International Monetary Fund.

Key data elements collected from the various secondary sources were agricultural commodity output, agricultural commodity consumption, prices of agricultural products, Gross Domestic Product, terms of trade, external reserves, foreign and domestic investment, policies (macro and micro related), inflation rate, consumer price index, debt service, exchange rate and credit to the domestic economy among others.

2.3.2 Methods of Data Collection

The primary data were collected with the aid of two survey instruments designed separately, one for policy makers/implementers and the other for private sector and other stakeholders in agriculture. The two instruments dwelt extensively on the perception of respondents on trends in agricultural investment, the pattern of flow, the state of investment climate, constraints to increased investment and so on. Specifically, the questionnaire for policy makers, policy implementers and bureaucrats addressed issues such as those relating to the identification of specific policies, regulations and institutions designed to promote agricultural development, the factors accounting for the effectiveness or ineffectiveness of policies, investment priorities in the upstream and downstream activities of agriculture across the geo-political zones of the country and the criteria used to determine investment priorities. Other salient issues addressed in the questionnaire were areas of Nigeria's comparative advantage, ways of strengthening Nigeria's comparative advantage, the prevailing climate and opportunities for investment in agriculture, and the policies, institutions and strategies for accelerating the pace of agricultural development.

The second survey questionnaire was addressed to agribusiness associations, individual investors and other private sector operators in agriculture. The key issues addressed were the rating of agricultural performance since 1999, the factors affecting the performance of different enterprises, the assessment of investment trends in the different enterprises, and the attractiveness of agribusinesses to private investors. In addition, issues such as the nature, sources and effects of various constraints to investment in agriculture, the persistence of constraints, beneficiaries and losers from the persistence of constraints, the nature of benefits and losses and the specific policies, regulations and institutions affecting development issues. Other issues covered in the questionnaire were those relating to priority areas of investment in Nigeria's agriculture across the geo-political zones, areas of Nigeria's comparative advantage, assessment of Nigeria's economic climate for investment in agriculture, policies programs and strategies for accelerated investment in agriculture, and suggested new policies, programs and strategies for promoting rapid agricultural development.

For the purpose of the study, the existing six development zones were adopted as strata for data collection. In addition the Federal Capital Territory (FCT) was treated as a zone on its own. A sample of two states per zone was selected for the survey, in addition to the FCT. The states were Benue and Kogi states in the North-Central Zone, Borno and Adamawa states in the North-East Zone, Kaduna and Kano states in the North-West Zone, Abia and Ebonyi states in the South-East Zone, Akwa-Ibom and Cross River states in the South-South Zone and Oyo and Ondo States in the South-West Zone.

Seven teams of two persons per team were dispatched to the different zones and the FCT to administer the survey instruments. The field survey lasted for four weeks. The teams ensured an all-inclusive coverage of wide range of stakeholders in their interviews.

A combination of field survey methods was employed for the study. These are discussed as follows:

1. *In-depth Interview*: This was held where the respondents preferred to respond to the contents of the questionnaires in the presence of the field enumerators. The contents of the questionnaires were explained to the respondents and their responses recorded.
2. *Focus Group Discussions (FGDs)*: This method was adopted for most groups and associations, which preferred to have their members together in the process of administering the instruments. This method enriched the responses of the groups as it allowed for diversity of views expressed while, at the same time giving room for consensus among the participants.

3. *Individual Completion of Questionnaires*: This involved leaving the questionnaires with individual respondents (on request) to be completed at their convenience, but to be returned on an agreed date. This method was adopted mostly for the organized private sector/ and the ministries/ parastatals.
4. *Taped Interviews*: Auto-taped interviews were used to capture some important opinions or to serve as strategic entry points for other major issues to be discussed during interviews.

The number of different agencies visited across the zones is shown in Table 2.1.

Table 2.1: Number of Instruments Administered in the Different Zones of the Country

Zones	Policy Makers		Private Organizations ¹	
	No Lodged	No Retrieved	No Lodged	No Retrieved
North-central	6	6	16	16
North-east	2	2	17	17
North-west	5	5	19	19
South-east	8	3	14	13
South-south	6	4	18	10
South-west	16	12	38	30
FCT	8	6	-	-
Total	51	38	122	105

Source: Field survey, February/March, 2003

2.4 Methods of Analysis

A multiple of analytical methods will be used to analyze the identified constraints in this study. These will include descriptive statistics, constraint mapping, development domain mapping, and regression analysis and the dream model.

2.4.1 Descriptive Statistical Analysis

This involves the use of means (averages), average growth rates, frequency distribution and measures of dispersion, like variance, standard deviation and coefficient of variation. The focus will be on the analysis of levels, trends and variability in key variables of interest to provide insight into their pattern of movement over time and over space.

2.4.2 Constraint Mapping

The field survey to be conducted for this study will be used to collect data on the relative prevalence and depth of the effect of various constraints to investment in agriculture in the six defined development domains of the country. This information will be superimposed on a map which will show how prevalent each investment constraint is in each zone, such that it will be easy to see at a glance which investment constraints are relatively more prevalent in each zone, using colour codes.

2.4.3 Regression Analysis of the Determinants of Private Investment

The conceptual framework developed earlier for this study has indicated the relationship between investment and some variables. The emphasis of the study which is on unlocking/reducing the major constraints to investment and

¹ The private organizations interviewed included farmers' organizations, commodity processors, input producers, agro-allied companies, Chambers of Commerce and Industries, and National Association of Small Scale Industrialists.

commercialization in Nigeria's agriculture itself implies that an empirical investigation needs to be conducted to identify the favorable and unfavorable factors affecting the investment climate in Nigeria. In the light of the foregoing, it is considered necessary to provide an analytical framework to be used to investigate the significant determinants of both domestic private investment and foreign private investment in Nigeria. The proposed models benefit substantially from the studies of Obadan (1990), Ajakaiye (1995), Serven and Solimano (1991), and Greene and Villanueva (1991). Others are: Rama (1990); Frot and Krugman (1990) and Cardoso (1993). Chete and Akpokodje (1997) and Salako and Adebuseyi (2000) have provided an excellent review of these studies and others. On the basis of the insight provided by these authors with respect to the expected relationship between investment flows and some causal variables, this study presents the following proposed models in general forms:

2.4.3.1 *The Models for the Regression Analysis*

- (a) Domestic private investment is hypothesized to be determined as:

$$DPI_t = f(GI_{t-1}, INFL_t, RER_t, DSR_t, \Delta TOT_t, DeY_t, \Delta C_{t-1}; v)$$

Where:

DPI = Domestic private investment as ratio of GDP

GI = Public investment as ratio of GDP

GR = Growth rate of real GDP

INFL = Inflation rate

RER = Real exchange rate which is defined as nominal exchange rate with respect to the US Dollar multiplied by the ratio of the US CPI to domestic CPI

DSR = Debt service charge expressed as a ratio of the total exports value of goods and services

ΔTOT = Changes in terms of trade

DeY = Economic instability index proxied by the deviation of actual GDP from its trendline values.

ΔC = Change in domestic credit to private sector plus net foreign capital inflow

v = Stochastic error term

The expected relationships between the dependent variable and its determinants are as follows. Both GI and GR can have either positive or negative relationship with domestic private investment. On the other hand, TNF, RER, DSR, ΔTOT and DeY are expected to negatively influence domestic private investment. Lastly, it is expected that ΔC will have a positive association with domestic private investment.

- (b) The determinants of foreign direct investment is specified as:

$$FDI_t = f(GI_{t-1}, GR_{t-1}, INFL_t, RER_t, DSR_t, \Delta TOT_t, DeY_t, \Delta C_t; e_t)$$

Where:

FDI = Inflow of foreign direct investment as ratio of GDP.

Where: GI, GR, INFL, RER, DSR, ΔTOT , DeY, and ΔC are as defined above; e is the stochastic error term.

The direction of the relationship between foreign direct investment and its determinants can be positive or negative. GI, GR, and ΔTOT can have either positive or negative influence on foreign direct investment. A negative relationship is expected between INFL, DSR and DeY and foreign investment. RER and ΔC are expected to positively influence foreign direct investment.

In order to have an appropriate specification, variants of the models will be experimented with, in the regression equations. The time series characteristics of the model will be examined to avoid spurious results, which can come as a consequence of regressing two or more non-stationary series. In this respect a co-integration analysis, which ensures a long-run relationship among non-stationary series, will be carried out. This will be done in a two-step procedure using the Augmented Dickey Fuller (ADF) test statistics. The first step is to test for stationarity of the

different variables while the second step involves co-integration test of the dependent variables against the independent variables.

2.4.3.2. Data Requirement and Sources for the Regression Analysis

The data required for this analysis are time series in nature and will cover the years between 1970 and 2001, if all required data are available. The variables of interest on which data is collected are:

- Domestic private investment (total and agriculture)
- Foreign direct investment (total and agriculture)
- Public investment
- Debt service charge
- Value of export, value of import
- Terms of trade index
- Inflation rate
- GDP at 1984 constant factor cost (total and agriculture)
- Growth rate of real GDP
- Nominal exchange rate ₦/USD
- Nigeria's consumer price index
- US consumer price index
- Foreign exchange receipts
- Interest rate in Nigeria
- Interest rate in the US
- Domestic credit to the private sector
- Growth rate of money supply
- International reserves
- Import capacity
- Foreign capital inflow

The data are from local and international sources. Terms of trade index, US consumer price index, import capacity of Nigeria and lending rate of US are sourced from World Debt Tables of the World Bank. Also, the data on private and public investment are sourced from IFC discussion papers on trends in private and investment in developing countries. Other data are to be sourced from the CBN Statistical Bulletin.

This analysis is only exploratory, as it has not examined the interdependence of investment, trade and growth in Nigeria, which will require the use of a simultaneous equation model. The data requirement for such a simultaneous equation model is beyond the scope of the present study. In the circumstance, a single-equation regression model is used in this study.

2.4.4 The Dream Model

One of the key tools of analysis in this study is the IFPRI DREAM (Dynamic Research Evaluation for Management) Model (Wood et al, 2000). DREAM is designed to measure economic returns to commodity-oriented research under a range of market conditions, allowing price and technology spill over effects among regions as a consequence of the adoption of productivity-enhancing technologies or practices in an innovating region. Linear equations are used to represent supply and demand in each region with market clearing enforced by a set of quantity identities and price identities. It is a single-commodity model without explicit representation of cross-commodity substitution effects in production and consumption --- although, of course, these aspects are represented implicitly by the elasticities of supply and demand for the commodity being modelled. In particular, DREAM assumes all commodities are tradable between regions (although a spectrum of possibilities from free trade to autarky can be represented). The supply, demand and market equilibrium are defined in terms of border prices which will differ from prices received by farmers (or paid by consumers) because of costs of transportation, transactions, product transformation, and so on that are incurred within regions between the farm and border. The linearity of DREAM model is good for small equilibrium displacements such as those single-digit percentage shifts of supply or demand, which is common for most of agricultural technology changes. Alston and Wohlgenant (1990) showed that changes

in benefits estimates from comparatively small equilibrium displacements of linear models provides a reasonable approximation of the same shifts (in this case parallel shifts) with various other function forms. Small shifts have the added virtue that the cross-commodity and general equilibrium effects are likely to be small (and effectively represented within the partial equilibrium model), and that the total research benefits will not depend significantly on the particular elasticity values used (although the distribution of those benefits between producers and consumers will). Even with all these simplifications, which make the DREAM model tractable, significant effort is needed to parameterise and use the model to simulate market outcomes under various scenarios (Alston et al, 1995; Alston et al, 2000).

The primary parameterization of the model's supply and demand equations is based upon a set of demand and supply quantities, prices, elasticities in a defined "base" period. DREAM also allows for underlying growth of supply and demand to be built into the model to project a stream of shifting supply and demand curves into the future that we can solve for a stream of equilibrium prices and quantities, in the "without research" scenario. These "without research" outcomes can be compared with "with research" outcomes, which are obtained by simulating a stream of displaced supply curves, incorporating research-induced supply shifts. The research-induced supply shifts are defined by combining an assumption about a maximum percentage research-induced supply shift under 100 percent adoption of the technology in the base year, with an adoption profile, representing the pattern of adoption of the technology over time. Finally, measures of producer and consumer surplus are computed and compared between the "with research" and "without research" scenarios, and these are discounted back to the base year to compute the present values of benefits. In the case that we know the costs of the research that are responsible for the supply shift being modelled, DREAM will compute a net present value or internal rate of return (IRR).

DREAM has been developed into a computer software package (Wood et al, 2000). It has menu-driven, user-friendly interface which hides the complex computation to allow user to focus on methodology, data collection and policy interpretation. DREAM explicitly includes four market types: horizontal multi-market, open economy, closed economy, and three-level vertical market. The region in DREAM can be any spatial unit, either geopolitical region such as country, province, county or agro-ecological zones such as humid and temperate zone, tropics and arid zone. DREAM allows users to specify technology shifts, adoption, elasticities, and exogenous growth rates that change over the simulation period. It provides a framework for exploring various kinds of policy, technology, extension and trade issues (Alston et al, 2000).

CHAPTER THREE

THE PERFORMANCE OF NIGERIA'S AGRICULTURE

3.1 Evidence from Literature

The performance of the agriculture sector was assessed using indicators from literature. Five key indicators were used for this purpose, namely mean gross domestic product (GDP) at 1984 constant factor cost, mean amount of guaranteed loan received by farmers under the agricultural credit guarantee scheme fund (ACGSF), mean total bank credit to the agricultural sector and the economy as a whole, mean capital expenditure of federal government on agriculture and on all sectors of the economy and share of labor force employed in agriculture. Four sub-periods were considered for this assessment: 1981 – 85, 1986 – 90, 1991 – 95 and 1996– 2000. For each indicator and for each sub-period, three parameters were taken into consideration: the annual values, the growth rates, and the variability in the growth rates. Details are discussed in the sub-sections below.

3.1.1. Annual Values of Performance Indicators

The results on the average annual values for the key performance indicators of the agriculture sector in Nigeria are summarized in table 3.1. The results show a mixed performance. It may be observed that first, the crops sub-sector dominated the agricultural sector GDP in all the sub-periods. Crops sub-sector alone accounted for between 71 percent and 80 percent of the agricultural sector GDP in the sub-periods. Second, the share of agriculture in both aggregate GDP and non-oil GDP increased only marginally between the 1981 – 85 and 1996 – 2000 sub-periods, but as expected, agriculture's share of non-oil total GDP alone was higher than its share of aggregate GDP. The difference is, however, not as large as expected because the contribution of the oil sector to the country's GDP is not as large as its contribution to national revenues may suggest.

Table 3.1: Indicators of Agricultural Sector Performance (in Mean Annual Values)

S/N	Indicators	1981 – 1985	1986– 1990	1991 – 1995	1996- 2000
1.	Mean GDP at 1984 Constant Factor Cost (₦ Millions):				
	Crops	18,134.2	24,773.3	30,195.1	35,745.0
	Livestock	4,306.8	4,959.0	5,212.0	5,825.0
	Forestry	1,258.7	1,328.6	1,290.0	1,390.0
	Fisheries	1,322.1	1,167.6	1,379.0	1,765.0
	Total agriculture GDP	25,229.2	32,228.5	38,075.9	44,725.0
	Total GDP	67,773.0	78,681.0	99,320.7	111,705.0
	Total Non-Oil GDP	58,368.8	68,486.0	86,445.0	99,160.0
	Share of agriculture in total GDP(%)	37	41	38	40
	Share of agriculture in non-oil GDP (%)	43	47	44	45
2.	Mean guaranteed loan under ACGSF (₦ Million):	44.2	103.4	104.6	228.2
3.	Mean Total Bank Credit (₦ Million):				
	Total credit to agriculture	1,000.5	3,600.4	15,789.0	37,819.6
	Credit to the economy	12,007.8	25,013.2	89,285.1	391,036.8
	Agriculture's share of total (%)	8.3	14.4	17.7	9.7
4.	Mean Capital Expenditure of Federal Government (₦ Million):				
	Expenditure on agriculture	985.4	910.7	2,125.2	6,338.2
	Expenditure on all sectors	6,516.4	8,529.4	24,644.1	159,591.6
	Agriculture's share of total (%)	15.1	10.7	8.6	4.0
5.	Share of Total Labor				
	Force employed in agriculture (%)	59.4	55.6	57.0	45.0
6.	Agriculture's Share of Export Value:				
	Share of total export	2.9	4.7	2.0	2.4
	Share of non-oil export	71.8	79.1	77.8	84.5

Source: Computed with data extracted from: Central Bank of Nigeria (CBN): Statistical Bulletin, Vol. 11, No.2, December 2000.

Credit flow to the agricultural sector is an indicator of the sector's capacity to invest and grow. This capacity is measured in Table 3.1 by the amount of guaranteed loan that flowed to the sector under the agricultural credit guarantee scheme fund and the total bank credit to the sector. As shown in the table, the nominal flow of guaranteed credit increased astronomically. But when expressed in real terms (i.e. in 1985 constant prices), there was a sharp decline over the sub-periods, from about ₦44.2 million in the 1981-85 sub-period to about 36.5 million in the 1986-90 sub-period and to only about 5.6 million in the 1996-2000 sub-period.

The total flow of credit from the entire banking system depicted a similar trend, with high and increasing flow in nominal terms but a decline over the sub-periods in real terms. But more significantly, the share of total bank credit going to agriculture first increased rapidly from about 8 percent in the 1981-85 sub-period to a peak of about 18 percent in 1991-95 sub-period, before declining to only about 10 percent in the 1996-2000 sub-period. This pattern of movement was a reflection of government priority for agriculture and, more importantly, the degree of compliance of the banking system with agricultural credit guidelines.

Also, in Table 3.1, it is shown that the share of federal government's total capital expenditure going to agriculture declined rapidly and consistently from about 15 percent in the 1981-85 sub-period to only about 4 percent in the 1996-2000 sub-period, probably reflecting the declining trend in federal government's investment priority in the sector. The table shows a declining share of total labor in agriculture, from about 59 percent in 1981-85 to 45 percent in 1996-2000.

Finally, it can be observed from Table 3.1 that agriculture's share of total oil and non-oil export values increased from the 1981-85 sub-period to the 1986-90 sub-period, but declined in the 1991-95 sub-period and remained virtually unchanged thereafter. However, the share of agricultural products in the total value of non-oil exports alone increased in the period from 72 percent in the 1981-85 sub-period to 84 percent in the 1996-2000 sub-period. The implication is that, within the group of non-oil exports, agricultural export performed relatively better by increasing its share. But because non-oil export in the aggregate did not perform as well as oil export, agriculture's share of total export value (oil and non-oil) could only stagnate in the 1981-2000 period.

3.1.2 Growth Rates of Economic Indicators

Table 3.2 shows the average annual rates of growth of a number of agricultural-sector performance indicators over the 1981-2000 period.

Six growth-rate indicators are listed in the table, namely, average annual growth rates of agricultural GDP and those of four sub-sectors of agriculture, average annual growth rates in indices of agricultural production and for five sub-sectors of agriculture, average annual growth rates in the amount guaranteed loans under the ACGSF, average annual growth rates in total bank credit to agriculture and the aggregate economy, and capital expenditures of federal government in the agricultural sector and in the aggregate economy.

The growth rates of the GDP in the agricultural sector and its sub-sectors show that the crops sub-sector performed relatively better than the other sub-sectors and the aggregate sector. Although not high, the crop growth rates improved over the 1981-2000 period, from an average 2.5 percent per annum in the 1981-85 to 4.9 percent per annum in the 1996-2000 sub-period. Growth rates in the livestock sub-sector were positive but declining, from 5.7 percent per annum in the 1981-85 sub-period to 2.7 percent in the 1996-2000 sub-period. Forestry sub-sector's growth rates were still poorer than those of livestock. Fisheries sub-sector displayed high but highly swingin g

growth rates, with high positive growth rates, alternating with high negative growth rates. This was an indication of a high degree of instability in the sub-sector. However, the growth performance of the agricultural sector GDP was, on the whole, slightly better than that of the economy as a whole.

Table 3.2: Mean Annual Percentage Growth Rates of Agricultural Sector Performance Indicators

S/N	Indicators	1981– 1985	1986 – 1990	1991 – 1995	1996 - 2000
1.	GDP at 1984 Constant Factor Cost (% p.a.):				
	Crops	2.5	4.7	3.1	4.9
	Livestock	5.7	2.3	1.5	2.7
	Forestry	0.4	-6.0	2.3	2.0
	Fisheries	-16.1	24.6	-10.2	11.7
	Total agriculture GDP	2.1	4.5	2.3	4.8
	Total GDP	-1.5	6.7	2.2	2.8
2.	Index of Agricultural Production (% p.a.):				
	Staple crops	4.3	1.4	0.2	3.0
	Other crops	-1.3	6.4	-0.8	5.3
	Livestock	3.8	9.1	1.6	2.2
	Fisheries	-16.7	5.2	-3.9	5.7
	Forestry	-1.2	2.6	1.8	1.3
	Sector aggregate	2.1	12.2	2.6	3.4
3.	Guaranteed loan under ACGSF (%)		10.3	16.1	13.1
4.	Total Bank Credit:				
	Credit to agriculture	22.0	26.4	48.6	5.8
	Credit to the economy	10.2	15.4	37.0	21.3
5.	Consumer Price Index (% p.a.):				
	All items	20.1	33.6	57.5	6.8
	Food items	21.3	38.4	54.6	3.8
6.	Capital Expenditure of Federal Government (% p.a.):				
	Expenditure on agriculture		27.5	74.7	9.2
	Expenditure on all sectors		26.5	36.3	47.8
7.	Agricultural Export Value:	31.0	70.5	68.5	18.2

Source: Computed with data extracted from: Central Bank of Nigeria (CBN): Statistical Bulletin, Vol. 11, No.2, December 2000.

The trend in the indices of production in the agricultural sector was similar to that of the sector's GDP. There were generally very low but positive growth rates in staple crops, livestock forestry and the sector aggregate production. Fisheries sub-sector displayed highly fluctuating growth rates. The production growth performance of the sector was, on the whole poor in the 1981-2000 period, except in the 1986-90 sub-period, due to the relatively efficient implementation of strut rural adjustment policies in that sub-period.

The trend in guaranteed credit to agriculture under ACGSF showed high nominal growth rates but a negative real growth rate as earlier indicated. But the rate of flow of bank credit was higher than for the economy as a whole, as indicated by the higher annual rate of increase in the amount of total bank credit flowing into agriculture than flowing into the economy as a whole, except in the 1996-2000 sub-period.

The relative rate of increase in the food-item consumer price index was generally lower than that of all items (food and non-food), an indication of relative food price stability in the economy. But the rates of both food and non-food consumer prices rose between the 1981-85 sub-period and the 1991-95 sub-period, although the rate of increase was

lower for food items than for non-food items. But in the 1996-2000 sub-period, the rates of increase in both food and non-food consumer prices declined dramatically, but the rate of decline was higher for food than for non-food consumer prices. On the whole, the rate of inflation in food prices was lower than the rate of non-food prices in the entire 1981-2000 period, an indication of a relatively stabilizing food security situation in the country.

It is observed in Table 3.2 that the rate of growth in capital expenditure by the federal government in agriculture was higher than the rate of growth for the economy as a whole from 1981 to 1995, showing an apparently increasing priority given to the sector by the federal government. However, the situation changed dramatically in the 1996-2000 sub-period when the rate of increase in capital expenditure was much lower for the agricultural sector than for the economy as a whole.

Finally, the average growth rate in the value of agricultural export increased astronomically in the 1986-90 sub-period due to the initial impact of SAP, remained a little lower but still high in the 1991-95 sub-period, again due to the effect of SAP, but became relatively low in the 1996-2000 sub-period, as the effect of SAP wore off.

Generally, there had been a lack of consistency in the growth performance of the agricultural sector in the 1981-2000 period, with some evidence of unstable or fluctuating trends, probably due to inconsistencies in policies and policy implementation in the period.

3.1.3 Variability in the Growth Performance of Indicators

In order to throw more light on the degree of instability in the growth performance of the agricultural sector in the period under review, Table 3.3 is presented.

The variability, which is measured in terms of coefficient of variation, shows the average percentage variation in either direction from the mean value from one year to the next. A coefficient of variation of zero percent depicts perfect stability and the higher it is from zero, the higher is the degree of instability, subject to a maximum of 100 percent. Instability in an agricultural performance indicator is a reflection of policy instability and/or implementation inconsistency, vagaries of nature (which is a prominent phenomenon affecting most agricultural activities), policy failures, market failures (e.g. unreliable input supply system, instable input and output prices, etc) and other weaknesses of the economy.

Looking at Table 3.3, it could be observed that most of the indicators had high average coefficients of variation (say, > 20%) over the sub-periods under review. These unstable indicators included GDP in the fisheries sub-sector, indices of production of staple crops and fisheries products, amounts of loans guaranteed under the ACGSF, food and all-item consumer price indices, total flow of bank credit to agriculture and the economy as a whole, and federal government capital expenditure on agriculture and the economy in the aggregate. It is easy to see that these are the types of indicators, which reflect inefficiencies in economic management, market imperfections and policy failures.

It may be concluded that high instability was a hall-mark of the agricultural sector, with most important indicators in the sector displaying wild periodic fluctuations from good performance to bad performance, and vice versa. In fact, it may be stated that very unstable growth pattern characterizes Nigeria's agriculture and points to the need to address the instability-inducing factors identified above.

Table 33: Variability in Agricultural Sector Performance Indicators (Coefficients of Variation in Percentage)

S/N	Indicators	1981 – 1985	1986 – 1990	1991 – 1995	1996 – 2000
1.	GDP at 1984 Constant Factor Cost:				
	Crops	8.5	7.9	2.9	6.2
	Livestock	8.8	3.6	1.1	3.5
	Forestry	2.3	1.2	2.0	2.9
	Fisheries	28.8	38.7	34.8	14.2
	Total agriculture GDP	6.0	7.5	2.3	6.1
	Total GDP	4.6	10.7	3.0	3.6
2.	Index of Agricultural Production:				
	Staple crops	7.5	22.3	25.4	4.7
	Other crops	5.4	10.4	3.2	8.1
	Livestock	6.6	18.1	1.6	3.5
	Fisheries	29.9	12.6	6.5	8.9
	Forestry	3.2	4.2	1.4	2.1
	Sector aggregate	4.3	18.1	8.2	5.3
3.	Guaranteed loan under ACGSF:		22.4	33.4	42.2
4.	Total Bank Credit:				
	Credit to agriculture	30.7	35.2	59.8	15.0
	Credit to the economy	15.1	23.0	47.3	33.9
5.	Consumer Price Index:				
	All items	42.1	44.8	71.8	10.5
	Food items	36.6	49.3	68.7	6.4
6.	Capital Expenditure of Federal Government:				
	Expenditure on agriculture	53.8	58.2	51.4	28.5
	Expenditure on all sectors	-	39.2	53.0	61.6

Source: Computed with data extracted from: Central Bank of Nigeria (CBN): Statistical Bulletin, Vol. 11, No.2, December 2000.

3.1.4 Recent Performance of Nigeria's Agriculture

In order to underscore the performance of Nigeria's agricultural sector in more recent years, a list of five indicators and their measured indices is presented in Table 3.4.

Table 3.4: Performance Indicators in Recent Years (1996-2000)

S/N	Indicators	1996	1997	1998	1999	2000	2001
1.	Share of agriculture in real GDP (%)	39.0	39.4	40.1	41.0	40.6	41.1
2.	Annual growth rate of agriculture's real GDP (%):	4.1	4.2	4.0	5.2	2.9	5.1
3.	Agriculture's share of total value of export (%):	1.3	1.6	2.2	1.0	2.2	-
4.	Average per caput calorie intake from cereals and tubers (Kcal/day):	2145.7	2147.1	2157.6	2161.3	2165.0	-
5.	Average per caput protein intake from animal and fish sources (g/day):	14.2	15.7	16.1	16.2	16.5	-

Sources: Computed with data extracted from:

- (1) NISER (2000)
- (2) CBN: Annual Report and Statement of Accounts (1999,2000 and 2001 issues)
- (3) CBN (2000): Statistical Bulletin

As shown in the table, the share of agriculture in the real value of total GDP recorded only a small increase between 1996 and 2001, moving from about 39 percent to about 41 percent. This, nevertheless, suggests that the overall performance of the agricultural sector was slightly better than that of the economy as a whole.

The growth rate of agricultural sector's real GDP was also fairly high in all the years, except year 2000, especially when compared with the average growth rate in the 1981-1996 period. This, again, is an evidence of significant improvement in the performance of the sector in more recent years. Agriculture's share of total export value from Nigeria, however, remained small, ranging between one percent and two percent. There were also annual fluctuations in the percentage shares, which was an evidence of relative instability in annual agricultural export values.

As indicators of food security situation in Nigeria in recent years, the average daily intake of calorie and protein from major food sources is presented in the table. As shown, average daily calorie intake from cereals and tubers (which provide about 90 percent of calories from all food sources) increased marginally by about one percent in the whole of the 1996-2000 sub-period. Average daily protein intake from animal and fish sources however, increased more substantially by about 16 percent in the whole of the 1996-2000 sub-period. Overall, therefore, it would appear that the average food security situation, measured in terms of calorie and protein intake increased in the 1996-2000 sub-period, but only very marginally. Furthermore, it would appear that overall, the average Nigerian was still marginally below the minimum daily calorie intake of 2250 kilo calories and minimum protein intake from animal sources of 35 grams per day (Olayemi, 1995).

In conclusion, it would appear that Nigeria's agricultural sector recorded a modest improvement in overall performance between 1981 and 2000, both in absolute terms and relative to the entire economy. However, much of this improvement was masked in wide periodic fluctuations in performance, which was an evidence of serious economic instability in the sector.

3.1.5 Factors Constraining Agricultural Performance

The problems constraining the performance of Nigeria's agriculture have been elaborately discussed in the literature by, among many others, Olayemi (1988), Olayemi and Akinyosoye (1989), Njoku (1998), Onyenweaku (2000) and NISER (2001). The major constraints identified are summarized as follows.

3.1.5.1. Technical Constraints

Technical constraints include the high incidence of pests and diseases, inadequate infrastructural facilities, dependence on unimproved inputs and rudimentary technology. Others are inadequate extension services, inefficient inputs supply and distribution system and high environmental hazards.

3.1.5.2. Resource Constraints

A major problem of agricultural labor supply arises from the increasing migration of able-bodied youths from rural to urban areas. The consequence of the massive migration of youths is seasonal labor shortage, especially at the peak periods of labor demand (during land preparation, planting, weeding and harvesting). There is also the problem of low agricultural labor productivity. There is an increasing population pressure on land as well as a declining quality of land. Rate of land improvement is low because of a low rate of capital investment by the predominantly traditional farmers.

3.1.5.3. Socio-Economic Constraints

The socio-economic problems that constrain Nigeria's agriculture include scarcity and high cost of improved farm inputs, inefficient marketing arrangements characterized by high marketing margins, lack of grades and standards,

and lack of legally enforceable ownership and control rights over land which serves as a disincentive to investing in agriculture and which arises from the lack of appropriate land tenure system. Other socio-economic factors are inadequate extension services and credit facilities, low rate of growth in international demand for primary export commodities arising largely from competition with synthetic products; and low income elasticity of demand, and increasing food deficit and high dependence on food import arising from the disequilibria in national agricultural resource base, a largely traditional agricultural production system and some domestic population dynamics.

3.1.5.4. Organizational Constraints

Agricultural production is predominantly in the hands of a multitude of small scale unorganized farmers, scattered across the country. Lack of organization, coupled with the dispersed nature of farm settlements, hinder the participation of farmers in agricultural and rural development. It particularly hinders the supply of extension services, farm credit and other vital inputs to farmers.

3.2 Stakeholders' Perception of the Performance of Nigeria's Agriculture

In order to confirm the performance of the agricultural sector as revealed through the analysis of secondary data, respondents were asked during field survey to indicate their perception of the performance of the sector in the last four years. Seven indicators were selected as presented in Table 3.5. As can be seen from the table, the overall performance of agriculture was rated slightly better than before. This corroborates the result of trend analysis presented in the earlier subsections. However, employment in agriculture remains stagnant. Indeed, agriculture's share of employment has been on the decline as noted earlier. Across the zones, the performance rating of agriculture (using the seven indicators) was perceived to lie somewhere between being unchanged and being slightly better than before. The north-central and south-south zones viewed agricultural performance as remaining at about the same level while the other four zones adjudged it to be slightly better. In particular, the performance in terms of improving the poverty status of farming households, agricultural exports and employment in agriculture were adjudged by two or more zones to have been poor while the performance in terms of the remaining indicators was viewed to have been slightly better by three or more of the zones. Indicators, which showed a slight improvement in the performance of agriculture, included those on food security, rate of return to agricultural enterprises and economic climate for investment in agriculture.

The key performance-enhancing factors for the different enterprises in agriculture are presented in Table 3.6. Across the zones, access to inputs, high demand for products, availability of transport facilities, availability of raw materials and good economic climate are the main enhancing factors. This is not surprising. For instance, access to inputs is facilitated by the sustained activities of the Agricultural Development Programs by providing adequate information on the market situation for the different inputs. Through this, the ultimate users of the different inputs at both the downstream and upstream segments of the agricultural sector are sensitized and enlightened. The population of the country confers on it a high market potential. Hence, there seems to be ready local market for whatever is produced in the country. This was enhanced by the recent increase in public sector salaries thereby improving people's purchasing power. Following from this is the high demand for products.

However, the constraining elements to the performance of the different agricultural enterprises are given in Table 3.7. From the table, it can be seen that high cost of inputs, lack of processing and storage facilities, insecurity and poor infrastructure were frequently mentioned across the zones. Though access to inputs was said to be performance enhancing, high prices of inputs due to high rate of inflation, had tended to constrain performance. In addition, downstream activities that entail the transformation of agricultural products (through value added activities) were constrained by lack of processing/storage facilities. Furthermore, poor infrastructure including epileptic power supply, inadequate supply of potable water, and the skewed distribution of available infrastructure in favor of urban areas were also negatively affecting the performance of enterprises in agriculture. Insecurity of lives and property was also an important performance-inhibiting factor in agriculture.

Table 3.5: Performance of Nigeria's Agriculture by Development Zones since 1999

Indicators	NC	NE	NW	SE	SS	SW	NIGERIA
Food security	3	4	4	4	4	4	4
Poverty Status of Farming Households	3	4	4	4	3	4	4
Agricultural Export	3	4	4	4	3	4	4
Employment in Agriculture	3	4	3	4	3	4	3
Rate of Return to Agricultural Enterprises	4	4	4	4	3	4	4
Economic Climate for Investment in Agriculture	3	4	4	5	4	4	4
Bridging Gender Gap						5	
Overall Average	3	4	4	4	3	4	4

N/B: Much better=5; slightly better=4; about the same=3; worse than before=2; worse than before=1.

Source: Field Survey, February/March 2003.

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

Table 3.6: Factors enhancing the Performance of Enterprises in Nigeria in order of importance

Rank assigned by respondents						
Factors	NC	NE	NW	SE	SS	SW
Access to inputs	1	1	1		1	2
Availability of cheap labor	2					
High demand for products	3	4	2	4	4	3
Better extension services	4					
Availability of raw materials		2	4		2	
Access to credit facilities		3			3	
Availability of transport facilities		5	5		6	
Good economic climate		6	6			1
Availability of grants				2		
Availability of qualitative input				3		
Import restriction for locally produced goods				6		
Fair producers prices				6		
Improved farming practices				1		
Reduction in input prices			3			
Availability of skilled manpower					5	4
Favorable agro-climatic environment						5
Government patronage						6

Source: Field Survey, February/March 2003.

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

The ranking is in descending order of importance.

CHAPTER FOUR

A REVIEW OF AGRICULTURAL POLICY IN NIGERIA

4.1 Past Government Policies in Agriculture

Nigeria's agricultural policy framework has gone through a number of evolutionary processes and fundamental changes that reflected, in a historical perspective, the changing character of agricultural development problems and the roles which different segments of the society were expected to play in tackling these problems. But, in the main, the form and direction of agricultural policy at a point in time were dictated by the philosophical stance of government on the content of agricultural development and the role of government in the development process.

In retrospect, four distinct agricultural policy phases can be identified in Nigeria. The first phase spanned the entire colonial period and the first post-independence decade from 1960 to about 1969; the second covered the period from about 1970 to about 1985; the third phase started from about 1986 in the structural adjustment period; and, the fourth was what could be characterized as the post-structural adjustment era, starting from about 1994.

4.1.1. The Pre-1970 Period

In the pre-1970 era, government philosophy of agricultural development was characterized by minimum direct government intervention in agriculture. As such, government attitude to agriculture was relaxed, with the private sector and particularly the millions of small traditional farmers bearing the brunt of agricultural development efforts. Government efforts were merely supportive of the activities of these farmers and government efforts largely took the form of agricultural research, extension and export crop marketing, and pricing activities. Most of these activities were regional-based towards the end of the colonial era with federal government contribution being confined largely to agricultural research.

The low visibility of governments in agricultural development efforts was borne out of a general philosophy of economic *laissez faire*. To be sure, some governments were bent on making their presence felt in agriculture, especially in the 1950s and 1960s, by creating government-owned agricultural development corporations and launching farm settlement schemes. But these actions found their justification more in welfare considerations than in hard-core economic necessities.

It was, however, becoming quite clear towards the end of the 1960s that the Nigerian agricultural economy might be running into some stormy weather. Telltale signs of emerging agricultural problems included declining export crop production and some mild food shortages. Even then, most of these problems were ascribed to the civil war and, as such, were considered to be only transitory in nature. But events soon proved these optimistic assumptions wrong as the agricultural sector sank deeper and its problems became much more intractable than anticipated.

4.1.2 Pre-Structural Adjustment Period (1970-1985)

The turn of the 1970s was, therefore, characterized by a state of general apprehension about the condition of the Nigerian agricultural sector. This led to a fundamental change in the philosophy of government on agricultural development from one of minimum government intervention to one of almost maximum intervention, particularly by the federal government. The feeling was pervasive that the solutions to the increasingly serious problems of agriculture and especially those of food supply required the heavy clout of government in the form of multi-dimensional agricultural policies, programs and projects, some of them requiring the direct involvement of government in agricultural production activities. The sudden smile of oil fortune on Nigeria reinforced this feeling. Hence, the decade of the 1970s and early 1980s witnessed an unprecedented deluge of agricultural policies, programs, projects and institutions. A highlight of these is presented as follows.

4.1.2.1. Agricultural Sector Policies and Institutions

Sector-specific agricultural policies were largely designed to facilitate agricultural marketing, reduce agricultural production cost and enhance agricultural product prices as incentives for increased agricultural production. Major policy instruments for this purpose included those targeted to agricultural commodity marketing and pricing, input supply and distribution, input price subsidy, land resource use, agricultural research, agricultural extension and

technology transfer, agricultural mechanization, agricultural cooperatives and agricultural water resources and irrigation development.

(a) *Agricultural Commodity Marketing and Pricing Policy*

The major instrument of agricultural commodity marketing and pricing policy was the establishment of six national commodity boards in 1977 to replace the regional, multi-commodity boards that had been operating since 1954. The six new national commodity boards were for cocoa, groundnut, palm produce, cotton, rubber and food grains.

The case of grains marketing board was particularly unique as it represented the first effort ever made to extend the marketing board system to cover food crops. The National Grains Board handled maize, millet, sorghum, wheat, rice and cowpeas. It administered a guaranteed minimum price policy whereby floor prices were nationally set for each of the six-grain crops as guaranteed minimum prices at which the board would intervene as a buyer of last resort if and when their regular market prices fell below the guaranteed minimum. The board also operated a strategic grain reserve scheme.

(b) *Input Supply and Distribution Policy*

Government policy on input supply and distribution focused on instruments for ensuring the adequate and orderly supply of modern inputs like fertilizers, agro-chemicals, seed and seedlings, machinery and equipment, and so on. The key policy instruments adopted were as follows:

- (i) Centralization of fertilizer procurement and distribution in 1975 as a result of which all fertilizer procurement and distribution activities in Nigeria were effectively taken over by the federal government. Also, the federal government established a superphosphate fertilizer plant in the country to reduce the country's dependence on foreign sources of fertilizer supply.
- (ii) The creation of a national network of agro-service centers to facilitate the distribution of modern inputs, including the provision of tractor and farm machinery services to farmers.
- (iii) The creation of a National Seed Service (NSS) in 1972 to produce and multiply the improved seeds of rice, maize, cowpea, millet, sorghum, wheat and cassava.

(c) *Agricultural Input Subsidy Policy*

As far back as the 1950s, various regional governments in Nigeria were already subsidizing the prices of key inputs, especially the prices of agro-chemicals used in the production of groundnut, cotton, cocoa, palm produce and other export crops. But in the early 1970s, input subsidy policy became centralized and its application extended to food crops. The policy instruments adopted comprised the following:

- (i) *Fertilizer subsidy*: Between 1976 and 1979, fertilizer attracted a 75 per cent subsidy, wholly borne by the federal government. But in 1980, the federal government's share was reduced to 50 per cent while the states were required to absorb the remaining 25 per cent. However, the total percentage subsidy was subsequently reduced to 50 per cent.
- (ii) *Seed subsidy*: There was a subsidy of 50 per cent or more on various improved seeds produced by the National Seed Service.
- (iii) *Subsidy on agro-chemicals*: Rates of subsidy on agro-chemicals varied, but were generally over 50 per cent.
- (iv) *Subsidy on tractor hire services*: Subsidies on tractor hire services that were mostly operated at the state level ranged from about 25 per cent to about 50 per cent of the actual cost of tractor services.

(d) *Agricultural Mechanization Policy*

The need for a coherent agricultural mechanization policy became very pressing in the early 1970s in view of an increasing shortage of agricultural labor that necessitated the substitution of some appropriate forms of mechanical power for human labor. In an attempt to achieve the objectives of an agricultural mechanization policy, the following policy instruments were adopted:

- (i) The operation of Tractor Hire Units (THUs) by states.
- (ii) Liberalized import policy in respect of tractors and agricultural equipment.
- (iii) Massive assistance program to farmers on land clearing through cost subsidies.
- (iv) The launching of a machinery ownership scheme in 1980 under which the federal government provided half of the purchase cost of farm machinery to be owned and used by farming cooperatives or group farms.

(e) *Agricultural Cooperatives Policy*

A number of policy instruments were adopted to mobilize rural people for social and economic development through agricultural cooperatives. The following were the major instruments:

- (i) The use of agricultural cooperatives for the distribution of some farm inputs as well as imported food commodities.
- (ii) The provision of necessary encouragement for the establishment of cooperative farms and other cooperative enterprises.

(f) *Water Resources and Irrigation Policy*

The major instrument of water resources and irrigation policy was the establishment of eleven River Basin Development Authorities in 1977 with the overriding responsibility for the development of the country's land and water resources. They had mandate for land preparation, development of irrigation facilities and construction of dams, boreholes and roads. They were also involved in the distribution of farm and fishing inputs. Under the civilian regime, between 1979 and 1983, they became the major instrument of government's direct agricultural production through large-scale mechanized farming.

4.1.2.2. **Institutional Framework**

To support the macroeconomic and microeconomic policies of government in this period, a number of institutions were created. The major ones were the institutions created for (i) credit supply to farmers (ii) technology transfer, (iii) improved seed supply, (iv) agricultural research, (v) agricultural mechanization and (vi) agricultural commodity marketing and pricing.

(a) *Agricultural Credit Institution*

In 1973, the Nigerian Agricultural and Cooperative Bank (NACB) was established as a specialized credit institution for agriculture and rural development. The bank had the mandate to supply credit to small-scale and large-scale farmers as well as farmer cooperatives and groupson favorable terms.

(b) *Seed Supply Institution*

A National Seed Service (NSS) was created in 1972 to produce and multiply the improved seeds of rice, maize cowpea, millet, sorghum, wheat and cassava;

(c) *Agricultural Research and Development*

The major policy effected in the 1970s concerned the provision of institutional mechanisms for the national coordination of agricultural research and for creating stronger linkages between research and extension services: The major instruments of agricultural research policy were as follows:

- (i) A decree promulgated in 1971 created Agricultural Research Council of Nigeria with the power to coordinate and control all agricultural research activities in Nigeria.
- (ii) A decree promulgated in 1973 empowered the federal government to take over all state research institutions.
- (iii) In 1975, the federal government reconstituted the Nigerian agricultural research institute network into 14 institutes.
- (iv) In 1977, the National Science and Technology Development Agency was created to coordinate all research activities in Nigeria. In the same year, the responsibility for the administration of all agricultural research institutes in Nigeria was moved from the Federal Ministry of Agriculture to a newly created Ministry of Science and Technology.
- (v) Also in 1977, a center for Agricultural Mechanization was created to conduct farm mechanization research and carry out tests on foreign farm machineries in order to determine their suitability or adaptability to Nigerian conditions.

(d) *Agricultural Extension and Technology Transfer Policy*

The most important feature of agricultural extension policy in the 1970s was the demise of the old system of state-based general agricultural extension service. Under this old system, only states employed and utilized the services of agricultural extension personnel and mainly for general advisory services to farmers. But with the demise of this

system came a new one that called for the deployment of extension personnel to specific national programs and projects.

The basic strategy for promoting the adoption of new technologies by farmers under the new system was the use of the National Accelerated Food Production Project (NAFPP) launched in 1972 and the Agricultural Development Projects (ADPs) launched in 1975 to reach farmers.

4.1.2.3. Legal Framework

The most important legal enactment that had considerable effects on Nigeria's investment climate in the 1970-85 period was the Nigerian enterprises promotion decrees of 1972 and 1977 and the Land Use Decree of 1978.

(a) *The Nigerian Enterprises Promotion Decrees*

These decrees, otherwise known as indigenization decrees, were promulgated in 1972 and 1977. The 1972 decree categorized all enterprises into two schedules. The first schedule with 28 enterprises was reserved exclusively for Nigerian investors and the second schedule with 25 enterprises kept open to joint participation by Nigerian and non-Nigerian investors, subject to a minimum of 40 percent equity participation by Nigerians.

After a review exercise, the Nigerian enterprises promotion decree of 1977 was promulgated. Under this decree, all enterprises were categorized into three schedules. Enterprises in the first schedule were reserved exclusively for Nigerians; enterprises in the second schedule were those which required a minimum of 60 percent equity participation by Nigerians, while enterprises in the third schedule were those in which Nigerian must have a minimum of 40 percent participation

(b) *The Land Use Decree*

The basic instrument of land use policy was the Land Use Decree promulgated in 1978. Under the decree:

- ownership of land was vested in the hands of state government in "trust for the people"; and,
- user rights were to be granted to people through statutory rights granted by state governors in respect of urban land, and customary rights were granted by local government councils in respect of rural land.

There was also the provision of soil survey and land evaluation facilities for the production of a comprehensive soil map of Nigeria.

4.1.2.4. Macroeconomic Policies

Major macroeconomic policies that affected the agricultural sector included fiscal, monetary and trade policies.

(a) *Fiscal Policies*

These consisted mainly of budgetary, tax, wages and incomes and debt management policies. Generally, both capital and recurrent expenditures of federal and state governments were high and increased at high rates. There were also increasing budgetary deficits in the period. Increasing revenues from petroleum export between 1973 and 1981 as well as ambitious direct investments in public-owned business enterprises were responsible for the observed trends in public expenditure and budgetary deficits. In the period, governments at all tiers invested heavily in direct agricultural and non-agricultural enterprises that were of doubtful economic viability.

The tax policies of government affecting agriculture were made up mainly of (i) accelerated depreciation allowances on agricultural capital investment to serve as an incentive to investors in the agricultural sector through a reduction in taxable income and profits and (ii) significant tax relief on incomes from new agricultural enterprises, also as an incentive to investors.

Wages and incomes policy focused on an increase in the minimum national wage as well as increases in the salaries of public-sector workers in the country. However, this policy introduced unintended distortions into the economy by exerting an inflationary pressure, widening rural-urban wage differentials and accelerating the pace of rural-urban migration. Both effects constituted disincentives to investors in the rural sector of which agriculture was the most important component. Investors in the rural sector were faced with labor shortage, higher rural wages and, hence, higher cost of production.

(b) *Monetary Policies*

Monetary policies that were of relevance to agriculture centered mainly on those designed to direct credit to the agricultural sector on concessionary terms. The policy instruments included the following.

- i. The designation of the agricultural sector as a “preferred sector” such that the Central Bank of Nigeria stipulated minimum percentages of commercial and merchant bank loans that should go to the agricultural sector.
- ii. The launching of a Rural Banking Scheme in 1977 under which designated commercial banks were required to open specified numbers of rural branches in different parts of the country and with at least 40 per cent of the total deposit in these rural banks lent to borrowers within those rural areas.
- iii. An Agricultural Credit Guarantee Scheme Fund (ACGSF) launched in 1977 to reduce the risk borne by commercial banks in extending credit to farmers. Under this scheme, the Central Bank of Nigeria guaranteed up to about 75 per cent of the value of the principal and interest on loans granted to farmers by any commercial bank up to some stipulated maximum amounts for individuals and corporate bodies.
- iv. As a matter of policy, the naira was allowed to appreciate in this period. In the period, three exchange rate systems were adopted. The fixed rate system was adopted from 1960 to 1972, the managed floating system was adopted from 1973 to 1978, while the pegged system (i.e pegged to a currency basket) was adopted from 1979 to 1985 (Iwayemi, 1995).

(c) *Trade Policies*

Nigeria's trade policies in the form of tariff, quantitative restrictions and foreign exchange regulations and their management were very important features of Nigeria's economic policies since independence. The key instruments of trade policy were:

- (i) the promotion of agricultural exports through the abolition of export duties on scheduled export crops in 1973; and,
- (ii) the abolition or reduction of import duties in respect of food, agricultural inputs, agricultural raw materials and agricultural machinery and equipment.

As at 1960, trade and payment controls were relatively moderate. But between 1966 and 1971, probably due to the national crisis created by the civil war of that period, foreign exchange controls and import licensing were introduced to an unprecedented dimension. These controls were relaxed gradually after the civil war. The oil boom of 1973-75 created corresponding increases in imports. The government undertook the importation and sale of cheap foreign grains (particularly rice and wheat flour), vegetable oils, meat products, and so on, thereby flooding the local markets with high quality imported foods at prices which were substantially lower than the unit costs of producing their local substitutes. As a result, these domestically produced substitutes were rendered uncompetitive with the cheaper imports, and their production declined drastically. An important feature of Nigeria's external trade policy in this period was the protection of the domestic manufacturing sector at the expense of the agricultural sector.

But when the rising import bill could not be sustained, a tight trade policy had to be introduced in the 1977-78 sub-period. Under that policy, many items of import were restricted. There was another period of boom that followed immediately. During the boom, all manner of imports were dumped in Nigeria. Towards the end of 1981, however, the oil market began to show signs of weakness. By April 1982, government had to resort to import controls once again. The problem of oil glut led to greater dependence on import licensing as economic policy tool to control imports and diversify the industrial base during the period 1982 – 1986. But rather than diversify, import licensing coupled with an over-valued naira combined to undermine the quest for the increased export of manufactures by unduly cheapening imports and increasing the production cost of export commodities (Mamman, 1987).

4.1.3 Structural Adjustment Period

The failure of the state led approach to development, Nigeria's dwindling fortune in the petroleum export market, a burgeoning debt burden and an unhealthy investment climate led to the realization that the country's economy required some drastic restructuring. This was what gave impetus to the structural adjustment program (SAP) launched in July 1986.

A structural adjustment program comprises a mix of demand-side policies, supply-side policies and other policies designed to improve a country's international competitiveness. Generally, structural adjustment policies in Nigeria were aimed not only at correcting existing price distortions in the economy but also structural imbalances and for promoting non-price factors which would enhance the effectiveness of price factors.

Broadly, structural adjustment policies in Nigeria could be categorized into four groups. In the first group were expenditure reducing or demand-management policies, which were designed to influence the economy's aggregate domestic absorption mainly through fiscal and monetary policy instruments. The second group included expenditure switching policies that were designed to alter domestic relative prices in favour of tradable commodities and improve the price competitiveness of export commodities and import-competing goods. The most important policy instrument for this was the devaluation of the national currency. Thirdly, there were market liberalization policies that were designed to give the free interplay of market forces more roles in the economy, reduce administrative controls as well as government intervention in the operation of the economy and, generally, render the economy more flexible and more resilient. Policy instruments required for these included those aimed at reducing import and export taxes, eliminating export and import prohibitions, relaxing input and output marketing controls, withdrawal of subsidies and price controls, and so on. Fourthly, there were institutional or structural policies that were designed to eliminate those structural constraints that tended to inhibit the effectiveness of other adjustment policies. Some major structural policy instruments were those designed to promote the flow of technological innovation, provide better input delivery systems, provide more infrastructure and utilities, improve national information systems, provide institutional framework for the smooth operation of free market system and, generally, create a more favourable environment for increased investment in the economy, efficient allocation of resources and enhanced profitability of public enterprises through commercialization and privatization.

Specifically, the structural adjustment program in Nigeria had been assigned the objectives of:

- Restructuring the Nigerian economy by restructuring and diversifying the economy's production base, rationalizing consumption patterns and reducing the economy's dependence on petroleum export and commodity import;
- Expanding non-oil exports;
- Reducing the import content of locally produced goods;
- Attaining self-sufficiency in food and raw material production within the shortest time possible;
- Rationalizing the country's monetary and fiscal policies, and,
- Liberalizing the country's external trade and payments systems and adopting appropriate measures to give the private sector a larger role in the domestic economy, increase the reliance of the economy on market forces and reduce administrative control of the economy by government. Clearly, the first four objectives above depended critically on agriculture for their achievement. Hence, it might be assumed that agriculture was the cornerstone of the structural adjustment program.

As far as Nigeria was concerned, and with particular reference to the country's agricultural sector adjustment process, the economic philosophy underlying the structural adjustment program had as its key elements the principles that:

- Agriculture was essentially a private-sector business and the role of government must be largely facilitating and supportive of private-sector initiative;
- The agricultural economy should be as free of government administrative control as possible and market forces must be allowed to play a leading role in directing the economy;
- The agricultural economy should be more inward looking and self-reliant by depending more on local resources while also ensuring self-sufficiency in food production and the supply of raw materials to industries; and
- The agricultural economy should serve as a primary avenue for the diversification of exports.

4.1.3.1. Agricultural Sector Policies

Major sectoral policies for agricultural development which were in operation in the SAP period included those on agricultural research, agricultural extension and technology transfer, input pricing and subsidy, water resources and irrigation, and land development. Their key elements are outlined as follows (See Okunmadewa and Olayemi, 1999).

(a) *Agricultural Research Policies*

Agricultural research policies in Nigeria have undergone many changes over several decades. But the broad objective of policies has always been the promotion of scientific investigations into agriculture with a view to developing viable new technologies that are well adapted to Nigerian conditions.

Although there have been many changes in the number of agricultural research institutes in the National Agricultural Research System (NARS) and in their mandates, the major reforms that have progressively occurred since the 1970s concern the setting up of institutional mechanisms for the national co-ordination of agricultural research and for a stronger linkage between agricultural research, extension and farmers. In the process, there were relocations of some research institutes and changes in the supervisory ministries or agencies to which agricultural research institutes were assigned.

One relatively recent institutional change in respect of agricultural research and development in the country involves the creation of the National Agricultural Research Project (NARP) in 1991 to fund priority agricultural research, strengthen agricultural research institutions and strengthen agricultural research - extension - farmer linkage.

(b) *Agricultural Extension Policies*

Agricultural extension and technology transfer policy objective was to promote the adoption of new agricultural technologies by farmers through a nationally coordinated extension service system. The basic strategy involved the use of a unified agricultural extension system under the aegis of statewide agricultural development programs (ADPs).

An important relatively recent development in agricultural research and extension in the country involved the creation of institutional arrangements for a strong linkage between agricultural research, extension and farmers. In 1987, the National Agricultural Extension and Research Liaison Services (NAERLS) evolved through a long process of mutation to become the organ for the planning and co-ordination of agricultural extension liaison nationwide and for conducting research on technology transfer and adoption.

(c) *Agricultural Input Supply and Pricing*

A major thrust of agricultural input supply and pricing policy in recent years was the withdrawal of government from agricultural input procurement, distribution and pricing activities. In this regard, government disengaged itself from the procurement and distribution of fertilizer, petroleum products, seed and agro-chemicals through a regime of deregulation and commercialization while market forces largely determined their market prices. Most input price subsidies were also withdrawn. But government still retained its ownership of petroleum refineries and fertilizer plants.

(d) *Water Resources Development and Irrigation Policy*

The network of eleven River Basin Development Authorities (RBDAs) established in 1977 still remains the major institution for water resources development and irrigation in the country. However, the RBDAs were partially commercialized in 1992 as a result of which some of the subsidy on irrigation water supplied to farmers was removed. The move towards full commercialization was expected.

(e) *Land Development Policy*

The implementation of land development policy in the country was largely the responsibility of a National Agricultural Land Development Authority (NALDA) established in 1991. NALDA's mandate covered provision of strategic support for land development and the promotion of the optimum utilization of the nation's rural land resources. However, NALDA proved to be ineffective and was subsequently scrapped.

(f) *Community Exchange Market*

The establishment of a private-sector commodity and futures exchange market (COMEX) was first proposed in the 1995 budget to fill the vacuum created by the abolition of commodity boards. However, nothing came out of this proposal.

(g) *Other Policies*

Privatization: The policy of privatizing important public-sector enterprises has been in existence for many years, although the implementation has not been smooth. A Bureau of Public Enterprises (BPE) was established but its impact was not much felt. However, a law was proposed under the 1999 budget to give a stronger legal backing to privatization. There were also proposals to strengthen the Bureau of Public Enterprises for a more efficient implementation of privatization programs.

Employment Policy: In pursuance of its employment policy, government established a new agricultural program for youth employment to complement the existing employment-promotion activities of the National Directorate of Employment (NDE).

4.1.3.2. Macroeconomic Policies

The major macroeconomic policies consisted of fiscal, monetary and credit, and trade policies. They are briefly described as follows:

(a) *Fiscal Policies*

The objectives of fiscal policies, which consist mainly of budgetary and tax policies, were to enhance fiscal efficiency and reduce inflation through fiscal discipline and reduction of budgetary deficit. The key instruments of policy in the period under review were as follows.

1. Tight fiscal policy characterized by reductions in extra-budgetary expenditures and budgetary deficit.
2. The introduction of a value of added tax (VAT) in 1993 at the rate of 5 percent in respect of 10 categories of goods (excluding basic food items) and 23 services.
3. A reduction in personal income tax rates in 1993, with the tax band declining from 10-45 percent to 10-35 percent. There was a further reduction in 1995, with the tax band declining to 5-10 percent.

In 1987, government decreed a five-year tax-free period for profits earned by companies engaged in agricultural production and agro-processing, provided at least one percent of the equity capital of the companies was imported into Nigeria not earlier than the beginning of 1987 and also provided the companies were incorporated in Nigeria.

There was to be a tight fiscal policy which had the objectives of reducing budgetary deficits, rationalizing government expenditures and, in particular, redirecting capital expenditure and credit to high priority sectors, that is, agriculture, rural development and manufacturing.

(b) *Monetary Policy*

A largely restrictive monetary policy was to be adopted in order to reduce liquidity in the economy and, to that extent, control aggregate demand and moderate inflationary pressure. The major policy instruments were as follows:

- (i) The naira was devalued through the creation of a second-tier foreign exchange market (SFEM) and, later, the Inter-Bank Foreign Exchange Market (IFEM) where the value of the naira in terms of other currencies would be freely determined by the forces of supply and demand. The consequence of this was the drastic and sustained decline in the value of the naira. This devaluation had remarkable effects on both agricultural input and output prices, most of which increased several-fold.
- (ii) A major monetary policy instrument that was of consequence to agriculture was the deregulation of interest rates as a result of which a minimum interest rate of 8.5 percent was stipulated for time deposits while the minimum bank-lending rate was increased from 13 to 15 percent. But agricultural loans attracted interest rates of between 10 and 11 percent. All interest rates later went up considerably.
- (iii) Agricultural loan terms were liberalized such that small-scale farmers could obtain loans of up to ₦5000 without tangible collaterals. This was later increased to ₦20000.
- (iv) In 1988, the grace period for the repayment of commercial bank loans and advances to investors in long-gestation cash crop plantations was increased from 4 to 7 years while that of investors in mechanized large-scale farms was increased from 5 to 7 years.
- (v) Also in 1988, the minimum share of total deposit generated by rural banks which must be given as loans and advances in the rural localities was raised from 40 percent to 45 percent.
- (vi) The People's Bank of Nigeria was established in October 1989 to (a) provide basic credit requirements to under-privileged Nigerians in both urban and rural areas who could not normally benefit from the services of the orthodox banking system due to their inability to provide collateral security and (b) accept savings from the same group of customers and make repayment of such savings together with interest. The bank has now been merged with the new Nigerian Agriculture, Cooperative and Rural Development Bank (NACRDB).

This is confirmed by the very high coefficients of variation in the foreign net private investment, which were above 50 percent in the entire period.

The annual flow of foreign net private investment into the agricultural sector was even more unstable than for the economy as a whole. In fact, it would appear from all indications that the flow of foreign investment into the

agricultural sector was much more sensitive to the vagaries of policy and political climate than the flow into non-agricultural sectors.

There were persistently higher growth rates in cumulative foreign investment in the economy between 1981 and 1995, followed by a much lower growth rate in the 1996-2000 sub-period. A similar growth pattern was displayed by cumulative foreign investment in the agricultural sector. The degree of variability in cumulative foreign investment in both the economy as a whole and the agricultural sector was high and increasing from 1981 to 1995. But there was a degree of relative stability in both between 1996 and 2000. (vii) The program for the establishment of community banks took off in December 1990. The banks were mandated to carry out most regular banking businesses at purely local level and their role in the financial system was to provide effective banking services for the economies of the rural area as well as small enterprises in the urban centres. Community banks were to be privately owned, although the Federal Government had undertaken to provide loan funds and technical support services.

(c) *Trade Policy*

Policy instruments in this category were those that involved trade liberalization, import substitution, the local sourcing of raw material, and tariff structure adjustments designed to encourage local production and protect local industries from undue international competition and dumping. Highlights of trade policy instruments were as follows:

- (i) Trade liberalization measures, the key elements of which were the abolition of commodity marketing boards, abolition of many import levies, reduction of some excise and export duties, reduction of the number of prohibited import items and a reduction from 100 percent to 25 percent in the advance payment of import duties required at the time of opening letters of credit.
- (ii) Export promotion of non-oil goods, including agricultural commodities, by allowing exporters to keep all their foreign exchange earnings in a domiciliary account from which they could freely draw for their foreign exchange transactions. Furthermore, export financing by commercial banks was facilitated through Central Bank discounting facilities.
- (iii) Import substitution measures, which involved the selective use of import regulations to restrict or ban the importation of many types of food and industrial raw materials in order to encourage their local production and, hence, promote self-sufficiency in domestic food production and the local sourcing of agro-industrial raw materials. Specifically banned were rice, maize, wheat, barley and vegetable oils. In addition, landing charges of equivalent values to the excise duties payable on a number of locally produced goods were imposed on their imported substitutes in order to enhance the price competitiveness of the local goods.

4.1.3.3. Institutional Policies

- (i) In pursuance of the objective of giving market forces more influence and the private sector a greater role in the economy, most enterprises owned by government and parastatals were to be either privatized or commercialized.
- (ii) There was a reorganization of the River Basin Development Authorities in 1986 as a result of which their functions were strictly restricted to land development and water resources management and development, including the provision of irrigation facilities.
- (iii) The National Directorate of Employment (NDE) was established in 1986 to promote employment programs all over the country as a strategy for ameliorating Nigeria's increasingly severe unemployment problem. The Directorate oversees various special school leavers and agricultural graduate programs now in operation in all states of the federation.
- (iv) A National Agricultural Insurance Company was established in 1987 to operate and administer the Nigerian Agricultural Insurance Scheme. The idea of the scheme was first mooted in 1984 as a strategy for tackling the problem of small farmers' inability to satisfy the collateral requirements of banks when asking for loans. It was then argued that an insurance scheme would serve a number of complementary purposes - It would enhance the confidence of commercial banks in giving loans to small farmers; the insurance certificate would serve as a collateral, and funds mobilized from the insurance scheme would be utilized for agricultural investment.

4.2 Constraints to Effectiveness of Past Agricultural Policy

4.2.1 Policy Instability

One of the major constraints to agricultural policy effectiveness was that of policy instability. Over the years, the rate of turnover in agricultural policies had been high, with many policies formulated and scrapped in rapid succession. Again, this problem could be partly ascribed to political instability, as every successive military government tended to jettison most of its predecessor's policies and programs in the erroneous belief that a new government could only justify its existence or make its mark by adopting entirely new policies and programs.

4.2.2 Inconsistency in Policies

It had been observed that some agricultural policies and programs of government tended to be mutually antagonistic rather than being mutually complementary and reinforcing. A popular example was the conflict, which existed between government's domestic food production policy and its cheap food import policy. The latter was so antagonistic of the former that it (the former) was rendered ineffective. One fundamental factor that made policy inconsistency so common was the failure of policy makers to adopt a *systems approach* to policy formulation. In a system approach, the entire spectrum of agricultural and rural development problems would be viewed globally and consistent, mutually reinforcing policies would be addressed to them. But as each problem was viewed in isolation of others and policy was addressed to each problem in isolation, the probability of inconsistency among policies could not but be high.

4.2.3 Narrow Base of Policy Formulation

The base of the agricultural policy formulation process in Nigeria had, in the past, been rather narrow as the level of involvement of the people and their institutions in the formulation of policies that affected their lives was minimal. In the circumstance, these policies tended to lack grassroots support and the popular mobilization required for their success.

4.2.4 Poor Implementation of Policies

There was a tendency to regard the formulation of policies as ends in themselves, rather than being means to desired ends. As such, little attention was paid to the efficient implementation of policies. Bureaucrats and policy implementers tended to lose sight of the fundamental objectives of policies. Instead, they tended to focus on superficial issues. Poor managerial capacity, bureaucratic bottleneck, corruption and high rates of policy turnover tended to complicate the problem of policy implementation.

4.2.5 Weak Institutional Framework for Policy Coordination

Inadequate institutional arrangements for policy and program coordination had often led to a duplication of effort and general inefficiency in resource use among agencies and ministries of the same government, between federal and state agencies and between states. Inadequate monitoring and evaluation arrangements for policy implementation had also led to situations in which policies and programs tended to lose sight of their focus and original goals without corrective measures being taken.

4.3 The New Nigerian Agricultural Policy

The previous agricultural policy document was finalized in 1988 and was supposed to remain operative until the year 2000. Hence, in year 2001, a new policy document was launched. The new policy document bears most of the features of the old one, but with more focused direction and better articulation.

4.3.1 Objectives of New Agricultural Policy

In a broad sense, the objectives of the new agricultural policy (as stated in the document) are very similar to those of the old one. They include:

- (i) The achievement of self-sufficiency in basic food supply and the attainment of food security;
- (ii) Increased production of agricultural raw materials for industries;
- (iii) Increased production and processing of export crops, using improved production and processing technologies;
- (iv) Generating gainful employment;
- (v) Rational utilization of agricultural resources, improved protection of agricultural land resources from drought, desert encroachment, soil erosion and flood, and the general preservation of the environment for the sustainability of agricultural production;
- (vi) Promotion of the increased application of modern technology to agricultural production; and,

(vii) Improvement in the quality of life of rural dwellers.

A synopsis of the new agricultural policy is presented in Appendix 4.1.

4.3.2 Key Features of the New Policy

The key features of the new policy are as follows:

- Evolution of strategies that will ensure self-sufficiency and improvement in the level of technical and economic efficiency in food production. This is to be achieved through (i) the introduction and adoption of improved seeds and seed stock, (ii) adoption of improved husbandry and appropriate machinery and equipment, (iii) efficient utilization of resources, (iv) encouragement of ecological specialization, and (v) recognition of the roles and potentials of small-scale farmers as the major producers of food in the country.
- Reduction of risks and uncertainties in agriculture, to be achieved through the introduction of a more comprehensive agricultural insurance scheme to reduce the natural hazard factor militating against agricultural production and security of investment.
- A nationwide, unified and all-inclusive extension delivery system under the Agricultural Development Programs (ADPs).
- Active promotion of agro-allied industry to strengthen the linkage effect of agriculture on the economy.
- Provision of such facilities and incentives as rural infrastructure, rural banking, primary health care, cottage industries etc, to encourage agricultural and rural development and attract youths (including school leavers) to go back to the land.

4.3.3 Major Content of the Policy Framework

The policies cover issues on (i) agricultural resources (land, labor, capital, seeds, fertilizer, etc) whose supply and prices affect the profitability of agricultural business, (ii) crops, livestock, fisheries and agro-forestry production, (iii) pest control, (iv) mechanization, (v) water resources and irrigation, (vi) rural infrastructure, (vii) agricultural extension and technology transfer, (viii) research and development (R&D), (ix) agricultural commodity storage, processing and marketing, (x) credit supply, (xi) insurance, (xii) agricultural cooperatives, (xiii) training and manpower development, and (xiv) agricultural statistics and information management (see Appendix 4.1).

The successful implementation of the agricultural policy is, however, contingent upon the existence of appropriate macroeconomic policies that provide the enabling environment for agriculture to grow in equilibrium with other sectors. They affect profitability of agricultural enterprises and the welfare of farmers through their effects on the flow of credit and investment funds, taxes, tariffs, subsidies, budgetary allocation, etc.

4.3.4 The New Policy Direction

According to the document, the new agricultural policy will herald in a new policy direction via new policy strategies that will lay the foundation for sustained improvement in agricultural productivity and output. The new strategies involve:

- (i) Creating a more conducive macro-environment to stimulate greater private sector investment in agriculture;
- (ii) Rationalizing the roles of the tiers of government and the private sector in their promotional and supportive efforts to stimulate agricultural growth;
- (iii) Reorganizing the institutional framework for government intervention in the agricultural sector to facilitate the smooth and integrated development of the sector;
- (iv) Articulating and implementing integrated rural development programs to raise the quality of life of the rural people;
- (v) Increasing budgetary allocation and other fiscal incentives to agriculture and promoting the necessary developmental, supportive and service-oriented activities to enhance agricultural productivity, production and market opportunities; and
- (vi) Rectifying import tariff anomalies in respect of agricultural products and promoting the increased use of agricultural machinery and inputs through favourable tariff policy.

4.3.5 Roles and Responsibilities of Stakeholders

The new agricultural policy has spelt out definitive roles and responsibilities for the federal, state and local governments as well as the private sector in order to remove role duplication and overlapping functions among them. The revised roles and responsibilities are outlined as follows

4.3.5.1. The Federal Government

Under the new policy regime, the Federal Government shall be responsible for: (i) the provision of a general policy framework, including macroeconomic policies for agricultural and rural development and for the guidance of all stakeholders; (ii) maintenance of a reasonable flow of resources into agriculture and the rural economy; (iii) support for rural infrastructure development in collaboration with state and local governments; (iv) research and development of appropriate technology for agriculture, including biotechnology; (v) seed industry development, seed law enforcement and seed quality control; (vi) support for input supply and distribution, including seeds, seedlings, brood stock and fingerlings; (vii) continued support for agricultural extension services; (viii) management of impounded water, supervision of large dams and irrigation canals and maintenance of pumping facilities; (ix) control of pests and diseases of national and international significance and the promotion of integrated disease and pest management; (x) establishment and maintenance of virile national and international animal and plant quarantine services; (xi) maintenance of favourable tariff regime for agricultural commodities; (xii) promotion of the export of agricultural commodities through, among others, the Export Processing Zones (EPZs); (xiii) establishment of an agricultural insurance scheme; (xiv) maintenance of a Strategic National Grain Reserve for national food security; (xv) coordination of agricultural data and information management systems; (xvi) inventorization of land resources and control of land use and land degradation; (xvii) training and manpower development; (xviii) participation in the mapping and development of interstate cattle and grazing routes and watering points; (xix) promotion of micro- and rural credit institutions; (xx) promotion of agricultural commodity development and marketing institutions; (xxi) maintenance of fishing terminals and other fisheries infrastructure, including cold rooms; (xxii) promotion of trawling, artisanal and aquaculture fisheries; (xxiii) promotion of fish feed production; (xxiv) protection of Nigeria's Exclusive Economic Zone for fisheries resources; and (xxv) periodic review of agreements on international agricultural trade.

4.3.5.2. The State Governments

The state governments will be primarily responsible for:

(i) the promotion of the primary production of all agricultural commodities through the provision of a virile and effective extension service; (ii) promotion of the production of inputs for crops, livestock, fish and forestry; (iii) ensuring access to land for all those wishing to engage in farming; (iv) development and management of irrigation facilities and dams; (v) grazing reserve development and creation of water access for livestock; (vi) training and manpower development; (vii) control of plant and animal pests and diseases; (viii) promotion of appropriate institutions for administering credit to smallholder farmers; (ix) maintenance of buffer stocks of agricultural commodities; (x) investment in rural infrastructure, including rural roads and water supply in collaboration with federal and local governments; and, (xi) ownership, management and control of forest estates held in trust for local communities.

4.3.5.3. Local Governments

The local governments will be expected to take over progressively the responsibilities of state governments with respect to: (i) the provision of effective extension service; (ii) provision of rural infrastructure to complement federal and state governments' efforts; (iii) management of irrigation areas of dams; (iv) mobilization of farmers for accelerated agricultural and rural development through cooperative organizations, local institutions and communities; (v) provision of land for new entrants into farming in accordance with the provision of the Land Use Act; and, (vi) coordination of data collection at primary levels.

4.3.5.4. The Private Sector

According to the policy document, since agricultural production, processing, storage and marketing are essentially private sector activities; the role of the private sector will be to take advantage of the improved enabling environment provided by the public sector for profitable agricultural investment. In particular, the public sector is expected to play a leading role with respect to: (i) investment in all aspects of upstream and downstream agricultural enterprises and agribusinesses, including agricultural commodity storage, processing and marketing; (ii) agricultural input supply and distribution; (iii) the production of commercial seeds, seedlings, brood stock and fingerlings under government certification and quality control; (iv) agricultural mechanization; (v) provision of enterprise-specific rural infrastructure; and, (vi) support for research in all aspects of agriculture.

4.4 Key Agricultural Development, Supportive and Service Delivery Programs of the Federal Government

Following the redefined roles and responsibilities of tiers of government and the private sector, the main thrust of federal government programs and activities will be directed at obviating the technical and structural problems of agriculture in the following respects.

4.4.1. Development Programs and Activities

These will include research and development, (including biotechnology development), animal vaccine production, veterinary drug manufacture, agro-chemicals manufacture, water management, adaptive technology promotion, and the creation and operation of an Agricultural Development Fund.

- (a) *Research and development, including biotechnology:* The effort in this direction is to finance agricultural research, including biotechnology and the breeding of predators for the biological control of crop pests which the private sector may not be willing to invest in due to the high capital outlay and a relatively low return from agricultural investments. The output of the research system will be disseminated by the extension services of the states and local governments to farmers, ranging from small-scale to large-scale farmers.
- (b) *Animal vaccine production:* The capacity of the National Veterinary Research Institute (NVRI), which is the premier institution for animal vaccine production in the West Africa sub-region, will be strengthened, enlarged and modernized in order to raise the level of vaccine production in Nigeria to a self-sufficiency level and also to cater for the entire West Africa sub-region.
- (c) *Veterinary drug manufacture:* A veterinary drug manufacturing outfit with the capacity to meet the needs of the West Africa sub-region will be established. Relevant agencies of government will collaborate with the private sector for the accelerated take off of the factory. Government interests in this venture will, however, be sold to the private sector in line with the privatization policy.
- (d) *Agro-chemicals manufacture:* Government will manufacture and promote the production of agro-chemicals by the private sector and will ensure the protection of the users, the eco-system and the environment through appropriate pesticide legislation. Effective monitoring mechanism to ensure compliance with the law will be put in place.
- (e) *Water management:* Currently, large dams constructed in the country have impounded a lot of water with high fisheries and duck farming potentials and having the capacity for irrigation. The completion of the outstanding downstream irrigation infrastructure of the already completed large dams in the country will be accorded top priority in order to make them useful to the farmers and to maximize the benefits of the huge investments already incurred in constructing them.

Emphasis will now shift to developing small dams as a more cost effective way of utilizing water resources for irrigation in the country. The maintenance of the existing large dams will, however, continue to be the responsibility of the Federal Government. In addition, rain harvesting for irrigation agriculture is to be promoted where surface and underground water is not readily available.

- (f) *Adaptive technology:* Economic deregulation has increased agricultural production costs astronomically. At the same time, globalization of trade, which thrives on comparative advantage in production, makes efficiency of production and the application of economies of scale mandatory if Nigeria is to get a sizeable market share in the highly competitive global trade arena. In order to improve efficiency of production, therefore, simple labor - and cost-saving devices that are appropriate for the current level of agricultural production and processing in the country will be developed and mass-produced. The National Centre for Agricultural Mechanisation (NCAM), the institution established for this purpose, will be strengthened. Other initiatives in this direction, such as animal traction and hand tools technology development, will be encouraged.
- (g) *Agricultural Development Fund:* The National Agricultural Development Fund is to provide the necessary impetus for the sustainable development of the agricultural sector. It will support both public and private sectors in carrying out activities that will boost agricultural and rural development, with emphasis on all facets of agricultural research, market development, extension delivery, long-term credit, rural institutions development, and enterprise promotion. The Fund will derive its revenues from: (i) savings from subsidy withdrawals on fertilizer, (ii) 5 percent of the proceeds from the privatization of government enterprises, (iii) funds from international commodity organisations, (iv) 2 percent levy on the profits of agro-based industries, (v) 50 percent of Sugar Development Levy, (vi) 1.0 percent levy on the profits of oil companies,

(vii) appropriation from government annual budget of not less than 2 percent of the total budget, and (viii) take-off grant from the federal government.

4.4.2. Supportive Activities

These will comprise input incentive support and commodity marketing and export activities.

- a) *Input incentive support:* Government incentive support for inputs will be administered in a cost-effective and focused manner to ensure that the intended beneficiaries derive full benefit from the distribution of: (i) seeds, seedlings, fingerlings, brood stock etc, (ii) fertilizers, (iii) agro-chemicals, (iv) tractors and implements, (v) vaccines (vi) veterinary drugs, and (vii) agricultural credit. State and local governments are also to be encouraged to subsidize these inputs, as an additional incentive for agriculture.
- b) *Commodity marketing and export:* The development of an efficient agricultural marketing system is being promoted through the provision of adequate market information. The buyer of last resort mechanism built into the marketing system will provide price stabilization effect on the system. The three multi-commodity marketing companies already approved by government will be the fulcrum of this system. The companies which will be private sector-led and managed, but with initial substantial public sector participation, will also ensure quality management and export promotion, in conformity with international quality standards for Nigeria's agricultural commodities.

4.4.3. Service Delivery Activities

These activities will cover input supply and distribution, agricultural extension, micro-credit delivery, cooperatives and farmer/commodity associations, commodity processing and storage, agro-allied industry and rural enterprise development, and export promotion of agricultural and agro-industrial products.

- (a) *Input supply and distribution:* Government is creating the more conducive environment for profitable investments in the production and distribution of inputs such as improved starter materials, animal health drugs, fertilizers, etc. Fertilizer supply will be hinged on complete privatization and liberalization in the production, distribution and marketing of the commodity. The main role of the government will be to strictly monitor the quality standard of all fertilizers (both local and foreign) to ensure that only certified products reach the farmer. Government will also encourage the use of organic fertilizers to complement the inorganic fertilizers currently in use. The seed industry development program will be reinvigorated and community seed development programs will be promoted to ensure the provision of adequate and good quality seeds to local farmers. The organised private sector will be mobilized, encouraged and given incentives to actively participate in the production of seeds, seedlings, broodstock, fingerlings, etc, and also to be involved in out-growers mobilization.
- (b) *Agricultural extension:* Agricultural extension is essentially an activity that should be carried out by the lower tiers of government. But given the overriding importance of technology dissemination, all the three tiers of government in Nigeria will be involved in jointly financing agricultural extension delivery and monitoring its impact. Also, extension service delivery will be streamlined through the integration of ADP and state extension services for greater effectiveness.
- (c) *Credit and micro-credit delivery:* The strategies to be adopted will include: (i) provision and improvement of rural infrastructure to attract investment and financial services; (ii) integration and linkage of rural financial institutions to the formal banking sector; (iii) regulating and supervising the growth of non-bank financial institutions with emphasis on savings mobilization at the grassroots; (iv) expanding the mandate of the restructured Nigerian Agricultural Cooperative and Rural Development Bank (NACRDB) to include savings mobilization; (v) supporting self-help groups in their savings mobilisation and credit delivery activities; (vi) modification of the credit delivery system to include the cooperative and community-based organisations as delivery channels to reduce transaction costs; and, (vii) modification of terms of credit such as interest rate, eligibility criteria, legal requirement, etc, to enhance access.
- (d) *Cooperatives and farmer/commodity associations:* Resource mobilization and the promotion of group action are the thrust of cooperative activities. This is to take advantage of group dynamics, with its concomitant mutual guarantee, as a strategy for agricultural development. Services which cooperatives can render include the administration of government incentives to agriculture, such as inputs supply, credit

delivery and retrieval, commodity marketing, and the pursuit of democratic ideals, in view of the democratic principles embedded in their operations.

- (e) *Processing, storage, agro-allied industry and rural enterprise development:* The use of simple but effective on-farm and off-farm storage facilities and agro-processing technology will be promoted to add value to products and increase their shelf life. The Strategic Grain Reserve Scheme will be modernized, strengthened and upgraded to a National Food Reserve Program, which will enable it to handle all staples and essential food products. This will be the launch pad for the accelerated attainment of Nigeria's national food security goal. The Buffer Stock Food Storage Scheme of the states will incorporate the use of private storage facilities to maintain a national strategic stock of food that will be needed in times of national food emergencies. It is also crucial to promote and develop agro-processing in the country for the evolution of virile agro-allied industries and rural micro-enterprises.
- (f) *Export promotion of agricultural and agro-industrial products:* Nigeria has comparative advantage in the production of a number of exportable agricultural commodities, such as cocoa, palm produce, rubber, ginger, spices, fruits and vegetables, flowers, shrimps and ornamental fish, cassava products, hides and skin, cashew, gum arabic, groundnuts and cotton (products). In order to diversify the base of the Nigerian economy and widen the market for agricultural commodities to absorb the expected increase in production, there is need to promote the export of these agricultural and agro-industrial products. To facilitate the acceptance of Nigerian agricultural commodities in the international market, including taking full advantage of the US African Growth and Opportunity Act (AGOA), there will be need to develop appropriate capacities and institutional framework within the agricultural sector as well as in other relevant sectors to meet the Sanitary and Phytosanitary Standards (SPS) and comply with the Technical Barriers to Trade (TBT) agreements of the World Trade Organisation (WTO).

4.5 Other Policies, Institutions and Legal Framework

The range of macroeconomic and institutional policies as well as legal framework that affect agricultural investment in particular and agricultural performance in general is wide. The policies broadly cover fiscal, monetary and trade measures. There is also a large body of institutional policies that support not only the implementation of macroeconomic policies but also that of agricultural sector policies. Then, there is a set of national and international legal framework, including bilateral and multilateral agreements and treaties that provide the enabling environment for foreign and domestic private investment, promote international trade and, therefore, promote economic growth. A summary of the major macroeconomic policies, institutions and legal enactments which are expected to impact significantly on foreign and domestic investment decisions is presented in Appendix 3.1 for reference.

Environmental concern has increasingly come into focus in the design of policies for sustainable growth and development in Nigeria, as elsewhere in the world. Hence, Nigeria has now put together a set of environmental policies and strategies that are of important relevance to agriculture. These are also summarised in Appendix 3.2.

4.5.1. Macroeconomic Policies

As summarized in the appendix, the key components of macroeconomic policies are fiscal, monetary and trade policies.

Fiscal Policies: These focus on budgetary, tax and debt management policy instruments. Budgetary policy influences economic stability and rate of inflation in the economy. These, in turn, influence the climate for the flow of investment, especially foreign private investment. Tax policies that focus on personal and corporate tax rates, tax reliefs, and other tax concessions are key incentives (or disincentives) factors affecting consumption and investment decisions. A favourable corporate tax policy regime enhances after-tax profits and, to that extent, may promote increased investment. A country's external debt burden affects its international credit rating and its capacity to finance public investment. International credit rating affects the flow of foreign private investment while the level and quality of public investment directly affect the flow of both foreign and domestic private investment.

Monetary Policies: In general, monetary policies refer to the combination of measures designed to regulate the value, supply and cost of money in the economy, in consonance with the expected level of economic activity. Liquidity, interest rates and foreign exchange rates are the channels through which monetary policy influences

economic activities. Liquidity is affected by money supply. Money supply influences credit supply and interest rate (cost of capital). Interest rate, in turn, influences consumption, savings and investment decisions in the economy. Basically, the existence of interest and exchange rate differentials, resulting from monetary policy measures, induces substitution between domestic and foreign assets (foreign currencies, bonds, securities real estate, etc) as well as domestic and foreign goods and services (CBN, 1997). Since 1986, the main instruments of market-based monetary policies have included the open market operations (OMO), changes in reserve requirements and discount policy. Open market operations involve the discretionary power of the CBN to purchase or sell securities in the financial markets in order to influence the volume of liquidity and levels of interest rates that ultimately affect money supply. The sale of financial instruments by the CBN restricts the capacity of banks to extend credit, thereby affecting inflation and interest rates. The reverse is the case when financial instruments are purchased.

Trade Policies: These are a very important component of structural adjustment policies. The main focus of trade policies is on measures to regulate export and import trade through such measures as tariffs, export and import quotas and prohibitions. They influence the investment climate in many ways. For example, a liberal trade policy constitutes an incentive for foreign investors who may need to import raw materials and / or export products. But a protectionist trade policy may also serve as an incentive for investors in non-tradable products that are largely locally consumed, or investors in import-substitute products.

4.5.2. Institutions

According to the World Development Report (2002), institutions are rules, enforcement mechanisms and organizations put in place in an economy. Distinct from policies that are the goals and the desired results, institutions are rules, including behavioural norms, by which agents interact, and the organizations that implement these rules and codes of conduct to achieve desired outcomes. Policies influence the types of institutions that evolve while institutions too affect the types of policies that are adopted. Appendix 4.1 presents some of the major institutions that affect or are affected by investment - related policies in Nigeria.

4.5.3. Investment Legal Framework

Investment legal framework provides incentives for, regulates or protects investments, especially foreign investment. According to Aremu (1997), a foreign investor is first concerned with some basic questions like: What areas of business are open to foreign participation? How easy is it to bring capital into the country and repatriate profits and capital from the country? What legal mechanisms exist to protect the investor's personal business interest? These questions underscore the importance of investment legal framework. Some of the important domestic investment legislations and international legal arrangements governing foreign private investment are summarized in Appendix 4.1.

4.5.4. Environmental Policies

Environmental policies are very important for sustainable growth and development. Hence, the Federal Environmental Protection Agency (FEPA) produced a revised version of the national policy on the environment in 1999. A summary of this is presented in Appendix 4.2 of the report.

The goals of National Policy on the Environment is to achieve sustainable development in Nigeria, and, in particular, to (i) secure a quality of environment adequate for good health and well being; (ii) conserve and use the environment and natural resources for the benefit of present and future generations; (iii) restore, maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of living natural resources and ecosystems; (iv) raise public awareness and promote understanding of the essential linkages between the environment, resources and development, and encourage individual and community participation in environmental improvement efforts; and (v) co-operate in good faith with other countries, international organisations and agencies to achieve optimal use of transboundary natural resources and for an effective prevention or abatement of transboundary environmental degradation.

The strategies to be adopted include: (i) addressing the issues of population growth and resources consumption in an integrated way; (ii) setting goals for the stabilization of national population at a sustainable level; (iii) integrating resource consumption and demographic goals with the other sectors and economic objectives; (iv) monitoring trends in population and resource consumption and assessing their implications for sustainability; (v) encouraging and involving the private sectors, NGOs and the public in the implementation of strategies and actions aimed at

achieving stated goals; (vi) the prevention and management of natural disasters such as flood, drought and desertification that more directly impact on the lives of the populace; (vii) integration of population and environmental factors in national development planning; (viii) solving public health problems associated with rapid urbanisation and squalid urban environments; (ix) prevention of the depletion of forests through judicious search for and adoption of alternative energy sources; and (x) control of the demands and patterns of land resources usage.

An extract of the environmental policy presented in the appendix covers policies, objectives of policies and policy strategies on human population, biological diversity, natural resources conservation, land use and soil conservation, water resources, forestry, wildlife and protected natural areas, energy, environmental health, transportation, communication, and science and technology. These are the policy instruments that are considered most relevant to agricultural investment in Nigeria.

4.6 Stakeholders' Perspective on the Effectiveness of Policies, Regulations and Institutions on Nigerian's Agriculture

Opinions on the effectiveness of policies and regulations in the different areas of agriculture were sought from both policy makers and policy implementers. The result is as presented in Table 4.1. In general, policies aimed at stimulating on-farm production rank highest. These include those policies aimed at stimulating agricultural production for domestic market, agricultural input demand by farmers, domestic agricultural commodity trade, agricultural input supply to farmers and domestic investment in agriculture. It is evident from the ranking that the more effective policies and regulations are those targeted to upstream agricultural production activities and geared towards the domestic market. Policies geared towards enhanced post-production activities such as commodity storage, commodity processing, transportation and distribution services as well as commercialization of agriculture are generally ranked low. Except for policies and regulations on food security and poverty reduction (which are indeed offshoot of domestic agricultural production), other policies and regulations associated with improved human welfare ranked very low. But overall, policies on foreign investment ranked lowest.

From the foregoing, it can be seen that current policies are more effective in the primary production subsector of agriculture than in the downstream subsector. Impact of policies on the welfare status of the people and on the environment remains weak. In general, the thrust of the effective policies is on food self-sufficiency as most of these policies have bearing on boosting agricultural production for food self-sufficiency.

The main factors influencing the effectiveness of policies and regulations on agriculture include high demand for agricultural produce, availability of improved technology, efficient dissemination of information by the ADPs, and value added leading to improved income. On the other hand, the common factors responsible for ineffectiveness of policies and regulations, especially on the downstream segment of agriculture, include instability of the political climate, insecurity of investment, nonstandardised product quality, non-competitive nature of agricultural products from the country in the export market due to high cost of production and lack of adequate processing facilities.

Table 4.1: Effectiveness of Policies, Regulations and Institutions on Nigeria Agriculture

Policies/Regulations on	Rank	Position
Agricultural input supply to farmers	2.83	4
Agricultural input demand by farmers	2.17	2
Foreign investment in agriculture	8.83	20
Domestic investment in agriculture	4.00	5
Commercialization of agriculture	6.17	14
Agricultural production for domestic market	1.83	1
Agricultural production for export market	5.33	8
Agricultural commodity storage	7.17	18
Agricultural commodity processing	6.17	15
Agricultural commodity transport, distribution and information	6.50	16
Domestic agricultural commodity trade	2.67	3

Agricultural commodity export	5.83	11
Agricultural commodity utilization	5.50	9
Agricultural research and technology development	4.33	7
Agricultural technology adoption	4.00	5
Food security	5.50	9
Poverty reduction	5.83	11
Closing gender gap	6.00	13
Protection/welfare of vulnerable groups	6.67	17
Sustainable environmental management	7.50	19

Note: The lower the value, the better

Source: Field Survey, February/March 2003

CHAPTER FIVE

ASSESSMENT OF INVESTMENT IN NIGERIA'S AGRICULTURE

5.1 Past Investment Trends in Nigeria's Economy

At the end of 1960, gross fixed capital formation (GFCF) in Nigeria stood at ₦258.2 million of which the private sector accounted for about 52 percent. By 1963, the GFCF had risen to ₦354 million with the private sector accounting for about 64 percent. The GFCF rose further to ₦485.2 million in 1966 with the share of the private sector being about 63 percent. The civil war disrupted the economy between 1966 and 1970. Nevertheless, the private sector still accounted for about 60 percent of the GFCF in 1970 (Iwayemi, 1995; Jerome, 2000).

The rising oil prices and revenues of the 1970s created a public-sector-led investment boom and altered the share of the total investment in favour of the public sector. Nominal gross domestic investment increased at an average rate of about 56 percent per annum between 1970 and 1975, but increased at a drastically reduced rate of only about 7 percent per annum between 1976 and 1980, and actually declined in absolute terms by about 13 percent per annum between 1981 and 1985. By 1974, the public sector was already accounting for more than 50 percent of total gross fixed investment in the economy, up from about 40 percent in 1970. Public-sector share continued to increase until it reached 75 percent by 1985. But most of public-sector investments were in large-scale commercial enterprises like fertilizer, iron and steel, aluminium and liquefied natural gas plants, virtually all of which eventually failed. There were also considerable investments in buildings and construction works in the period that were not properly maintained (see Iwayemi, 1995; Jerome, 2000).

Normally, public investment is supposed to complement private investment by providing the enabling environment for a growing private investment. However, this complementarity is based on the assumption that public investment is in such supporting facilities as infrastructure, utilities, research and development, social and human capital, and so on. But in the period under review, public investment was in commercial ventures and public-sector enterprises were competitive rather than complementary to private-sector commercial initiatives, according to Iwayemi (1995); Jerome (2000). Hence, public sector investment became a disincentive rather than an incentive to private sector investment. Worse still, most of the public-sector enterprises were very badly managed, with rampant corruption, mismanagement and inefficiency. On top of these were other factors that made Nigeria a hostile environment for foreign investments, factors like political and economic instability, policy discontinuity and inconsistency, negative international image, and so on.

Given, therefore, the generally unfavourable private investment climate in the country in the period, both domestic and foreign investment flow suffered a declining trend. Gross domestic investment in Nigeria that increased at a very annual rate between 1970 and 1975, increased at a much lower annual rate between 1975 and 1980, and then declined in absolute terms between 1980 and 1985. Foreign capital inflow into Nigeria followed a similar deteriorating trend, accompanied by high annual fluctuations. For example, net long-term capital inflow increased modestly between 1970 and 1975, with some fluctuations, then suddenly became negative in 1976 (representing a net capital outflow), only to increase again from 1977 to 1979. There was a net capital outflow in 1980, followed by increasing inflows from 1981 to 1983, and then followed by net outflows again in 1984 and 1985. Generally, the rate of capital flight was high.

Net direct foreign investment flow into the country followed a high fluctuating trend, rising between 1970 and 1975, generally on the decline from 1976 to 1980, becoming negative in 1980 and then becoming erratic from 1981 to 1985. Overall, gross investment in the Nigerian economy expressed as a percentage of gross domestic product summarizes the investment trends and patterns outlined above. In this regard, a declining percentage was evident over the 1970-85 period. From 16.88 percent in 1970, gross investment rose to 26.00 percent of gross domestic product in 1975 but declined to 23.97 percent in 1980 and then to 11.72 percent in 1985.

It is noteworthy that the fluctuating movements in both domestic and foreign investment were highly correlated with the changing states of political and policy instability in the country. For example, there

was relative political and economic stability between 1970 and 1974 after which there was another military coup in 1975. There was a state of uncertainty from 1976 to 1979, especially in view of the tightened indigenization decree of 1977 and other restrictive economic policies. The civilian rule era of 1979 - 83 should normally have been expected to generate more confidence in the country's economy and enhance the investment climate; but, unfortunately, there was an economic crisis in the country from about 1980, brought about by the crash in international oil prices and the decline in the country's revenues from oil. It should also be mentioned here that, poor as the aggregate investment record in Nigeria was in this period, investment in the non-oil sectors recorded a still much poorer performance and the agricultural sector recorded about the worst performance, as will be evident in the next section of this chapter.

5.2 Levels and Trends of Investment in Nigeria's Agriculture

5.2.1 Evidence from Literature (Secondary Data)

Two broad categories of investment in agriculture can be identified. They are the local and foreign sources. The local sources include public and private investment while the foreign sources include multilateral, bilateral and private investment. Generally, available data on investment in Nigeria's agriculture are very scanty and data on domestic investment are still much more scanty than those on foreign investment. The little data that have been collected in this study are analyzed and the results summarized as follows:

5.2.1.1. Levels of Investment

(a) *Domestic Public Investment*

In the absence of better quality data, the total capital expenditure of federal, state and local governments in Nigeria is used as a proxy for domestic public investment. The summary data available from 1996 to 2000 are presented in Table 5.1.

Table 5.1: Real Domestic Public Investment (₦ million)

Year	Federal Government	State Governments	Local Governments	Total
1996	8,071.2	1,105.4	229.2	9,405.8
1997	935.8	1,142.6	295.3	10,673.7
1998	9,812.6	2,021.1	631.6	12,465.3
1999	15,053.0	1,826.5	566.6	17,446.1
2000	6,998.6	4,644.2	1,608.7	13,251.5

Sources: CBN (2000). Statistical Bulletin, Vol. 11, No. 2

CBN (2001), Annual Report and Statement of Account.

The figures are in real terms because the nominal values have been deflated by the consumer price index. The table indicates that the federal government accounted for a very high share of domestic public investment. The share stood at about 86 percent in 1996, 1997 and 1999; it was 79 percent in 1998 and a relatively low 53 percent in 2000. On the other hand, the local governments accounted for the lowest share, ranging from about 2.4 percent in 1996 to 12.1 percent in 2000.

Furthermore, the table shows that total real domestic public investment increased progressively by 13.5 percent, 16.8 percent, and 40.0 percent respectively between 1996 and 1997, between 1997 and 1998, and between 1998 and 1999. But between 1999 and 2000, there was a decline of about 24 percent, due to a sharp drop of about 53 percent in federal government's investment. Overall, real domestic public investment increased at a healthy rate of 11.6 percent per annum between 1996 and 2000.

(b) *Real Gross Domestic Investment*

This is measured as real gross fixed capital formation (GFCF) that is the total capital expenditure on fixed assets, either for replacing or adding to the stock of existing fixed assets. It is in real value in that it is measured at a constant 1984 purchasers value. It is a proxy for gross domestic investment. The information is summarized in Appendix 5.2. As shown in Appendix 5.2, average total gross fixed

capital formation declined from a peak in the 1981-85 sub-period to a low point in the 1986-90 period, and then increased modestly in both 1991-95 and 1996-2000 sub-periods. This cannot be regarded as a good performance, more so as further analysis showed that gross fixed capital formation's share of gross domestic product declined consistently over the entire 1981-2000 period, from about 15 percent of real GDP in the 1981-85 sub-period to 9.7 percent in 1986-90, to 8.4 percent in 1991-95 and to 6.3 percent in 1996-2000. This consistent decline implies that consistently lower shares of real GDP were going into domestic investment.

Agricultural sector GFCF followed the same pattern as the aggregate GFCF of the economy, as shown in Appendix 5.2. It is observed, however, from the table that agricultural sector's share of the aggregate GFCF increased consistently over the 1981-2000 period, from about 5 percent in the 1981-85 sub-period to about 14 percent in the 1996-2000. This implies that the agricultural sector performed better than the economy as a whole in terms of the rate of capital formation. However, the agricultural sector's share of the aggregate GFCF was very low, averaging only about 9 percent in the entire 1981-2000 period. Public expenditure on infrastructure in the agricultural sector is not known. But available information for the economy as a whole indicates that investment on infrastructure constituted a small and declining share of the total, as shown in the table. The share fell from about 20 percent in 1981-85 to 7 percent in 1986-2000.

(c) *Flow of Foreign Net Private Investment*

Net flow of foreign capital into Nigeria in the 1981-2000 period under review was characterized by increases in mean nominal values in all sub-periods for both the economy as a whole and the agricultural sector. However, in real terms (i.e. at 1985 constant prices), aggregate foreign net private investment flow into the economy declined consistently between the 1981-85 and 1991-95 sub-periods, and then increased marginally in the 1996-2000 sub-period. The reverse is the case for real foreign net private investment flow into agriculture, which increased between 1981-85 and 1991-95 and then declined in the 1996-2000 sub-period. However, agriculture's share of total foreign net private investment was generally very low, being only about 0.2 percent in the 1981-85 sub-period, but rising to 4.6 percent and 9.1 percent in the 1986-90 and 1991-95 sub-periods respectively. It then declined again in the 1996-2000 sub-period. In all, there were negative flows (i.e. capital flight from agriculture) of foreign investment into from agriculture in 1980, 1985, 1987 and 1994.

(d) *Cumulative Foreign Investment*

This represents the total stock of foreign investment, as against the annual flow discussed above. For the economy in the aggregate, the stock of foreign investment in nominal terms increased more than twenty-fold between 1981 and 2000. But in real value, it declined between 1982-85 and 1986-90, then increased in the 1991-95 sub-period, and decreased again in the 1996-2000 sub-period. It is thus evident that there were wide fluctuations in the real values of cumulative total foreign investment in the country in the period under review. The real value of cumulative foreign investment in agriculture, however, declined persistently over the entire 1981-2000 period. As a result, agricultural sector's share of the total stock of foreign investment declined persistently from about 2 percent in the 1981-85 sub-period to less than 1 percent in the 1996-2000 sub-period.

The general picture that emerges from the foregoing is that the agricultural sector did not perform well in terms of attracting foreign investment in the whole period under review. Similarly, and as observed earlier, the sector's share of total public domestic investment in the economy was also very low. It flows, therefore, that most of the investment in agriculture was made by small-scale farmers and other local private entrepreneurs who invested their own individual small savings as well as small loans obtained from relatives, friends, commercial and specialized banks, cooperative societies and money lenders in micro-enterprises in and outside the agricultural sector.

5.2.1.2. Growth and Variability in Investment

As may be observed from the above analysis, the pattern of both domestic and foreign investment in Nigeria in the period under review tended to be volatile, displaying highly variable growth rates and high degrees of fluctuation or instability. To capture these characteristics, Appendix 5.2 presents the average annual growth rates as well as the average coefficients of variation (as measures of instability) in both domestic and foreign investment in the 1981-2000 period. As shown in the table real gross fixed capital formation in the economy as a whole displayed highly variable average annual growth rates, first declining in the 1981-85 sub-period, then increasing in the 1986-90 sub-period, then

decreasing again in the 1991-95 sub-period, and then increasing in the 1996-2000 sub-period. The agricultural-sector gross fixed capital formation displayed more positive but equally unstable growth rates.

On the whole, the coefficients of variation in the real gross fixed capital formation for the economy as a whole declined from a very high level in the 1981-85 period to much more modest levels thereafter, indicating some relative stability in the post-1985 period. The agricultural-sector coefficients of variation in real gross fixed capital formation were very high in the 1981-85 and 1986-90 sub-periods, but also declined to more modest levels in the post-1990 period. It appears, therefore, that the pattern of domestic investment emerged from a highly volatile state in the 1980s and early 1990s, to a more steady state thereafter. This pattern conforms very much to progression from an unstable policy and political regime of the pre-1995 era to the more stable regime thereafter.

As shown in Appendix 5.2, the average annual growth rate for infrastructure investment was negative in the 1981-85 sub-period, but improved rapidly in both 1986-90 and 1991-95 sub-periods before coming down to a more modest rate in the 1996-2000 sub-period. The rate of growth for non-infrastructure expenditure followed a similar trend. On the whole, the degree of variability in both infrastructure and non-infrastructure expenditures was equally high in the 1981-2000 period.

The patterns of growth and variability in the total annual flow of foreign net private investment into the economy shown in the table indicate a very high growth rate in the 1981-85 sub-period, followed by a negative growth in the 1986-90 sub-period, followed by a very high growth rate in the 1991-95 sub-period, and followed by a positive but small growth rate in the 1996-2000 sub-period. On the whole, the growth pattern was highly unstable.

The conclusion that may be drawn from the foregoing is that the pattern of domestic investment in Nigeria was very unstable between 1981 and 1995, but more so for investment in agriculture than for the whole economy. There was, however, a measure of relative stability after 1995 in both aggregate and agricultural sector investment. As regards the annual flow of foreign net private investment, the degree of volatility was even higher than for domestic investment. And, again, the agricultural sector recorded a higher degree of volatility than the economy as a whole.

The pattern of investment growth and variability described above was a direct reflection of the unstable and sometimes inconsistent policy regime that prevailed in much of the 1981-95 period. It was a reflection of the generally very unstable investment climate in the country in the period. The degree of political and social instability in the country was particularly high for most of the period, creating an unduly high degree of uncertainty for investors, particularly foreign investors.

Table 5.2: Summary of Direction of Foreign and Domestic Investment Flows to Agriculture by Zone*

Type of Investment	NC	NE	NW	SE	SS	SW	ALL
Foreign private	0	0.2	0.6	0.3	0.8	0.1	0.3
Foreign public	0	-0.1	0.3	0.3	0.5	-0.1	0.2
Domestic private	0	0.4	0.3	0.6	0.4	0.4	0.4
Domestic public	-0.1	-0.2	0.3	0.5	-0.4	-0.1	0

Note: Negative (-) values imply decreasing investment; positive (+) values imply increasing investment while zero means no change in investment. Upper limit is +1 and lower limit is -1.

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

5.2.2 Evidence from Field Survey

The results of primary data analysis corroborate those of secondary data analysis. Table 5.2 shows the perception of respondents in the different zones of the country on the flow of investment into Nigeria's agriculture. It is evident that the flow of private investment (both foreign and domestic) improved more than that of public investment (both foreign and domestic). In general, domestic public investment as claimed by respondents in four zones, was declining while two zones indicated that foreign public investment was on the decline in the country. On the other hand, foreign private investment flow was perceived to be increasing in five zones, with the strongest indication given by

respondents in the south-south zone of the country. Domestic private investments were also perceived to be increasing in five of the six zones. But respondents in the north-central zone claimed that investment from different sources had either remained stagnant or had declined.

The main factors responsible for the improved flow of private investment into agriculture were improved economic climate, high returns to investment and availability of markets. On the other hand, inconsistent policies and poor infrastructure combined to constrain the inflow of private investment. Public investment was constrained by political instability, poor grassroots participation and insecurity. However, domestic public investment was positively influenced by the policies of government on food self-sufficiency and poverty eradication.

5.3 Determinants of Investment in Nigeria

5.3.1 Evidence from Literature

Extensive literature search has revealed that investment flow into the economy and a wide range of factors determines the agricultural sector within the economy. These are summarized in Appendix 5.4. The nature and direction of their effects on investment flow are also indicated.

5.3.2 Empirical Estimate of Determinants of Investment in Nigeria

As earlier proposed in chapter two of this report, this section quantitatively examines the determinants of investment in Nigeria. Two sets of equations, one for domestic private investment and the other for foreign direct investment, were experimented with. However, paucity of data did not allow for a disaggregated analysis, which could have led to the identification of key determinants of investment in agriculture as opposed to the determinants of investment in the economy in the aggregate. The discussion that follows starts with that of the stationarity of the variables used for estimation. This is followed by a discussion of cointegration tests. Finally, the results of the econometric analysis are discussed.

5.3.2.1 Stationarity Tests of the Variables Used

The stationarity test was carried out to examine the time series characteristics of the data. The order of integration, using ADF classes of unit root tests, is presented in Table 5.3. The table reveals that all the variables are not stationary at their level but they become stationary at their level of first difference. This indicates that the variables are integrated of order one $I(1)$ and any attempt to specify the equation in the level of the series will be inappropriate and may lead to the problem of spurious regression. In particular, the results of econometric analysis at the level of the series may not be suitable for policy making (Adams, 1992). Having established that the variables are of $I(1)$ series, we proceeded to test for the cointegration of the dependent variables with their arguments.

5.3.2.2 Cointegration Tests of the Dependent Variables

Cointegration or Error Correction Model (ECM) is accepted when the residuals from the linear combination of the non-stationary series $I(1)$ are themselves stationary. The acceptance of cointegration or ECM indicates that the model is best specified in the first difference of the variables. The ECM framework guarantees non-loss of information from long-term relationships in the first differences. Though, there are many test statistics that can be used, including the ADF, Sargan-Bhargava Durbin-Watson (SBDW) and Johansen test, this study used the Johansen test since it is able to appropriately determine the actual number of cointegrating vectors.

Table 5.3: Augmented Dickey Fuller (ADF) Unit Root Test for the Variables Used in Regression Analysis

Variable	ADF test statistic	No of lags	Stationary at level
DEY	-1.5178	1	NO
FDI	-0.7796	1	NO
TC	3.0776	1	NO
DSR	-1.8805	1	NO
GNI	-0.5467	1	NO
TOT	-3.0397	1	NO
IGI	1.4903	1	NO
GI	-0.9103	1	NO
RER	-2.5286	1	NO
GRT	-1.8077	1	NO
DPI	-2.2385	1	NO
95 percent ADF critical value = -3.6119			

Source: Computer printout

Table 5.4 indicates that the dependent variables actually cointegrate with their fundamentals. The number of cointegrating equations ranges from 4 to 6 for the different component of the tables. The existence of cointegration provides justification for the inclusion of ECM in the specification of the models. The test also tries to establish the existence (or lack of it) of a long run relationship between the dependent variables and their arguments. The coefficient of the ECM defines the feedback mechanism among the cointegrating variables.

Table 5.4: Cointegration Test of the Dependent Variable

Series	Eigen Value	Likelihood Ratio	5% critical value	1% critical value	Hypothesized No. of Ccs
(1)					
DPI	0.9994	416.0174	156.00	168.36	None**
DEY	0.9164	192.0394	124.24	133.57	Almost 1**
DSR	0.7597	117.5833	94.15	103.18	Almost 2**
GI	0.6217	74.8134	68.52	76.07	Almost 3*
GRT	0.5548	45.6471	47.21	54.46	Almost 4
INFR	0.3728	21.3679	29.68	35.65	Almost 5
RER	0.1958	7.3720	15.41	20.04	Almost 6
TOT	0.0275	0.8353	3.76	6.65	Almost 7

*(**) Denotes rejection of the hypothesis at 5% (1%) significance level

LR test indicates 4 cointegrating equations at 5% significance level

(2)					
DPI	0.9998	537.8984	192.89	205.95	None**
DEY	0.9856	273.6893	156.00	168.36	Almost 1**
DSR	0.7638	162.2810	124.24	133.57	Almost 2**
GI	0.7341	118.9944	94.15	103.18	Almost 3**
GRT	0.6466	79.2582	68.52	76.07	Almost 4**
INFR	0.5514	48.0558	47.21	54.46	Almost 5*
RER	0.3347	24.0096	29.68	35.65	Almost 6
TC	0.2932	11.7845	15.41	20.04	Almost 7
TOT	0.447	1.3723	3.76	6.65	Almost 8

*(**) Denotes rejection of the hypothesis at 5% (1%) significance level

LR test indicates 6 cointegrating equations at 5% significance level

(3)					
DPI	0.9999	691.0921	233.13	247.18	None**
DEY	0.9876	373.3896	192.89	205.95	Almost 1**
DSR	0.9332	241.7028	156.00	168.35	Almost 2**
GI	0.8074	160.5218	124.34	133.57	Almost 3**
GRT	0.7344	111.1058	94.15	103.18	Almost 4**
IGI	0.6140	71.3262	68.52	76.07	Almost 5*
INFR	0.4815	42.7655	47.21	54.46	Almost 6*
RER	0.3409	23.0620	29.68	35.65	Almost 7
TC	0.2902	10.5531	15.41	20.04	Almost 8
TOT	0.0090	0.2716	3.76	6.65	Almost 9

*(**) Denotes rejection of the hypothesis at 5% (1%) significance level

LR test indicates 6 cointegrating equations at 5% significance level

(4)					
FDI	0.9996	479.9426	156.00	168.36	None**
DEY	0.9796	244.9457	124.24	133.57	Almost 1**
DSR	0.8319	128.1560	94.15	103.18	Almost 2**
GI	0.6665	74.6507	68.52	76.07	Almost 3**
GRT	0.5845	41.7119	47.21	54.46	Almost 4**
INFR	0.3297	15.3615	29.68	35.65	Almost 5*
RER	0.0951	3.3620	15.41	20.04	Almost 6
TOT	0.0121	0.3646	3.76	6.65	Almost 7

*(**) Denotes rejection of the hypothesis at 5% (1%) significance level

LR test indicates 4 cointegrating equations at 5% significance level

(5)					
FDI	0.9999	628.9708	192.89	205.95	None**
DEY	0.9889	318.6205	156.00	168.36	Almost 1**
DSR	0.8779	183.6810	124.24	133.57	Almost 2**
GNI	0.8316	120.6025	94.15	103.18	Almost 3**
GRT	0.6018	67.1565	68.52	76.07	Almost 4**
IGI	0.5192	39.5329	47.21	54.46	Almost 5*
INFR	0.2752	17.563	29.68	35.65	Almost 6*
RER	0.1803	7.9083	15.41	20.04	Almost 7
TOT	0.0627	1.9420	3.76	6.65	Almost 8

*(**) Denotes rejection of the hypothesis at 5% (1%) significance level

LR test indicates 4 cointegrating equations at 5% significance level

5.3.2.3 Results and Discussions

In order to fully understand the nature of the determinants of investment in Nigeria, five equations were estimated. Of these, three were related to the domestic private investment while the remaining two were related to foreign direct investment. The three variants of domestic private investment were such that the first equation used aggregate public expenditure as one of its determinants, along with six other variables. In the second variant, another variable (total credit to the economy plus foreign reserve) was added to the variables in the first equation. The third equation split public expenditure into its components, viz. infrastructure and non-infrastructure expenditure.

In the case of foreign direct investment, the first equation used aggregate public spending as an argument, while this was split into its components (infrastructure and non-infrastructure expenditures) in the second equation. The results are presented in Tables 5.7 and 5.8. In general, the adjusted coefficient of determination ranges from 0.396 in the third equation on domestic private investment to 0.733 in the second equation for foreign direct investment. The Durbin Watson statistic does not indicate positive auto-correlation while the F statistic shows that the models generally perform well.

Table 5.5: Determinants of Domestic Private Investment

Independent variables	Domestic Private Investment (DDPI)		
	(1)	(2)	(3)
C	0.042 (0.106)	-0.099 (-0.266)	0.171 (0.400)
D(DEY)	1.421 (0.298)	0.429 (0.099)	0.367 (0.114)
D(DSR)	-2.297 (-0.408)	0.007 (0.001)	-8.369 (-1.169)
D(GL ₁)	-1.868 (-1.202)	-5.433** (-3.285)	-
D(GRT)	0.247 (0.3210)	-0.076 (-0.110)	-2.829 (1.297)
D(INFR)	-0.82** (-3.530)	-0.105** (4.65))	-0.061* (-2.337)
D(RER)	0.046 (0.100)	0.229 (0.569)	0.363 (0.595)
D(TOT)	0.027* (2.398)	0.029* (2.774)	0.015 (1.246)
D(TC)	-	3.792* (2.498)	1.327 (0.626)
D(IGL ₁)	-	-	40.310 (0.983)
D(GNL ₁)	-	-	-6.455* (-2.721)
ECM1 ₁	-0.786** (-3.626)	-	-
ECM2 ₁	-	-0.859** (-4.364)	-
ECM3 ₁	-	-	-0.733
R ²	0.583	0.678	0.612
Adjusted R ²	0.416	0.525	0.396
Durbin Watson	1.666	1.691	1.875
Log Likelihood	-53.610	-52.913	-52.564
Akaike info. Criterion	1.480	1.291	1.546
Schwarz Criterion	1.904	1.762	2.064
F-statistic	3.489	4.435	2.835
Prob (F-statistic)	0.011	0.003	0.026

Figures in parentheses are t-values

* Significant at 5%

** Significant at 1%

Table 5.6: Determinants of Foreign Direct Investment

Independent variables	Foreign Direct Investment (DFDI)	
	(1)	(2)
C	0.012 (0.799)	0.008 (0.527)
D(DEY)	-0.023 (-0.126)	-0.054 (-0.318)
D(DSR)	0.359 (1.662)	-0.106 (-0.434)
D(GL ₁)	0.068 (1.183)	-
D(GRT)	0.025 (0.773)	3.301** (3.709)
D(INFR)	0.001 (0.673)	0.002 (1.810)
D(GNL ₁)	-	-3.509** (-3.639)
D(IGL ₁)	-	3.361** (3.743)
D(RER)	0.047* (2.468)	0.018 (0.808)
D(TOT)	-0.001 (-1.285)	-0.0003 (-0.830)
ECM7 ₁	-1.098** (-4.797)	-
ECM5 ₁	-	-1.82** (-4.849)
R ²	0.787	0.819
Adjusted R ²	0.702	0.733
Durbin Watson	1.520	1.893
Log Likelihood	41.090	43.404
Akaike info. Criterion	-5.051	-5.142
Schwarz Criterion	-4.627	-4.670

F-statistic	9.271	9.548
Prob (F-statistic)	0.000	0.000

Figures in parentheses are t-values

* Significant at 5%

** Significant at 1%

Source: Regression results

In the first equation on domestic private investment, the coefficients of all the variables, with the exception of debt service ratio (DSR) and terms of trade (TOT), conform with *a priori* expectation. However, only inflation rate (INFR) and the terms of trade (TOT) have significant influence on domestic private investment. While inflation rate tends to dampen domestic private investment, the term of trade enhances it. The effect of inflation rate is that it increases the riskiness of longer-term investment projects and reduces the average maturity of commercial lending (Dornbusch and Reynoso, 1989). However, external shocks as mirrored by the TOT actually have positive effect on domestic private investments. Hence, the higher the TOT is, the higher the domestic private investment and vice versa. The coefficient of the ECM shows high rate of adjustment of short equilibrium to long run equilibrium value.

The inclusion of total credit and foreign reserve variable (TC) in equation two for domestic private investment actually improves the model. The debt service ratio (DSR), the RER and the TOT do not conform to expectations. Four variables, namely public investment (GI_{-1}), inflation rate (INFR), terms of trade (TOT) and total credit plus foreign reserves (TC) significantly influence domestic private investment. However, both public investment and inflation rate dampen domestic private investment. On the other hand, the terms of trade and the total credit positively influence domestic private investment. The negative relationship between public investment and domestic private investment can be attributed to higher fiscal deficits which may crowd out private investment through high interest rates and credit rationing, among others. The higher the flow of domestic credit into the private sector and the higher are foreign reserves, the more likely is an increase in investment in the domestic private sector as investors would have access to investible funds for their operations. The ECM parameter also indicates a high feed back mechanism.

The third equation for the domestic private investment replaces public investment with its components – investment in infrastructure and non-infrastructure goods. While investment in infrastructure positively influences domestic private investment, investment on non-infrastructure has negative influence on it. Both inflation rate and investment on non-infrastructure by the public sector have negative but significant effects on domestic private investment. The negative sign of the coefficient of non-infrastructure public investment confirms the earlier result on the crowding out of domestic private investment by public sector investment.

The first equation of the foreign direct investment shows that only real exchange rate significantly influences the inflow of foreign direct investment. This has a positive relationship, thus indicating the positive effect of a rise in foreign prices measured in domestic currency. In this instance, there will be a boost to investment in tradables relative to non-tradables. The ECM coefficient agrees with those of earlier equations.

In the second equation, which incorporates a public investment variable (in terms of infrastructure and non-infrastructure capital expenditures), four variables have significant effects on foreign direct investment. The variables are the two components of public capital expenditure, the growth rate of the economy and the inflation rate. However, inflation rate coefficient has positive sign, contrary to expectation. While public investment in infrastructure promotes foreign direct investment, investment in non-infrastructure inhibits it. The growth rate of an economy is an indicator of the performance of that economy which tends to affect the confidence of would-be investors in terms of guaranteed returns from investment. Its positive sign is a signal of potential earnings to foreign investors. The ECM value also indicates a high rate of adjustment of short-run equilibrium to long-run equilibrium values. Finally, economic instability index (DeY) and debt service ratio (DSR) do not significantly influence both domestic private and foreign direct investment in Nigeria.

CHAPTER SIX

CONSTRAINTS TO PRIVATE SECTOR INVESTMENT IN NIGERIA'S AGRICULTURE

This chapter starts with a compilation of the various constraints affecting foreign and domestic investment in Nigeria's agriculture. Then, there is an assessment by stakeholders of the economic climate for private investment in the country's agricultural sector, as revealed by the field survey conducted for the study. This is followed by the analysis of stakeholders' perspective on the constraints to private investment in Nigeria's agriculture and by the stakeholders' perception of the persistence of these constraints and the effects of the constraints on agricultural commercialization and investment.

6.1 Evidence from Literature

Literature search reveals that there is a very large number of constraints affecting investment in the Nigerian economy in general and the agricultural sector in particular. It is, however, not possible to list all of them here, not only because it is impossible to identify all of them, but also because many of them tend to overlap. Instead, what is presented here may be regarded as a representative listing of identified constraints from selected sources. Appendix 6.1 presents this list. The table lists the identified constraints from different sources under eleven constraint categories, namely technical, infrastructural, economic, financial, political, social, policy, institutional, environmental, external environmental and labor market constraints. Although the categorization of the specific nature of constraints listed under these eleven constraint categories may sometimes be arbitrary, the range that they represent is indicative of the wide overall breadth of the constraints to investment in Nigeria.

Not surprisingly, policy and institutional constraints are the most frequently mentioned in the literature consulted. Policy instability is the most mentioned nature of policy constraint while institutional instability, complexity, inefficiency, and weakness are the most mentioned nature of institutional constraint. Economic constraint is the next most frequently mentioned, followed by social and political constraints. The specific nature of economic constraint includes poor economic and investment climate, economic mismanagement, high cost of production, poor access to market information, high investment risk, etc. Social constraint is mainly in the form of corruption, indiscipline, insecurity of life and property, social instability/crises, etc. Political constraint is mainly in the form of political instability, high country risk and poor governance.

Technical constraints take the forms of poor technological base, inadequate availability of viable technology, low productivity, high production hazards, etc. The nature of constraints associated with unfavourable external economic/political environment includes poor country credit rating, poor image of the country abroad, unfavourable perception of the country's investment climate by foreigners and lack of confidence in the country's economy. The nature of constraints associated with infrastructure centers around poor or poorly developed infrastructure, poor state or condition of available infrastructure, etc. It should, however, be mentioned that the infrastructural constraint is also indirectly associated with some other constraints, such as economic, institutional and technical constraints.

Financial constraint is mainly in the forms of inadequate supply of credit, inadequate financial services and high external debt burden. It is noteworthy that environmental forms of constraint on investment hardly feature in the literature consulted. This is a reflection of the poor perception of the relevance of environmental factors to investment decision-making and/or lack of priority attention to the study of environmental constraint as it relates to investment decisions in the country.

6.2. Stakeholders' Assessment of Nigeria's Economic Climate for Private Investment in Agriculture

The extent to which the Nigerian agricultural sector's investment climate is favorable or unfavorable to foreign and domestic investors was assessed through the informed opinions expressed by respondent groups in the zones. The result of this is shown in Tables 6.2 and 6.3 for the foreign and domestic investors respectively.

6.2.1 Foreign investors

Table 6.1 shows the rating of the economic climate for foreign private investment in Nigeria's agriculture and agro-allied industries, and the reasons for the rating. From the table, it is observed that, although the average rank scores by respondents vary by zone, the average is 3.0, meaning that the economic climate for foreign private investment in Nigeria's agriculture is very fair.

The rank scores were determined by balance of the assessment of both positive and negative factors. The positive factors (as identified by the respondents) were improved democratic governance, natural resources endowment, large local market, adequate policy support, high returns on investment, ban on the importation of some agricultural commodities, political/economic stability, high investment opportunities, and security to investors. On the other hand, the negative factors responsible for this ranking include policy instability/inconsistency, political discrimination, dishonesty, poor technology, low policy effectiveness, fraud/corruption, insecurity, bureaucratic bottlenecks, poor infrastructure, political instability, religious/ethnic/political strife, poor state of infrastructure, and over-dependence of the economy on oil revenue.

Table 6.1: Assessment of Nigeria's Economic Climate for Foreign Private Investment in Agriculture and Agro- Allied Industries

Zone	Rank	Positive Reasons	Negative Reasons
North Central	2.5	Democratic governance Availability of raw materials Adequate policy support Natural resource endowment	Policy instability, Political discrimination, Dishonesty, Poor technology, Low policy effectiveness
North East	4.0	Large local market, Abundant resources, Abundant opportunities, High returns on investment, Democratic governance	Corruption Insecurity Bureaucratic bottlenecks
North West	3.4	Favorable political climate, Raw materials availability, High demand, Resource endowment Comparative advantage	Insecurity, Political instability, Poor infrastructure, Naira devaluation, Low investment opportunities
South East	2.5	Resource availability, ban on agricultural commodity import	Political/religious/ethnic strife, Political instability, Unfavorable political climate
South East	2.4	Democracy Economic/political stability Raw material availability	Bad roads, insecurity/violence, Political instability, corruption, Greed/ fraud, high dependency on oil revenue, poor electricity and water supply, policy inconsistency
South West	3.3	Low labor cost, High potential profit, Large market, High investment opportunities, Conducive atmosphere, Security of investors	Insecurity Poor attitude to work Policy inconsistency Political instability

Note: Maximum score is 5.0 and minimum score is 1.0

6.2.2 Domestic Investors

The average rank per zone of the economic climate for domestic private investment in agriculture and agro-allied industries in Nigeria and the reasons for the assigned rank are shown in Table 6.2. The average rank of the economic climate for domestic private investment in Nigeria's agriculture is 3.7. This means that the climate is fairly good for domestic investment. This particular rank assignment was conditioned by the interplay of some positive and negative factors. The positive factors include the availability of raw materials and other inputs, market availability, good climate/environment, high returns on investment, democratic governance, good investment promoting policies, cheap labor, political stability and adequate funding. Others are the establishment of the Agricultural Development

Projects (ADPs), the use of modern crop varieties and other technologies, wage/salary increases for public workers, and familiarity with the domestic market.

On the other hand, the negative factors limiting the economic climate for domestic private investment in Nigeria's agriculture include poor infrastructure, poor policy effectiveness due to poor implementation, corruption, and inadequate funding. Others include high rate of interest on loan, insecurity, and high risk of investment.

Table 6.2: Assessment of Nigeria's Economic Climate for Domestic Private Investment in Agriculture and Agro Allied Industries

Zone	Rank	Positive Reasons	Negative Reasons
North Central	4.1	Good policies, Raw material availability, Land availability, Availability of markets, Good economic environment, Good indigenous technologies	Poor infrastructure Low technology Poor policy effectiveness
North East	5.0	Large domestic market, Abundant raw materials, High returns on investment, Resource endowment, Democratic governance, Abundant opportunities	Corruption Insecurity Bureaucratic bottlenecks
North West	3.6	Good policies, Good economic climate, Resource availability, Cheap labor, Political stability, Adequate funding, High local demand, Salary/wage increase	Smuggling, Political instability, Poor infrastructure, Poor policy implementation, Low returns on investment, Paucity of funds
South East	3.1	Good investment promoting policies, Establishment of ADPs, Availability of improved crop varieties	Unfavorable political climate High interest rate on loans
South East	3.3	Increase in workers wages Availability of raw materials Improved local production technology Economic/political stability Patriotism	Bad roads Insecurity/robbery Poor infrastructure Corruption Poor policy enforcement/policy reversals Advanced fee fraud (419) Poor security system Lack of protective policy
South West	3.3	High potential profit Familiarity with market Large local market High investment opportunity	Inadequate infrastructure Lack of adequate capital Underperformance of utilities Political instability High risk/uncertainty

6.3 Stakeholders' Perspectives on Constraints to Private Sector Investment in Nigeria's Agriculture

Thirteen constraints were identified in this study as affecting private sector investment in Nigeria's agriculture. Of all the constraints, infrastructure constraint seems to be most critical to investment in Nigeria's agriculture (Figure 6.1). This is followed by technical and financial constraints. Institutional, health and land tenure constraints were identified in that descending order of importance as the least limiting factors to private sector investment in agriculture in Nigeria.

However the intensity of the constraints differs across the six developmental domains as indicated by the respondents (See Figure 6.2). Each of the constraints is elucidated on in subsequent paragraphs.

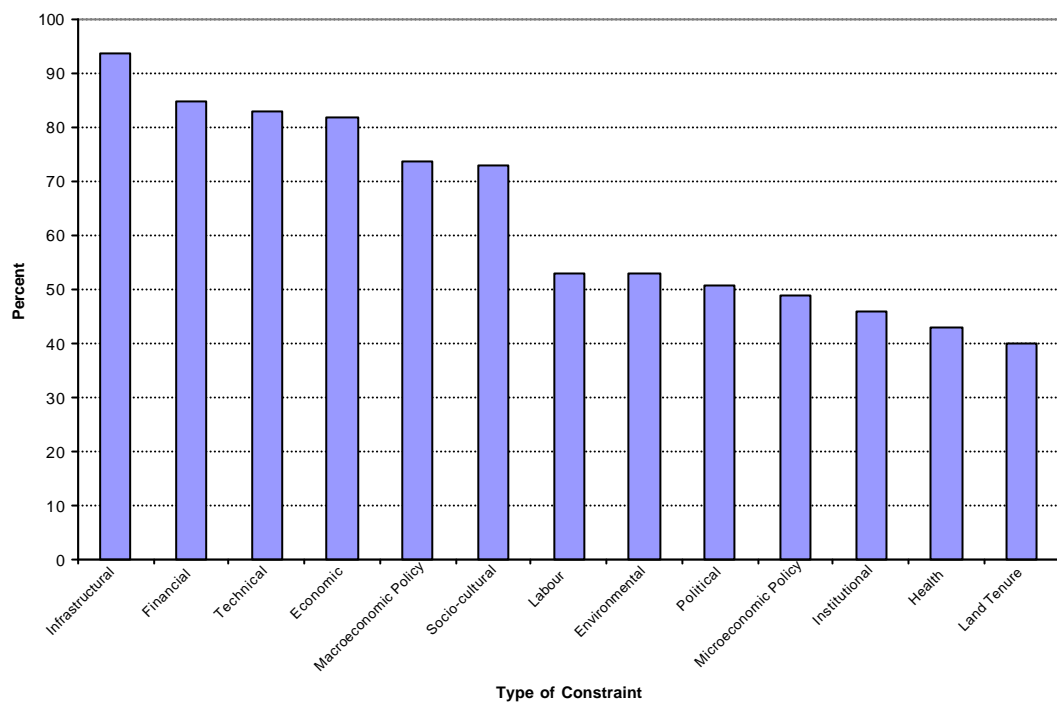


Figure 6.1. Relative Frequency Distribution of Constraints to Foreign and Domestic Investment in Nigeria's Agriculture (Percentage of responses by institutions surveyed)

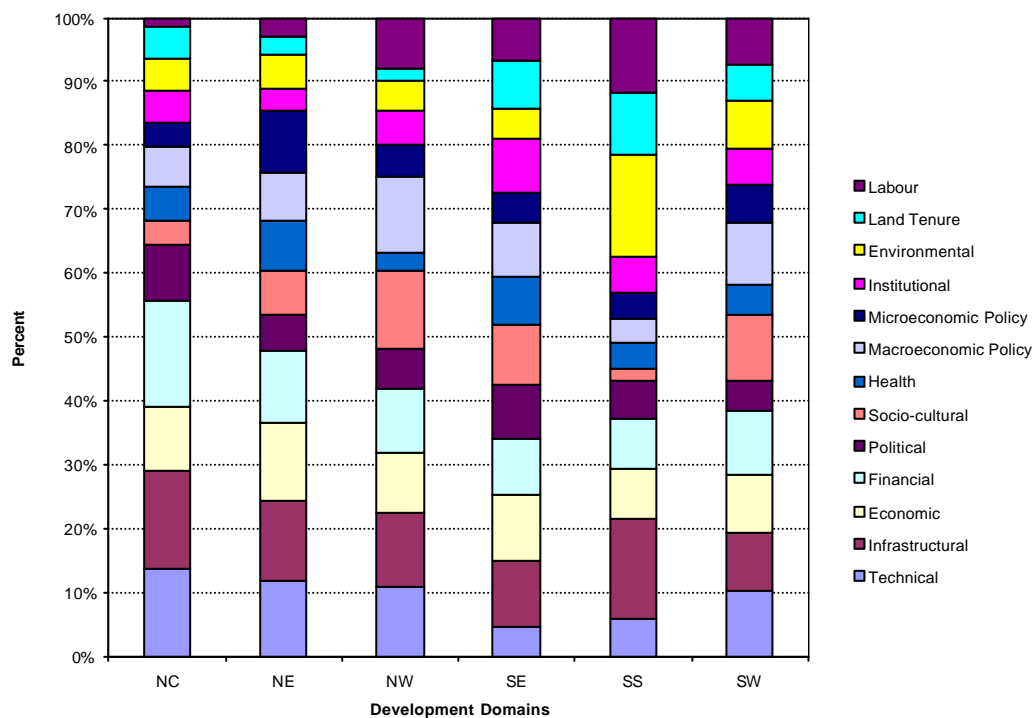


Figure 6.2. Intensity of Constraint to Foreign and Domestic Investments across Development Domains of Nigeria (% of Responses by Domain)

i) **Technical Constraint**

This is the third most important constraint to private sector investment in agriculture in Nigeria. This constraint is most pronounced in the northeastern part of the country where about 84 percent of the respondents subscribed to the pervasiveness of the constraint. The northwest, the southwest and the north central, in a descending order of the intensity of the constraint to investment in agriculture, follow this. However respondents in both southeast and the south-south zones of the country viewed this constraint as being not too limiting to agricultural investment as only one-third of the respondents identified with it. In general, poor technology, poor access to markets and lack of improved inputs are constraints in the country. In addition to these, the northcentral, northeast, and southwest zones identify poor managerial skill as another technical constraint in their respective domains. Also, the north central identified poor harvesting and processing technology as the specific nature of technical constraint in that domain (Figure 6.3).

ii) **Infrastructural Constraint**

The most critical constraint to private sector investment in Nigeria's agriculture is the infrastructural constraint. At least 80 percent of the respondents in all zones of the country identified infrastructure as an important constraint to private investment in Nigeria's agriculture. Infrastructural constraint manifests most in the physical context across the zones in the form of bad roads/poor states of roads, poor marketing facilities and outlets, and epileptic power supply. Specifically, the key nature of infrastructural constraint in both the north central and northwest is the poor state of telecommunication services. On the other hand, lack of processing facilities is common to both the northeast and the Southsouth. Both the southeast and the southwest identified poor state of health facilities as an important infrastructural constraint in their domains (Figure 6.4).

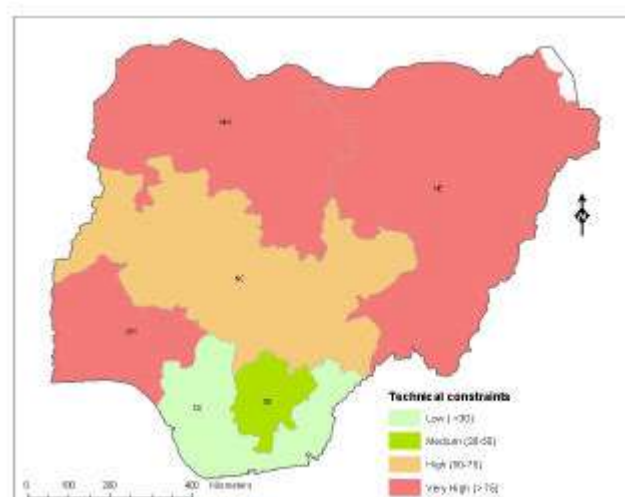


Figure 6.3. Intensity of Technical Constraint Affecting Agriculture by Development Domains of Nigeria

iii) **Economic Constraint**

Though very important, economic constraint is the fourth in the hierarchy of constraints to private sector investment in Nigeria's agriculture. This constraint is critical to private sector investment in agriculture in the northeast, southeast, and southwest zones of the country as over 80 percent of the respondents identified with it. Also, the constraint is fairly pronounced in the northwest, north central, and Southsouth. Across the zones, economic constraint manifests in the form of high cost of production and low returns to investment. Similarly high cost of marketing is a common nature of economic constraint in the northeast, northwest and the south-south zones. Both the southeast and the southwest identified low income and poverty as additional nature of economic constraint in their zones. Furthermore, the Southsouth viewed corruption as an element of economic constraint (Figure 6.5).

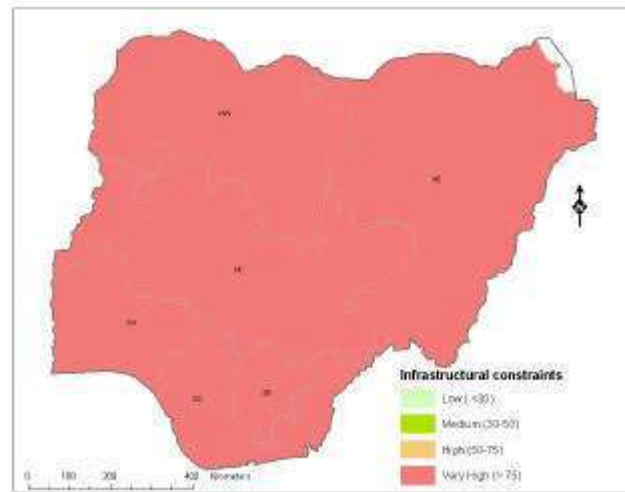


Figure 6.4. Intensity of Infrastructural Constraint Affecting Agriculture by Development Domains of Nigeria

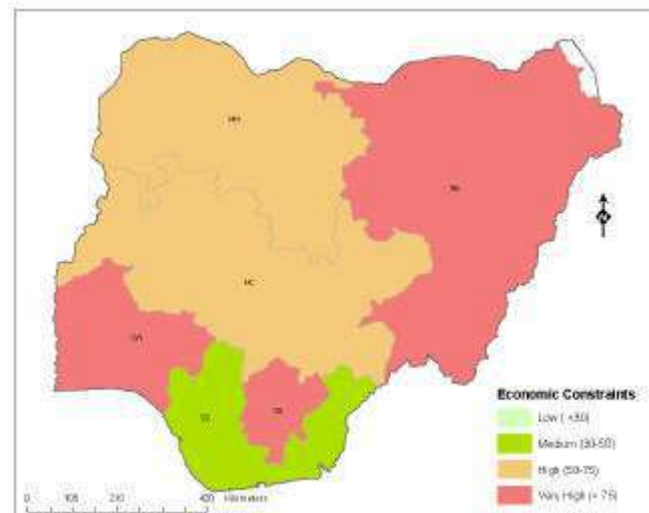


Figure 6.5. Intensity of Economic Constraint Affecting Agriculture by Development Domains of Nigeria

iv). **Financial Constraint**

Financial constraint is the second most important constraint to private investment in Nigeria's agriculture. It has been a perennial problem confronting investors in both the up-stream and down-stream segments of agriculture. The constraint, as attested to by the respondents, is most visible in the southwestern part of the country, while it is not so visible in the South-south. Except in the south-south where only 40 percent of the respondents identified financial constraint as limiting, more than 68 percent of the respondents in the other zones viewed it as impeding investment in agriculture. Overall, the constraint manifests in terms of poor access to credit, and high lending rates. The two combined, along with bureaucratic bottleneck, lead to an inefficient financial market. Because of the small-scale nature of agriculture in Nigeria and its dependent on weather, the respondents identified high risk of lending to the sector as a feature of financial constraint in Nigeria (Figure 6.6).

v). **Political Constraint**

This is one of the constraints that militate against private investment in agriculture. It is ranked as the eighth most critical constraint or problem affecting investment in agriculture in Nigeria. This southeastern part of the country attached a relatively high importance to this factor as 76 percent of the respondents identified it as a critical factor for private investment in agriculture. In descending order of importance, Northwest, northcentral, northeast, southwest and the southsouth, prioritised the constraint as having a critical effect on investment in agriculture. Two macro issues bordering on governance were identified as the main nature of political constraint across the zones. These are political instability and poor governance. Along with the features identified above, the northeast also identified distribution of agricultural facilities on political basis, or on whom you know in government, as another nature of the constraint thereby leading to the diversion of agricultural facilities to unintended beneficiaries. Civil disturbance was an additional element identified by the northwest, while selfish interest was also identified by southwest (Figure 6.7).

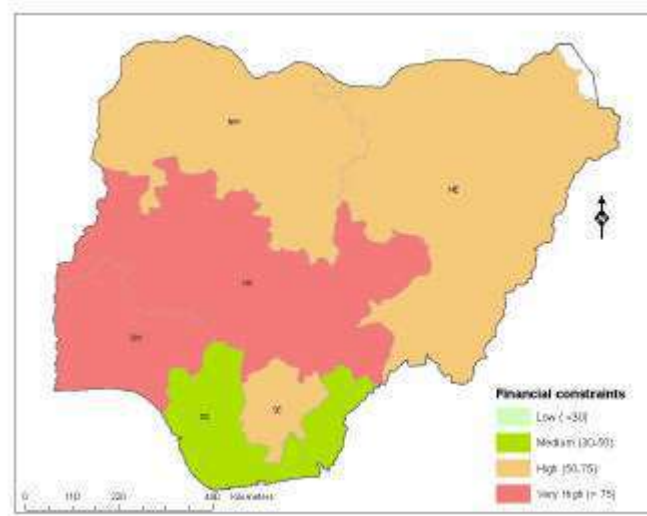


Figure 6.6. Intensity of Financial Constraint Affecting Agriculture by Development Domains of Nigeria

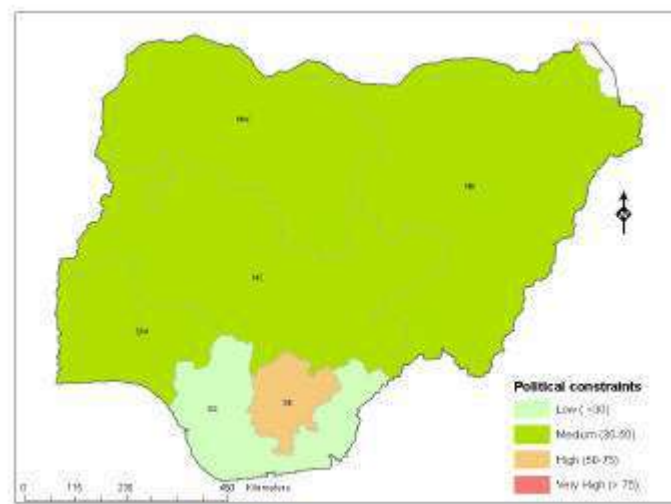


Figure 6.7. Intensity of Political Constraint Affecting Agriculture by Development Domains of Nigeria

vi). **Socio-cultural Constraint**

Socio-cultural constraint is the sixth most important constraint to private sector investment in Nigeria identified by the respondents. However, not many of the respondents identified the problem in the north central and the southsouth where cases of conflicts are more prominent. This may be due to the fact that the two zones have come to terms with living with the problem and have adjusted to the situation. Overall, corruption, insecurity, and ethnic strife/crisis cut across the different zones. The northeast and the northwest zones identified religious strife disguising as ethnic crisis as an additional element of the constraint. The southsouth and the southeast also identified ethnic strife as an element of socio-cultural constraint. This is understandable from the point of view of the southsouth where fights over land and water resources are predominant. The availability of mineral resources, especially crude oil, further compounds this situation. A secondary element of socio-cultural constraint is high crime rate, which is a function of insecurity within the system, and which cuts across the six zones (Figure 6.8).

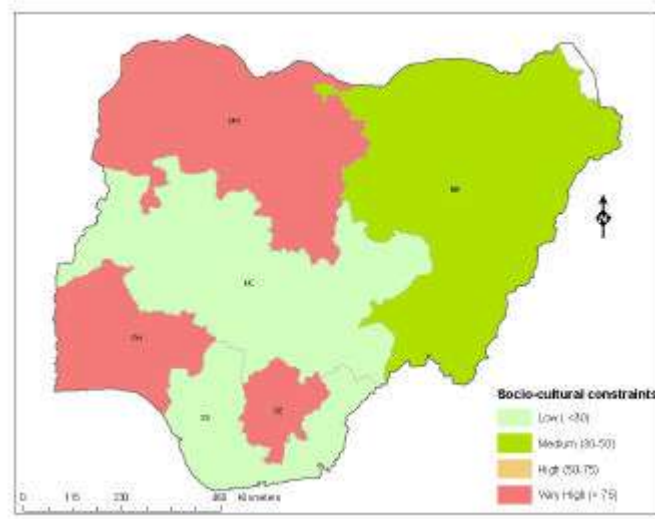


Figure 6.8. Intensity of Socio-cultural Constraint Affecting Agriculture by Development Domains of Nigeria

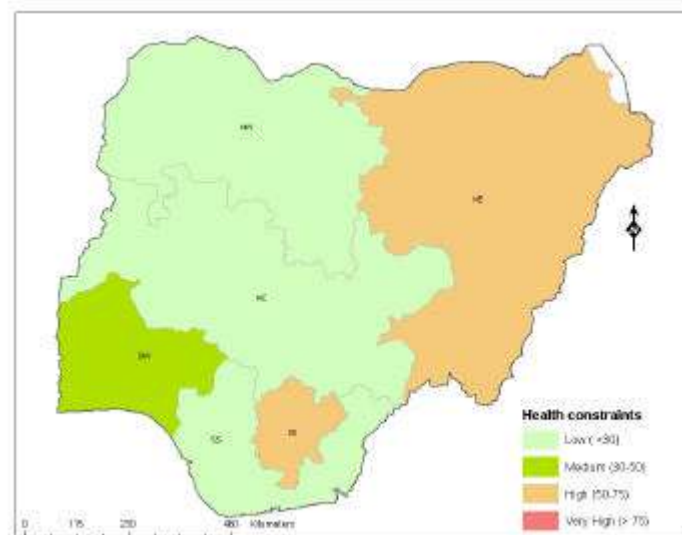


Figure 6.9. Intensity of Health Constraint Affecting Agriculture by Development Domains of Nigeria

vii). **Health Constraint**

Health is another constraining factor to private sector investment in Nigeria. However, judging by the responses across the zones, the northeast and the southeast zones are more affected by this constraint than the other zones of the country. The main elements of the constraint are inadequate health care facilities and the threat of HIV/AIDS and malaria, which cut across the zones. Interestingly, fake or expired drugs were identified as an additional element of health constraint in the southeast zone. This is expected as the bulk of the fake or expired drugs comes from the southeast where the National Agency for Food and Drug Administration and Control (NAFDAC) is currently engaged in a running battle with fake drug dealers (Figure 6.9).

viii) **Macroeconomic Policy Constraint**

The macroeconomic policy climate dictates the environment in which sectoral activities are carried out. This constraint ranks fifth among the constraints to private sector investment in Nigeria's agriculture. The constraint has as its elements high exchange rate, high interest rate, multiple taxation, poor trade policy, and policy inconsistencies. Multiple taxations were reported by the northeastern and northwestern zones as one of the main elements of macroeconomic constraint. This is expected, given the inter-state flow of agricultural commodities, especially staples and livestock products from the northern part of the country to the southern part. Policy inconsistencies have been the bane of Nigeria's macroeconomic policies with a number of policy summerraults. A vivid example is the banning and unbanning of the importation of some agricultural commodities (e.g. rice, livestock products etc.) (Figure 6.10)

ix) **Microeconomic Policy Constraint**

Microeconomic constraint is another factor impeding private sector investment in agriculture. Ranked ninth among the constraints, it is characterized by poor agricultural credit and input policies, poor technological policy and poor storage and processing policies which cut across the zones. A greater proportion of the respondents in the southwest (55%) and the northeast (68%) identified this constraint as limiting to private investment in agriculture. In the other zones of the country less than 40 percent of the respondents claimed that the constraint affects private investment in agriculture (Figure 6.11).

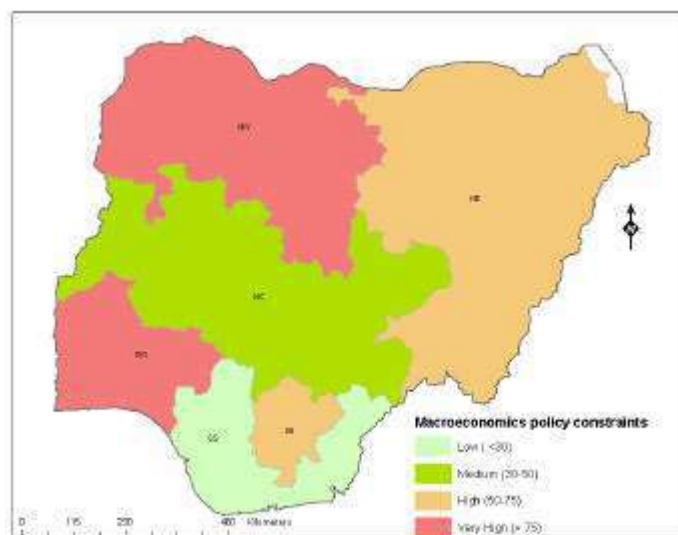


Figure 6.10. Intensity of Macroeconomic Policy Constraint Affecting Agriculture by Development Domains of Nigeria

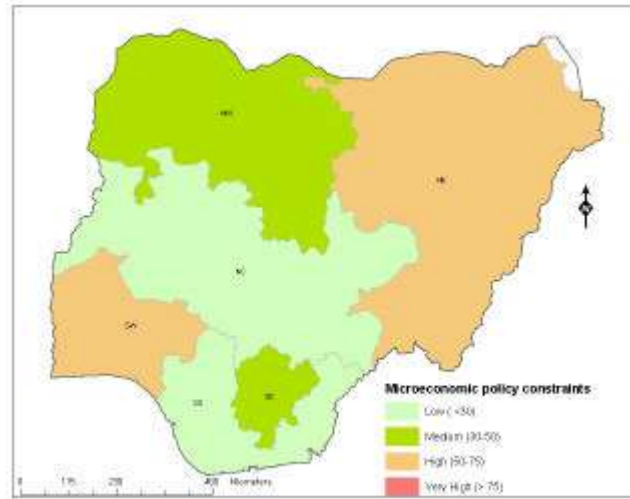


Figure 6.11. Intensity of Microeconomic Policy Constraint Affecting Agriculture by Development Domains of Nigeria

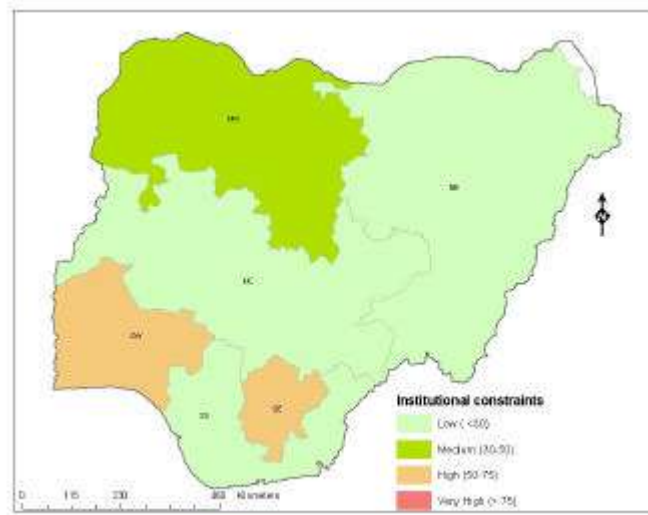


Figure 6.12. Intensity of Institutional Constraint Affecting Agriculture by Development Domains of Nigeria

x). **Institutional Constraint**

Institutional constraint is one of the factors affecting private investment in Nigeria's agriculture. It is ranked eleventh among the critical factors affecting investment in agriculture. The constraint is less severe to agricultural investment in northern Nigeria as shown by the proportion of the respondents (30%) compared to what obtains in the southern (50%) part of Nigeria. However the constraint is most severe in the southeast zone of the country followed by the southwest. The key elements of institutional constraints are ineffective banking services, inefficiency of the public institutions and poor attitude to work by government officials leading to bureaucratic bottleneck. The south-south zone identified discrimination against agriculture by financial institutions in its domain, while the southeast specifically identified inefficient labor and poor saving systems as part of the elements of institutional constraint in the domain (Figure 6.12).

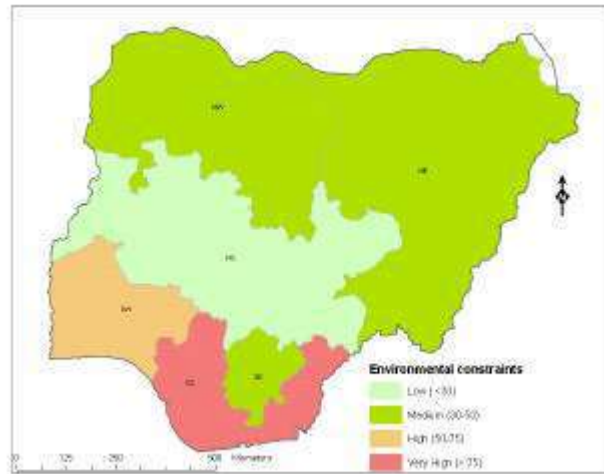


Figure 6.13. Intensity of Environmental Constraint Affecting Agriculture by Development Domains of Nigeria

xi) Environmental Constraint

This is ranked seventh among the identified constraints to private sector investment in agriculture in Nigeria. The problem was observed to be more severe in the southern part of the country as up to 80 percent of the respondents identified it, compared with 32 percent in the northern part of the country. The nature of the constraint can be classified broadly into two, namely: environmental regulations and physical environmental degradation. Whereas four of the zones recognized environmental regulations as an element of environmental constraint, each of the zones identified specific nature of the constraint in their area. For instance, in the north central, chemical pollution and deforestation are the main elements, while erosion, drought and pest and disease attack were identified in the northeast. The South-south identified oil spillage and erosion, southeast identified erosion and soil infertility and the southwest identified environmental pollution. Of the four zones, the environmental constraint was the highest in the south-south zone (Figure 6.13).

xii) Land Tenure Constraint

Ranked low among the constraints to private sector investment in agriculture, land tenure constraint was the most pronounced in the southeastern part of the country as about 62 percent of the respondents identified it. The problem is least pronounced in the northwest zone of the country where only about 13 percent of the respondents viewed it as constraining private investment in agriculture. In general, the southern parts of the country experience more severe land tenure constraint than the northern parts of the country. This is understandable, given the high population density and the attendant land fragmentation in the southern parts of the country. The various zones identified land fragmentation as a general phenomenon. Specifically the northwest, south-south and the southwest zone identified cumbersome land acquisition process as an element of land tenure constraint, similarly, the northeast, southeast and southwest zones identified insecurity of title to land as an element of the constraint. Additionally, the southeast identified high rate of land rent, while the north central and the southsouth identified fraudulent practices (Figure 6.14). This constraint is also an element of the socio-cultural constraint.

xiii) Labor Constraint

This is ranked joint seventh with environmental constraint among the constraints to private sector investment in Nigeria's agriculture. The constraint is least pronounced in the northcentral as it was identified by only about 7 percent of the respondents while it is most pronounced in the Southwest part of the country as it was identified by about 68 percent of the respondents. Overall, labor constraint is more limiting to private investment in agriculture in the southern parts compared with the northern parts of the country. The key elements of labor constraint across the zones are lack of skilled manpower

and high wage rate. Specifically, the southsouth, southeast and the southwest identified inadequate supply of all categories of agricultural labor as an element of labor constraint (Figure 6.15).

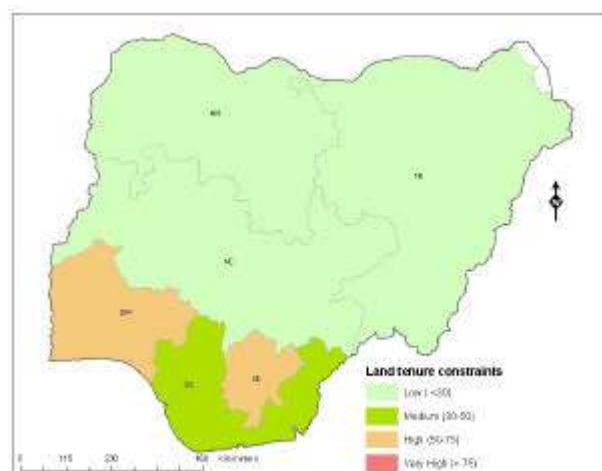


Figure 6.14. Intensity of Land Tenure Constraint Affecting Agriculture by Development Domains of Nigeria

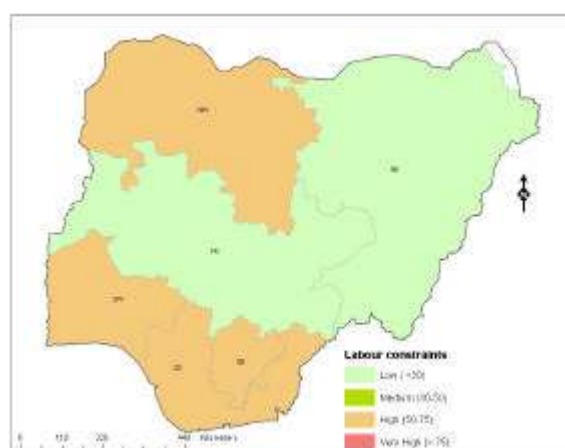


Figure 6.15. Intensity of Labour Constraint Affecting Agriculture by Development Domains of Nigeria

6.4 The Persistence of Constraints to Investment in Nigeria's Agriculture

In the previous section, the taxonomy and the elements of the different constraints were discussed. In this section, attempt will be made to explain the persistence of different constraints to investment in Nigeria within the political economy framework. In this context, we shall discuss the causes/ sources of the persistence of each constraint, and the gainers and losers from these constraints. In broad terms, four main causes or sources of persistence of constraints can be distinguished. First, there are those causes attributable to government. Second, there exist those constraints attributable to the citizenry. The third classification identifies those causes that are economy-wide while the last considers sector specific causes of the persistence of constraints. In general, bad governance, poor leadership, poor

government and corruption can be linked to the government while population increases, poor resource management, ethnic/ religious strife, and insecurity can be attributed to the citizenry. However, there is only a fine distinction in the strands of the classification above, as there exist interlinkages/interrelationships between one group of causes and the others. For instance, bad governance can lead to a second-degree problem of insecurity which then constrains the economy in general and the agricultural sector in particular. In subsequent sub-sections, an attempt is made to evaluate the causes of persistence of constraints as well as the gainers and losers from these constraints. Appendix 6.2 gives an overview of the causes/sources of the persistence of constraints as indicated by the respondents in each of the zones.

6.4.1 Causes and sources of persistence of constraints

The causes/sources of persistence of constraints in Nigeria differ for the different constraints and across the development domains of the country. However, these sources combined provide a framework for explaining the inability of the country to adequately tackle the constraints. They are further elaborated upon as follows.

(i) **Technical Constraint:** The technical constraint in Nigeria affects both the upstream and the down stream segments of agriculture. The constraint manifests in poor technology, poor quality of raw materials and inadequate supply of fertilizer. The main causes of the constraint include low support from government, poor government policy, poverty, low level of awareness, lack of adequate research and increases in the prices of inputs. Poor government support and poor government policy prevent the emergence of innovations from research institutes, thereby curtailing the level of available technically feasible and efficient agricultural practices. Even when they are available, there seem to be communication gaps between farmers (end-users) of research efforts and the researchers. The existence of unified agricultural extension system notwithstanding, there is still poor coordination between researchers, extension agents and farmers. This situation is worsened by the low extension-farmer ratio, which hovers around 1 to 1000. The poverty incidence among farmers, which is the highest in the economy, also contributes to the persistence of technical constraint in Nigeria. Thus, farmers are unable to take up new innovations aimed at boosting their productivity and, by extension, their output. The low level of productivity translates to a vicious cycle of poverty, thereby leading to low level of production. The technical constraint is further sustained by high input prices, which is a consequence of inflation in the economy as well as the dependence of the agricultural economy on foreign inputs. The situation is aggravated by the collapse of the local fertilizer producers namely NAFCON at Onne and National Super Phosphate Plant in Kaduna. Despite the wide recognition of the effect of fertilizer on crop production, farmers do not get this all-important input as at and when required. This is worsened by the existence of unintended beneficiaries who capture the benefits from fertilizer allocation to the farmers, due to their closeness to corridors of power at the expense of poor farmers.

(ii) **Infrastructural Constraint:** The infrastructure constraint has persisted due to government neglect, poor governance, poor political leadership, poor maintenance culture and poor funding. Infrastructure in this instance is construed to include physical infrastructure, such as roads and railway system, educational and health facilities, social services such as potable water and electricity and communication system. In terms of road facilities, the efforts of the Agricultural Development Programs, the Directorate of Foods, Roads and Rural Infrastructure, the National Agricultural Land Development Authority and the Petroleum Trust Fund have not been sustained to ensure good road networks in the rural areas where the bulk of agricultural activities takes place. In addition, the railway system that is expected to provide relief has been comatose for years thereby restricting the movement of agricultural inputs and outputs to the road transport system. The constructed roads do not often last for more than three to five years before they start to crumble due partly to poor maintenance culture. As regards educational and health facilities, these are largely urban-biased. Supply of potable water has not been adequate for a majority of rural dwellers. Electricity supply is often epileptic and communication system is still poor. Although recent expansion of the Global System of Mobile Communication (GSM) infrastructure and Internet services has improved the communication situation somewhat, the services are urban-biased and too expensive for the average people.

(iii) **Economic Constraints:** The persistence of economic constraint is a function of some socio-economic factors. These factors, as identified by respondents, include political instability, poor governance, ineffective government policies, high inflation rate, low investment, and inadequate credit

for agriculture, poor resource management, and corruption. Political instability affects policy continuity and economic climate. It creates undue risks and uncertainties for investors. Furthermore, because agriculture is widely perceived to be a high-risk business, financial intermediaries are highly averse to lending to the sector. Thus, the vicious cycle of low credit flow, low investment, low income to farmers and low savings/investment is responsible for the widespread incidence of poverty among farmers and hence, the persistence of the economic constraint in the agricultural sector.

(iv) **Financial Constraints:** This is a constraint the persistence of which has many economic and social dimensions. Among the factors identified by respondents as being responsible for the persistence of the financial constraint in Nigeria's agricultural sector are ineffective financial policies, inefficient financial market, inadequate financial facilities, low credit supply, high risk of lending, corruption, bureaucracy, unstable exchange rates, poor agricultural funding by governments and low returns from farming.

Poor financial/ credit policies, coupled with ineffective policy implementation, are largely responsible for high interest rates and unstable exchange rates which, in turn, tend to engender the persistence of the financial constraint. The financial constraint also persists due to poor credit supply to agriculture which manifests in the form of banks' reluctance to lend to agriculture. For example, between 1994 and 1998, commercial bank loans and advances to agriculture represented only 12.1 percent of the banks' total loans and advances to the economy. This was in sharp contrast to the 41 percent contribution of agriculture to the GDP.

Also, corruption is an important causal factor for the persistence of the financial constraint. This often takes the form of kickbacks to bank officials. Added to this are the bureaucratic bottlenecks involved in loan procurement and the stringent collateral requirements for loans. Besides, the informal sector that provides the bulk of the credit requirement in agriculture operates at high interest rates.

(v) **Political Constraints:** The persistence of this constraint is a function of poor political leadership, political instability, poor governance and non-participatory governance. In her 43 years of independence, Nigeria has witnessed only 14 years of civilian rule with the remaining years spent under different military regimes. The problem of military incursion into politics started in January 1966 with the coup led by Major General Aguiyi Ironsi. Since then, Nigeria had operated under dictatorial regime that adopted unitary system of government, except from 1979 to 1983 and from 1999 to date. The incursion of the military into power truncated the decentralized development strategy practiced prior to 1966. Hence, the different components of the country could no longer develop at their own pace. Another problem with the military regime was the instability of governance with frequent changes in military regimes. Between 1993 and 1999 alone, there were four regimes. This was clear evidence of political instability which also created an unfavorable investment climate. The long years of military rule also adversely affected broad participation in governance. The non-participation of people in governance has affected the decision-making process, thus constraining agricultural development.

(vi) **Socio-cultural Constraint:** This has been a persistent constraint for a number of reasons that include the heterogeneous nature of the country in terms of religion and ethnic nationalities. There are more than 300 ethnic nationalities in the country. This accounts for variations in attitudes and beliefs. The constraint is aggravated by unemployment, nepotism, corruption, gender discrimination and poverty. In general, the rising level of unemployment amongst the youth makes them willing tools in the hands of troublemakers. This is particularly so in some parts of the country where people hide under the guise of religion to foment trouble. In the Niger-Delta where the bulk of Nigeria's petroleum resources are situated, there are complaints of marginalization and agitations for self-determination. In the middle belt, there is often inter-ethnic strife fueled basically by land disputes. In the southwestern and southeastern parts of the country inter-community strife is also a common occurrence. Such strife is often the consequence of land disputes. The socio-cultural constraint is aggravated by the socio-economic relegation of women. In many, where women are disadvantaged in terms rights of inheritance and land ownership. Poverty is another causative factor for the persistence of the socio-cultural constraint, as poor community members are often willing to engage in civil strife for economic gains.

(vii) **Health Constraint:** This constraint has persisted due to government inaction /neglect, poor leadership, inconsistent policies, lack of good drugs, poor environmental management and poverty. According to respondents, governments have not been alive to their responsibility of providing adequate health care facilities for a majority of Nigerians. Generally, the health care facilities are urban biased leaving the rural populace to depend heavily on natural/traditional medicine. The inaction of government is a consequence of poor leadership and poor health policy. In areas with health care facilities, there is inadequate supply of manpower. Added to this are incessant strike actions by health workers due to poor funding of the health institutions as well as poor salary structure. Generally, adequate attention is not paid to both preventive and curative medicine. Under such an atmosphere, fake medical centers and pharmaceutical companies thrive. There is the widespread production of substandard drugs for human consumption. The situation is precarious in many parts of the country where fake drug dealers freely operate. But for the effort of National Food and Drug Administration and Control (NAFDAC), the problem would have been out of control. Also the strapping of the old sanitary inspector system and non-observance of the usual monthly sanitation exercise have combined to compound the health problems of the country. Highly related to agriculture is the poor health services to farmers in terms of deaths, useful labor days lost due to ill-health and low productivity by farmers.

(viii) **Macro-economic Policy Constraints:** The persistence of the macroeconomic constraint in the country derives from many factors, as identified by respondents. These factors include political instability, policy instability, ineffective policies, poor implementation of policies, and poor coordination of policies. Political instability creates policy instability, as rates of turnover in policies are strongly associated with rate of turnover in governments. Each new regime tends to discard the policies of old regimes only to start instituting its own new set of policies. Related to this are the problems of policy ineffectiveness, poor implementation of policies and poor coordination of policies that derive from political and policy instability. A clear example of policy instability is the frequent banning and unbanning of the importation and exportation of agricultural commodities, especially the frequent banning and unbanning of the importation of some food commodities like rice and wheat. Also notable are the frequent changes in import tariffs that sometimes make imported goods cheaper than their local substitutes, thereby discouraging their local production.

(ix) **Micro Economic Policy Constraints:** The persistence of micro-economic policy constraint derives partly from the macro-economic policy constraint. In addition, there is inadequate attention to micro-economic/sectoral policy issues. When sector-specific policies are instituted, there seems not to be proper synergy between the different sectors of the economy thereby leading to disjointed sectoral policies that are sometimes contradictory or constitute duplications across the sectors. As such, there is lack of coordination of policies aimed at addressing the different segments of the economy. Credit also surfaces as one factor that is responsible for the sustenance of microeconomic policy constraint in agriculture. Generally, in this regard, microeconomic policies that are aimed at addressing credit availability and utilization in the agricultural sector are not very effective.

(x) **Institutional Constraint:** The elements of institutional constraint that make it persistent are related generally to the banking sector. These include inefficient banking services, including cumbersome loan processing procedures. The resultant effect is the long time lag between the loan application and loan approval. In essence loans are not given as at when required thereby causing misapplication of funds. Along with this is the unwholesome activity of those involved in agriculture both at the upstream and the downstream segments. For instance, the activities of the middlemen in the marketing chain though required, are such that lead to marked differences in the farm gate prices and the retail prices. Furthermore, the institutions saddled with the responsibilities of providing input as at when necessary are not very effective in the discharge of their duties. The end result is the untimely delivery of input to farmers, which may not be totally useful for agricultural activities.

(xi) **Environmental Constraint:** The environmental constraint has the consequence of a combination of human activities and natural occurrences. These result in the pollution of the air, land and water. The seriousness of the constraint did not dawn on the country until recently when the Federal Environmental Protection Agency (FEPA) now Federal Ministry of Environment was established. The key causative agent of the persistence of environmental constraint include government inaction, poor

enforcement of environmental laws, lack of awareness on the part of farmers and excessive bureaucracy. Others are sabotage, bad farming practices, poor weather, erosion, obnoxious fishing methods and oil spillage. In particular, the riverine areas of the country are affected by obnoxious fishing methods. Similarly, areas of oil exploration especially in the Niger Delta are affected by oil spillage thereby preventing serious agricultural activities. The agricultural activities affected include fishing and crop farming. In fact, large expanse of land are lost to oil exploration in the Niger Delta. In the southeast, the most constraining factor is soil and land erosion.

(xii) **Land Tenure Constraints:** Land tenure constraint has persisted in the country principally because of rapid growth in population, traditional land tenure system, weak enforcement of land policy and gender discrimination. These factors combined lead to high monetary demand by landowners and the unwillingness of communities to do away with their land. Series of programs introduced, such as the farm settlement scheme, the National Agricultural Land Development Authority and the River Basin Development Authority have not been able to unlock this constraint. In fact, population growth has led to high level of land fragmentation due to it's the fixed nature of land.. The land use decree of 1978 has not also fully addressed the issue, hence, the persistence of land tenure problem. Added to this is the gender discrimination in respect of land holdings, in most communities where women do not have ownership rights over land, although they may have use rights.

(xiii) **Labor Constraints:** Labor constraint in agriculture continues unabated due to rural-urban drift, lack of skilled laborers, poor technology and high wages in other sectors of the economy. Agriculture takes place in the rural areas, which are lacking in infrastructural facilities. The consequence is the movement of able-bodied men out of the rural areas. Similarly, higher wage rates in other sectors of the economy draw away labor from agriculture. The high enrolment rates in schools have also depleted agricultural labor. All these factors aggravate the persistence of the labor constraint.

6.4.2 Gainers and Nature of Gains from the Persistence of Constraints

The persistence of the identified constraints affects various entities in the economy differently. There are gainers and losers from the continued existence of the different constraints. This section identifies the gainers from the constraints as well as the nature of gains. Appendix 6.3 identifies the gainers and the nature of their gains due to the persistence of the different constraints. There are two categories of gainers viz foreigners and Nigerians. At the local level, Nigerian beneficiaries can also be divided into two public officials and private individuals. One common feature of the gainers is that they are well-organized sets of people. At the local level, the gainers are often those saddled with the leadership responsibility both in government and out of government.

The respondents identified public officials as the highest gainers from the persistence of the constraints as they benefit from most of the constraints. These officials include political appointees, policy makers, policy implementers and lower cadre civil servants. They derive benefits ranging from hard currency, receipt of financial kickbacks from suppliers and contractors and nepotism in the award of contracts to their cohorts. Other major gainers from the persistence of the constraints are the politicians and their associates. These derive benefits in terms of contract awards, which in many instances are not executed, and in terms of outright diversion of public funds to personal uses. Local private investors, contractors, marketers, importers, spare part dealers, bankers, financial institutions, middlemen and private lenders also derive benefits from the persistence of some of the constraints. Their gain is mainly financial through the exploitation of the masses by charging exorbitant prices, through smuggling and through the receipt of bribes.

At the foreign level, the main gainers from the persistence of the constraints in Nigeria are foreign investors, foreign suppliers, technical partners and foreigners who take advantage of the unstable economic situation in the country. These groups of gainers import all kinds of goods, evading import tax through bribery. Then, collude with their local counterparts to ensure that efforts to produce or provide these goods and services locally are unsuccessful in order to perpetuate their nefarious activities. Some of the constraints benefit specific groups. For instance, political constraints benefit political thugs and the military. This perhaps explains the frequent change of guard through coups and counter coups. The main benefit to the military derives from the frequent seizure of power and consequent exploitation of the masses. They also use their position to amass wealth. On the other hand, socio-cultural constraint benefits armed robbers, other criminals, touts, and thugs. The land constraint benefits landowners and their intermediaries through excessive charges and multiple sales of lands.

6.4.3. Losers and Nature of Losses from the Persistence of Constraints

Appendix 6.4 provides the list of identified losers from the persistence of the different constraints. In general, the downtrodden masses, including farmers and women are the worst losers. The persistence of each of the constraints affects both women and farmers. In other words, the most vulnerable groups losing from these constraints are the farmers and women. Farmers' losses take the forms of reduced output, low income, loss of assets and reduction in land area available for farming. The consequence is chronic poverty, which is evident from the high incidence of poverty among the people in agriculture. Commodity processors, marketers and entrepreneurs suffer from the persistence of technical, infrastructural, economic, political, health, environmental and land tenure constraints. The nature of the losses due to the technical constraint for example, includes the persistence of local unproductive technology, high processing cost and reduced output. Similarly, the infrastructure constraint imparts losses to entrepreneurs and processors in the form of low capacity utilization, high cost of power generation and reduced output. Political instability tends to send wrong signals to investors thereby constraining the growth of the economy. Here, the economy is the loser. Businessmen, ordinary workers, government, the economy are potential constraints. Their losses are in the forms of high transaction costs, loss of time, loss of business opportunities, loss of revenues to government, loss of potential investment and loss of employment.

6.5 Effects of Constraints on Commercialization and Investment in Nigeria's Agriculture

The identified constraints to commercialization and investment in Nigeria's agriculture contained in section four of this chapter produce some effects. These effects impact on agricultural commercialization, agricultural production, commercialization, processing, storage and transportation. Others include input and output distribution, product utilization, food security, exports and environment. These various activities in the agricultural production process are related. Hence, some of the effects produced on these activities as a result of the constraints to commercialization and investment in Nigeria's agriculture are similar. For example, whatever affects agricultural production automatically affects food security, exports, agricultural processing, storage, transportation and even commercialization among others.

What is contained below is the report of the findings of the effects of constraints on commercialization and investment in Nigeria's agriculture. The information was obtained from the various stakeholders (agribusiness associations, individual investors and other private sector operators in the agricultural sector) interviewed in the survey in each of the defined development domains of Nigeria. The summary of the effects, the constraints causing effects in each zone is presented in Appendix 6.5.

6.5.1 Low Output/Productivity

The low level of production/productivity from agricultural enterprises is a product of all the identified constraints in the previous chapters. In addition, this effect is produced in all the zones of the country.

The technical and financial constraints to commercialization and investment in Nigeria's agriculture have been identified to produce low production in all the six development domains of the country. On the other hand, the health constraint was identified to produce its effect in all the zones of the country except in the southwest. All the southern zones plus the north central on one hand identified land tenure constraints as being responsible for low agricultural production. This is expectedly so as the man-land ratio is higher in the southern part than the Northern part. On the other hand, the southern zone plus the northeast zone identified labor constraint as being responsible. This is because shortage of labor is more pronounced in the south where many have better opportunities to non-farm employment that are easily found in the urban areas.

Three out of the six zones (northeast, northwest and southwest) mentioned microeconomic policy constraint, while the northeast, southsouth, and southwest mentioned infrastructural constraint, and the northwest, southsouth, and southwest mentioned institutional constraints as being the cause of low production in the agriculture sector. But only two zones identified economic constraint (northwest and south-south) and socio-cultural constraint (north central and northwest) as limiting agricultural production in Nigeria. Those zone- specific constraints accounting for the low level of output in Nigeria's agriculture include political and macro-economic policy constraints. These were mentioned in the northcentral and northwest respectively.

From the above analysis, it is evident that low output is a product of all the identified constraints and it is about one of the commonly observed effects of the constraints to investment and commercialization in Nigeria's agriculture.

6.5.2 High Cost of Production

This effect manifests in two forms. One is the high cost of investment and the other is the high cost of acquiring all necessary inputs required in the agricultural sector of the economy. The high cost of production automatically reduces the level of output and may limit commercialization and food security among others. It can also reduce the level of investment in the various sub-sectors of the agricultural industry. All the identified constraints have been perceived to produce this effect, though at varying levels across the zones. Of all the constraints, labor and macroeconomic policy constraints are common to all the zones of the country as causing high cost of production. These are followed by economic constraint, mentioned in all the zones except northeast. The technical, infrastructural, micro-economic policy, environmental and land tenure constraints were mentioned in four of the six zones while only the institutional constraint was identified in three zones of the country. All other constraints (financial, political and socio-cultural) were mentioned in only two zones of the country as causing high cost of production. One can conclude that the high cost of production, just as low production, is a common effect produced as a result of the constraints on commercialization and investment in Nigeria's agriculture. This is because, where these constraints have to be unlocked/removed, it is done at extra cost of production. This extra cost, when added to the normal production cost leads to high cost, of production.

6.5.3 Low Returns to Investment

The rate of the return on an investment is a major measure of its attractiveness to investors. Low returns to investment are primarily caused by either very high cost of inputs of production or very low prices for output produced in the production process. Low return to investment was identified as one of the effects of some of the constraints to investment and commercialization in Nigeria's agricultural sector. Some of these constraints are technical, infrastructural, economic, political, and health constraints. Others are macro-economic policy, institutional and land tenure constraints. Four geopolitical zones (north central, northeast, northwest and southeast) mentioned technical and economic constraints as causing low returns to investment. On the other hand, the north central, northwest and southeast zones identified infrastructural constraint while macro-economic policy constraints was identified in the northeast, northwest and the southeast zones as being responsible for low returns to investment. The southwest and north central zones specifically mentioned political constraint as causing low returns to investment. The south-south and northeast zones identified health and environmental constraints respectively as being responsible for low returns to investment while only the southeast zone identified the institutional and land tenure constraints as to the causes of low returns to investment in the agricultural sector of the economy.

6.5.4 Low/Poor Level of Investment

Low level of both domestic and foreign investment in the agricultural sector was identified as one of the effects of the constraints. Low level of investment, apart from being the effect of the constraining factors constraining factors, is also a direct result of low level of savings, which emanates because of low income and low output. According to the respondent groups, nine of the thirteen constraints are responsible for this effect. The northeast, northwest, southeast and southsouth identified micro-economic policy constraints as being responsible for the low level of investment in the agricultural sector. The socio-cultural and political constraints were identified in the northwest and southeast zones as being the cause of the low level of investment in Nigeria's agricultural sector. The financial constraint was mentioned in the southsouth and southwest zones while the macro-economic policy constraints were identified in the north central and northeast as causing poor level of investment. Economic, health, institutional, and land tenure constraints were identified only by the northwest zone as being the cause of the low level of investment in the Nigeria's agricultural sector.

6.5.5 High Price of Agricultural Products

One of the effects of the constraints to investment and commercialization of Nigeria's agriculture is the generally high prices of agricultural products. This problem of high prices of outputs is, however, largely seasonal. Prices are usually high during the off harvest seasons while these are depressingly low during the peak of harvest, due largely to inadequate storage and processing facilities. In the field survey, three constraints (economic, infrastructural and labor) were most frequently mentioned as

producing high prices of agricultural commodities. While the southeast and southwest zones identified economic constraints as being responsible, the north central and the southeast respectively identified infrastructural and labor constraints as being responsible for the high prices of agricultural produce.

The above is understandable because where the cost of production and marketing is high, due to poor Infrastructural and labor constraint, , the prices of the produce should be expected to be high also.

6.5.6 Collapse/Disruption of Businesses

The collapse of a business or its abandonment or disruption is one of the consequences of the constraints militating against commercialization and investment in the agricultural sector of Nigeria's economy. The respondent groups/associations across the length and breadth of Nigeria identified six constraints as being responsible for the collapse or disruption of business ventures in the agricultural sector. The south-south and southeast zones jointly mentioned the socio-cultural constraint as being responsible for this effect. The north central zone mentioned the technical and financial constraints as causing the collapse/disruption of business while the northeast zone identified both the institutional and political constraints as the cause of business failure. The economic constraint was however identified by only the south-south zone as causing the collapse or disruption of businesses.

In an economy where there are high crime rates, fraud, poor technology, non-availability of improved technology, shortage of raw materials, poor access to market, inefficient financial markets and policy instability, among others make widespread collapse of businesses inevitable.

6.5.7 Insufficient Working Capital

The capital required for the day-to-day running of any business, including agricultural ones, can either be from the owners or from non-owners of the business or both. Inadequacy of working capital is often a result of inadequate or poor access to credit and the inability to earn sufficient income and save adequately for investment. In addition, poor macroeconomic policy environment could also cause an inadequacy of capital for investment.

The institutional constraint was highly ranked as producing insufficient working capital by the respondent groups in the northeast, northwest, southeast and southsouth. Closely ranked to the institutional constraint is the financial constraint. This was identified in the north central, northeast and southeast as being responsible for insufficient working capital. But, only the southwest zone recognized the macro-economic policy constraint is being responsible for inadequate working capital among farmers in Nigeria.

6.5.8 Low Capacity Utilization

Whenever the installed capacity of an asset is not being optimally used there is an under utilization of capacity. Low capacity utilization is an effect produced as a result of some constraints militating against investment and commercialization in the agricultural sector of Nigeria's economy. Financial and economic constraints were, respectively identified in the Southwest and Southeast zones of the country as the cause of under utilization of capacity in Nigeria's agriculture. Other zones did not see low capacity utilization in agriculture as a major effect of the various constraints

6.5.9 Poor Investment Climate

Apart from the fact that low level of investment is one of the major effects of the identified constraints, another effect is unfavorable investment climate which acts to discourage investors. Three constraints were identified as producing poor investment climate in Nigeria. Respondent groups in the southwest and north central zones of the country mentioned socio-cultural constraint, while political constraint was identified in the North central zone and macro-economic policy constraint was mentioned in the south-south zone as being responsible for the poor investment climate in Nigeria.

Political constraints manifests in the form of political instability that has such grave consequences as policy instability, frequent political crises and violence. In addition, the socio-cultural constraint manifests in the form of fraud and corruption, high crime rate, insecurity, etc. Macro-economic policy constraint manifests in form of unfavorable tax, interest rate and low income. All these in one way or the other lead to a poor climate for investment thereby discouraging investors from putting their money in investments in the agricultural sector of the economy.

6.5.10 Loss of products

One very important consequence of the constraints militating against investment and commercialization of the Nigeria's agriculture is the high losses of products due to poor storage, poor processing facilities, and/or poor transportation system in the country. Quite a substantial percentage of Nigeria's agricultural produce is lost annually due to these marketing problems brought about by the inter-play of some constraints to investment and commercialization in Nigeria's agriculture.

Respondent groups have identified technical constraints as being responsible for the loss of produce in the north central, northeast and northwest and the southwest. The north central and southwest zones identified infrastructural constrain, while only the North central zone recognized institutional constraint as being responsible for the high loss of agricultural produce.

The technical constraint manifests in lack of spare parts, poor managerial skill, non-availability of improved technology Bad roads, epileptic power supply, and inadequate storage, processing and marketing facilities are some manifestations of the infrastructural constraint.

6.5.11 Poor Quality of Products

The chief factor responsible for poor quality of products is the infrastructural constraint as identified in the northeast, northwest and southeast zones of Nigeria. The southwest zone identified both the economic and micro-economic policy constraints as being responsible for poor quality of products while the southeast zone alone identified the financial constraint as the cause of poor product quality. The poor quality of a product can be the result of inadequate processing and storage infrastructure inefficient marketing system or poor technology.

6.5.12 Poor Economic Growth

Economic growth is one of the measures of the performance of an economy. Poor economic growth is one of the combined effects produced by the various constraints to investment and commercialization agriculture. In the survey of respondent groups, the southeast zone identified macro-economic policy constraint, while the north central zone identified financial, micro-economic policy and institutional constraints as being responsible for the poor rate of economic growth. But the political constraints, manifesting in form of political and policy instability, was mentioned identified in the north central, northeast and southeast, as being responsible for the stagnation of the economy.

Agriculture is a dominant sector of the Nigerian economy. Any constraints that impede investment and commercialization in the sector will adversely affect the growth of the national economy. Not minding the fact that oil has continued to dominate the economy's source of revenue, the contribution of agriculture to the gross domestic product is still the largest.

6.5.13 Loss of Invested Fund

The loss of invested funding the agricultural sector has been recognized as one of the consequences of the various constraints to investment and commercialization of agriculture in Nigeria. The respondent groups in the south-south cited macro-economic policy constraint while those in the north central zone mentioned financial constraint as leading to loss of funds invested. On the other hand, the micro-economic policy and institutional constraints were cited by the Southwest zone as being responsible for the loss of invested fund in the sector. The element of financial constraint that is largely responsible for this effect is inefficient financial market while adverse macroeconomic policies (high interest and unstable exchange rate) are also contributory factors.

6.5.14 Loss of Life

Apart from financial losses, lives are also lost due to the persistence of some of these constraints. Two constraints were particularly cited. These are the political constraints in the southwest and the health constraints in the north central and northwest zones. Political constraint in form of political violence and crises and health constraint in form of inadequate health care facilities and prevalence of malaria and HIV/AIDS have led to loss of lives in the country in general and the rural sector in particular

6.5.15 Loss of Asset or Property

Loss of property can be through destruction by man or other agents, through theft or through inability to replace obsolete assets. The persistence of some constraints to commercialization and investment in Nigeria's agriculture has led to the loss of valuable assets, tangible and intangible. One of the

constraints mentioned as causing the loss of property is the political constraint in the southwest zone. On the other hand, socio-cultural constraint was cited by the northeast as leading to loss of assets. Political violence and crises, insecurity, high crime rate, ethnic and religious strife etc. are the elements of both political and socio-cultural constraints causing property loss in the country.

6.5.16 Loss of Confidence in the Economy

The extent of confidence that investors have in the economy tends to decrease as the constraints to investment and commercialization in the agricultural sector persists. Three constraints were identified as causing the loss of confidence by investors in the economy. The south-south zone of the country recognized both infrastructural and socio-cultural constraints as causing the loss of confidence in the economy while financial constraint was mentioned as the cause of loss of confidence in the economy in the southeast. An economy that is able to provide good road networks, adequate power supply and other utilities, efficient financial market that is devoid of high lending risk, low crime rate and no religious and ethnic strife will promote the confidence of investors in the economy.

6.5.17 High Marketing Cost

One of the effects of the persistence of the constraints to investment and commercialization in Nigeria's agriculture is the high marketing cost of agricultural products. According to the respondents sampled, two main constraints were largely responsible. These are infrastructural and macro-economic policy constraints. The elements of infrastructural constraint causing high marketing cost include bad roads and inadequate utilities, inadequate processing and storage facilities, and epileptic power supply, while unfavorable wage and income policies, import/export tariff, high and unstable interest rates regimes etc. are the elements of the macro-economic policy constraint likely to be responsible for high marketing cost.

6.5.18 High Transportation Cost

Transportation cost is one of the components of marketing cost. It is also one of the effects of the various constraints to investment and commercialization in Nigeria's agriculture. This effect was identified in the southeast and south-south zones of the country where there is a serious land degradation problem. In the south-south zone, infrastructural constraint, manifesting in the form of bad road network and inadequate transportation facilities lead to high transportation cost of agricultural inputs and. In addition, the Southeast zone recognized environmental constraint as a major factor responsible for the high cost of transportation in the zone.

6.5.19 Excessive Importation/Dumping of Fake and Substandard Products

The type and quality of food commodities imported into a country roughly determine the extent of self-reliance of the country. Excessive reliance on imported agricultural products is a major consequence of some of the constraints militating against investment and commercialization in the agricultural sector of the economy. This excessive taste for imported commodities often leads to the dumping of fake/substandard and even dangerous products in the country. According to respondents, two constraints were largely responsible for excessive commodity importation. One is the technical constraint mentioned in the southeast zone and the other is the infrastructural constraint identified in the northwest zone.

The technical constraint manifests in form of non-availability of improved technology, shortage of inputs, poor market access, poor managerial skill, and poor quality products. Infrastructural constraint on the other hand, manifests in lack of physical, social and institutional infrastructure. These combined together, will lead to inadequate local production of food leading to excessive food importation to meet local demand. Another causal constraint is social, whereby those who benefit from the country's import dependency discourage local production in order to make continued importation inevitable.

6.5.20 Uncompetitiveness of Product in the World Market

Uncompetitiveness of Nigeria's agricultural products in the international market leads poor demand for the country's products in the international market. This uncompetitive nature of products in the international market is one of the consequences of the economic constraint, which is reflected in high cost of production, high cost of marketing and poor quality of products.

6.5.21 Drudgery of farming

The non-availability of improved/modern technologies of agricultural production, which are time and energy saving, is one of the main components of the technical constraint. Only the northeast zone recognized this constraint as causing drudgery among farmers. This problem of drudgery is still a common feature of Nigeria's agriculture due to the use of rudimentary tools. And it is one of the consequences of the persistence of the technical constraints to investment and commercialization of Nigeria's agriculture. Unlocking these constraints to investment will lead to an increased use of modern technologies that will reduce the drudgery in farming.

6.5.22 Insecurity/Violence

As a result of the persistence of constraints to investment and commercialization in Nigeria's agriculture, some effects that are external to the sector are normally produced. Insecurity/violence is one of these and it may lead to loss of lives and property. From the survey conducted, both the northeast and northwest zones identified two constraints as being responsible for insecurity and/or violence. These are political and socio-cultural constraints. The elements of the political and socio-cultural constraints that are likely to cause insecurity and violence include frequent political crises high crime rate, ethnic strife, religious strife and fraud (419), among others.

6.5.23 Poverty and Suffering

The lack of basic needs necessary for decent living which leads to general suffering is one of the outcomes of the constraints to investment and commercialization in Nigeria's agriculture. Food, which is basic to human survival, is sourced from agriculture, and anything impeding investment and commercialization in the sector will not allow agriculture to perform its role of providing adequate food for the population

Only the respondent groups in the southsouth identified technical, infrastructural, political and micro-economic constraints as being responsible for poverty and suffering in the country. The elements of the technical constraints that are likely to be responsible for these are poor/non-availability of improved technology, poor quality of inputs, poor access to market, shortage of inputs and poor managerial skill. The lack of good road network, stable power supply, storage and processing facilities are elements of the infrastructural constraints that are likely to be responsible for these effects. In addition, instability of government policies, as a result of political instability, poor governance is an element of the political constraints that is responsible for this effect. Finally, the element of micro-economic policy constraint that is likely to produce these effects is the poor agricultural credit supply system.

6.5.24 Capital Flight

The transfer to other economies of the world of investment funds from the Nigerian agriculture is one of the outcomes of the constraints militating against investment and commercialization in Nigeria's agriculture. This outcome (capital flight) is not limited to the foreign capital alone as domestic capital is also disinvested from agriculture. This is largely the effect of political and economic instability that leads to unfavourable and insecure investment climate

6.5.25 Sickness/Poor Health Condition

The persistence of some constraints to investment and commercialization of the agricultural sector have been noted to cause poor health or serious health hazards in people living in some areas. Respondent groups in the northeast, southeast, south-south and southwest zones of the country attribute some of this sickness or poor health condition to the persistence of health constraints while those in the north central zone of the country attribute this effect to the persistence of the environmental constraint. The basic elements of the health constraint are inadequate health care facilities and high cost of healthcare to the people. On the other hand, poor environmental sanitation and, unsafe disposal of human and animal wastes constitute some of the elements of the environmental constraint producing poor health condition.

6.5.26 Destruction of Natural Production Resources and Loss of Biodiversity

The destruction of the natural resources that support to agricultural production is one of the consequences of serious environmental degradation especially soil erosion, deforestation, desertification, and oil spillage. All the zones of the country except, the north central identified the persistence of environmental constraint as being directly responsible for the destruction of these natural resources. Also, the northeast zone identified the overexploitation of the living natural resources (e.g.

fauna and flora) as main cause of the loss of biodiversity and the extinction of some useful plants and animals.

CHAPTER SEVEN

INVESTMENT OPTIONS IN NIGERIA'S AGRICULTURE

7.1. Attractiveness of Agricultural Enterprises to Private Investors

Investors are always willing to put their money in attractive enterprises. In Nigeria's agriculture, thirteen such main areas of investment have been identified in the course of this study. These are: input production and supply enterprises, staple food crops production enterprise, industrial crops production enterprises, livestock production enterprises, fisheries enterprises, forestry enterprises, and commodity processing and storage enterprises. Others are agricultural commodity marketing, agro-industry/manufacturing, agricultural commodity export and agricultural support services. Table 7.1 indicates the relative attractiveness of these enterprises to both foreign and local investors across the zones. A summary of the views of the respondents in the different zones reveals that foreign investors will be attracted to activities/enterprises that are capital-intensive and that add value to primary output. In this connection, downstream activities are relatively more attractive to foreign investors. On the other hand, primary/upstream enterprises and agro-services are relatively more attractive to local investors. In addition, the relative attractiveness of the different enterprises is indicative of the comparative advantage conferred on each of the zones by their agro-ecological conditions.

Activities that are infrastructure-related are not highly favored by private investors as they are seen as belonging to government domain (i.e. public goods). The general inference is that agricultural enterprises in Nigeria are fairly attractive to domestic investors while they are less attractive to foreign investors. Nine out of the thirteen enterprises are hardly attractive to foreign investors while three are fairly attractive. The remaining one is weakly attractive. Following from this, it can be inferred that foreign investors will be much more interested in input production/supply enterprises and commodity processing and agro-industry/manufacturing enterprises, all of which are downstream activities and are highly capital intensive. Domestic investors will be willing to invest in input production and supply, agricultural production enterprises, commodity processing, commodity marketing, and agro-industry/manufacturing. It follows, therefore, that both upstream and downstream agricultural enterprises are fairly attractive to domestic investors. This is probably explained by the advantages of backward and forward integration that exist between the upstream and downstream activities. Hence, domestic investors can take advantage of this interrelationship to enhance returns from their investment portfolio.

In terms of the relative attractiveness of agricultural enterprises across the zones, there exist different areas of emphasis as can be seen in the table. In the north-central zone, there are three fairly attractive and three very attractive enterprises. The fairly attractive enterprises to foreign investors are input production and supply enterprises, commodity processing enterprises and commodity marketing enterprises. Similarly, the enterprises of strongest attraction are industrial crops production, forestry, and agro-industry/manufacturing enterprises. On the other hand, staple crop production is not at all attractive for foreign investment while investments in livestock production and agricultural transport service are only weakly attractive.

The investment climate in the north-central zone is fairly attractive to local investors. The key enterprises that offer some attraction to domestic investors in this zone are staple crops production, industrial crops production, forestry, commodity processing, commodity marketing and agro-industry/manufacturing. In contrast, agricultural transport service and other agricultural support services are weakly attractive areas to domestic investors in the north-central zone.

In the northeast zone, seven agricultural enterprises have the potential to attract investment from foreign investors. These enterprises are agricultural input production/supply, livestock production, agricultural commodity processing, agricultural storage, agro-industry/manufacturing, agricultural commodity export and agricultural support services. However, industrial crops production enterprises are weakly attractive to foreign investors. At the domestic investors level, there are nine enterprises that are attractive for investment. In particular, input production/supply and provision of support services are very attractive for local investment. Further, industrial crops production and agricultural transport are fairly attractive areas of investment to domestic investors.

The investment climate in the northwest zone is attractive to foreign investors and fairly attractive to domestic investors. Three areas of fair attractiveness to foreign investors are input production/supply, commodity processing, and agro-processing/manufacturing. However, five areas are identified as being

weakly attractive for foreign investment. These are staple crops production, forestry, agricultural storage, agricultural transportation and commodity marketing. In the case of domestic investors, ten enterprises are identified to be fairly or very attractive for investment. The most attractive enterprises include input production/supply, staple crops production, commodity processing, commodity marketing and agro-industry/manufacturing. The fairly attractive enterprises are industrial crops production, livestock production, fisheries, agricultural transport and commodity export. Forestry enterprises are adjudged to be weakly attractive for domestic investment.

In the southeast zone, the investment climate is fairly attractive for both foreign and domestic investors. There are four fairly attractive enterprises for foreign investment in this zone. These are input production/supply, industrial crops production, and commodity processing and agro industry/manufacturing. Three enterprises are considered to be weakly attractive for foreign investment, viz: fisheries, agricultural storage and agricultural transport service. The local investors can invest in six enterprises, which are rated to be fairly attractive. These are staple crops production, industrial crops production, livestock production, commodity processing, commodity marketing, and agro-industry/manufacturing. An enterprise with weak attractiveness to domestic investors in the southeast zone is forestry.

The south-south zone of the country identified eight and three enterprises that are fairly attractive to foreign and domestic investors respectively. On the other hand, one enterprise was said to be weakly attractive to foreign investors compared with two identified for domestic investors. The fairly attractive enterprises for foreign investment include input production/supply, staple crops production, livestock production, fisheries, commodity processing, agricultural storage, agro industry/manufacturing and commodity export. The weakly attractive enterprises for foreign investment in the zone are those on agricultural support services. The domestic investors would find investment in staple crops production; livestock production and commodity export attractive. They would, however, not find investment in forestry and support services attractive.

Four enterprises are fairly attractive to foreign investors in the southwestern zone while five are in the same category for domestic investors. The foreign investors will be fairly attracted to investment in industrial crops production, forestry, commodity processing and commodity export. Similarly, local investors will be fairly attracted to staple crops production, industrial crops production, fisheries, forestry and commodity processing enterprises.

The reasons for the attractiveness or otherwise of the different enterprises are given in tables 7.2 and 7.3. While Appendix 7.1 gives reasons for the attractiveness of the enterprises to foreign investors, Appendix 7.2 gives the reasons for the attractiveness of the enterprises to domestic investors. Across the zones and enterprises, three main reasons stand out for the attractiveness of the enterprises to foreign investors. These are high level of demand, availability of raw materials/inputs and high rate of returns. All of these indicate economic viability of the different enterprises. There are, however, specific reasons for the attractiveness of the enterprises across the zones. For instance, lack of competing local investors is identified in the northeast as one of the reasons for the attractiveness of commodity processing to foreign investors. Similarly, poor infrastructure and high perishability of agricultural commodities are considered to be incentives for foreign investment in agricultural commodity storage.

The three main incentives for domestic investment are high demand, high rate of return and availability of raw materials. However, huge capital requirement is a disincentive for domestic investors' involvement in input production/supply enterprises and agricultural commodity processing enterprises. Similarly, land fragmentation is a major disincentive for domestic investors' participation in forestry enterprises in both the southeast and the southsouth. In sum, the potentials for domestic and foreign investment in different agricultural enterprises in the different zones of Nigeria are high, in view of the large population size of the country, the availability of abundant resources/raw materials and the opportunity to earn good returns from investment. Hence, any efforts put into removing the identified constraints to investment in Nigeria will go a long way in stimulating the flow of investment into the agricultural sector.

Table 7.1. Attractiveness of Agricultural Enterprises to Foreign and Domestic Private Investors by Zones

	INDUSTRY/ENTERPRISES	NC		NE		NW		SS		SE		SW		NIGERIA	
		FRN	DMT	FRN	DMT	FRN	DMT	FRN	DMT	FRN	DMT	FRN	DMT	FRN	DMT
i	Input production/ Supply enterprises	4	3	4	5	4	5	4	3	4	3	3	3	4	4
ii	Staple crops production enterprises	1	4	3	3	2	5	4	4	3	4	3	4	3	4
iii	Industrial crops production enterprises	5	4	2	4	3	4	3	3	4	4	4	4	3	4
iv	Livestock production enterprises	2	3	4	4	3	4	4	4	3	4	3	3	3	4
v	Fisheries	3	3	3	4	3	4	4	3	2	3	3	4	3	4
vi	Forestry	5	4	3	3	2	2	3	2	3	2	4	4	3	3
vii	Commodity processing	4	4	4	4	4	5	4	3	4	4	4	4	4	4
viii	Agricultural storage	3	3	4	3	2	3	4	3	2	3	3	3	3	3
ix	Agricultural transport	2	2	3	4	2	4	3	3	2	3	3	3	2	3
x	Commodity marketing	4	4	3	4	2	5	3	3	3	4	3	3	3	4
xi	Agro-industry/ manufacturing	5	4	4	4	4	5	4	3	4	4	3	3	4	4
xii	Commodity export	3	3	4	3	3	4	4	4	3	3	4	3	3	3
xiii	Support average	3	2	4	5	3	3	2	2	3	3	3	3	3	3
	Overall average	3	3	4	4	3	4	4	3	3	3	3	3	3	4

FRN = Foreign; DMT = Domestic

Ranking: 1 = not attractive; 2 = weekly attractive; 3 = attractive; 4 = fairly attractive; 5 = very attractive

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

Source: Field Survey, February/March, 2003.

7.2 Priority Commodities for Investment in Nigeria's Agriculture

7.2.1 Agricultural Commodities of Comparative Advantage in Nigeria

This section presents those agricultural commodities in which Nigeria is perceived to have comparative advantage in the domestic regional or world market. It also identifies factors responsible for the competitive advantage that Nigeria currently enjoys in those commodities and, finally, discusses those policies, programs or institutions to be adopted by the government and the private sector in order to strengthen Nigeria's comparative advantage in these commodities in the world market.

7.2.1.1 Agricultural Commodities of Comparative Advantage

The agricultural commodities in which the different zones have comparative advantage in the domestic regional or world market have been divided into two groups. One such area comprises unprocessed commodities, and the other comprises of processed commodities. For the unprocessed commodities, field survey results summarized in Table 7.2 show that the southern zones have comparative advantage in the production of palm produce, cocoa, yam, cocoyam, and some other tree crop commodities plus timber. The northeast and northwest have their comparative advantage in the production of cotton, gum Arabic, vegetables (tomatoes, pepper, onion, etc.), cereals and legumes. The northcentral is a transitional zone between the northern and southern zones. Hence, it has comparative advantage in the production of some commodities that are produced in the north and the south. These include soybean, yam, cassava, groundnut, maize, palm produce, citrus, cashew, etc. Although most of the commodities can be produced with comparative advantage in more than one zone, there are also some commodities that are specific to only one or two zones. Good examples of these are crayfish and shrimps in the south-south zone and shrimps in the southwest.

Table 7.2. Agricultural Commodities in which Development Domains have Comparative Advantage in the Domestic, Regional or World Market by zones

Zone	Unprocessed	Processed
North Central	Soybean, yam, cassava, benniseed, groundnuts, neem, fruits, honey, mango, cashew, palm kernel, maize, citrus.	Soya oil and meal, canned fruits, orange juice, vegetable oil.
North East	Vegetable production (tomatoes, pepper, onion etc); oil seeds production (groundnuts); Gum Arabic production, cotton.	Vegetable processing (tomatoes, pepper, onion etc); cotton lint; Gum Arabic products.
North West	Ginger, tomatoes, cotton, sorghum, groundnut, garlic, gum Arabic, soybean, sesame, cowpea and wheat.	Textiles, beer, groundnut oil, hides & skin, tomato paste, resin, leather
South East	Oil palm, cassava, yam, rice, poultry, coco yam, plantain, banana, vegetables, ginger, timber, cashew nuts, cocoa, maize, melon, rubber and copra.	Palm oil, cassava chips/garri, yam flour, fruit juice, canned fish, cocoyam chips, plantain chips, vegetable oil, cassava flour, honey, plantain flour, rubber products, cashew products and kola nuts.
South South	Cocoa, palm fruit, rubber, timber, non-timber forest products, cassava, fish, crayfish and shrimps.	Cassava chips, palm oil, latex, cassava toasted granules (garri), cocoa powder and chocolate and palm kernel oil and cake.
South West	Cassava, palm produce, cocoa, timber, oil palm, fish and shrimps.	Fish and shrimps, yam, timber, cassava, cocoa cake.

Source: Field Survey, February/March, 2003.

The processed products in which the zones have comparative advantage are derived from the unprocessed commodities listed above. In the northcentral, there are orange juice, vegetable oil, soy oil and meal, and so on. In the northeast and northwest, processed commodities in which there is comparative advantage include processed vegetables, cotton lint, textile, and hides and skin, among others. In the southern zones, processed commodities that are commonly produced across these zones include cassava products such as 'garri', 'fufu', and 'elubo', and cassava chips. Those commodities that are specific to the southeast include yam flour, rubber products, cassava products, plantain chips,

etc. Those specific to the south-south zone include cocoa powder and chocolate, and rubber latex. The southwest zone has, among others, timber, cocoa products and cassava products.

7.2.1.2 Reasons for the Comparative Advantage

The reasons cited for the comparative advantage of the various zones in the various commodities were categorized into those for processed and unprocessed commodities as shown in Table 7.3. The only reason that cuts across the zones and the commodities is that of the natural resource endowment. Each zone attributed their comparative advantage to the availability of resources required in the production of the unprocessed commodities and the availability of suitable agro-climatic environment for their production. Besides this, the northeast zone mentioned that high demand for the products, availability of infrastructure and high rate of returns on investment were responsible for its competitive advantage. In the north-central zone, relatively low cost of production and large local production base conferred on it the comparative advantage. The northwest zone, as seen in Table 7.3, identified the availability of irrigation facility and cheap labor as factors accounting for its comparative advantage. The Southeast zone recognized good high resource productivity, skilled labor, low cost of production and the relatively large production base for the crops as the reasons responsible for its comparative advantage in the production of those unprocessed commodities. The good quality of soil was one of other reasons mentioned in the south-south zone, while good quality product was one of the reasons identified by the respondent groups in the southwest as being responsible for their comparative advantage.

Table 7.3. Factors Accounting for Development Domains' Comparative Advantage in the Domestic, Regional or World Market

Zone	Unprocessed	Processed
North Central	Low cost of production, availability of resources- land and cheap labor, highest producer in the zone, large production, favorable climate.	High quality of the products in the world market, market availability, high capacity utilization, high quality raw materials.
North East	Availability of raw materials (resources endowments), high demand for the products, availability of infrastructure, availability of skilled man power, high rate of return on investment, suitable soil and climate, availability of labor and large market.	Availability of labor, high demand for products, availability of raw materials.
North West	Good quality and fertile soil, irrigation facility, suitable climate, cheap labor and its availability, natural resource endowment, high economic value.	Raw material availability, large domestic market, high productivity of resources, availability of skilled labor, natural resource endowment.
South East	Good soil/ high fertility, enabling climatic condition, availability of inputs, cheap labor, low cost of production, relative abundance of the crop, ecology of the area, high productivity, experienced labor availability, natural endowment.	Cheap labor, good climate, availability of raw material, low production cost, skilled man power availability, technological advancement, availability of large number of milled rice and high consumption level.
South South	Natural resource endowment, large forest resource, high demand by expatriates and good quality land/ soil.	Good raw material base, high output of raw materials, resources endowment, skilled manpower and good quality production especially their genetic makeup e.g. flower, odour etc.
South West	Favourable agro-climatic environment, soil type, favourable vegetation, and high quality cocoa.	Availability of raw materials, increased productivity, high returns, and materials not fully utilized. High demand.

Source: Field Survey, February/March, 2003.

The common reasons cited for the comparative advantage of the zones in the production of processed agricultural commodities included the availability of raw materials, high output/productivity and good quality products in the zones. But in the southeast zone, the availability of advanced technology for processing and large market were cited while the south-south identified good genetic make-up of crops, manifesting in the pleasant odor and flavor of the processed products, as being responsible for its comparative advantage.

7.2.2 Stakeholders' Perspective on Priority Commodities for Investment in Agriculture in Nigeria

The investment options available in the different ecological zones of the country, as identified by respondents during the field survey, are presented details in Appendices 7.3 and 7.4. The respondents used six main criteria to identify these investment options. These are natural resources availability (endowment), availability of good infrastructure, availability of skilled manpower and capital, and high productivity of resources. Other criteria are large market or high demand for products and high rate of returns on investment.

The figures in the tables show the ranking of the investment options across the zones in descending order of importance under the different commodity groups. From the table, it is observed that four key staple crops rank high for investment across the zones. These are maize, cassava, yam and rice in that descending order of importance across the zones. There are, however, some staple crops that are specific to the northern zones. These commodities include cowpea, millet and sorghum. The southeastern part of the country also specifically identified sweet potato, cocoyam and melon as staple crops with good investment potentials. In the southsouth, plantain was identified as an important area of investment option.

As regards industrial crops, investments in oil palm and vegetables cut across the zones as viable investment options. In the north-central zone, soybeans, groundnut and benniseed are the specific crops identified for investment. Cotton is an investment option identified only in the northeast. The northwest identified ginger and gum Arabic as the specific industrial crops for investment in the zone. Cocoa, cashew and citrus were industrial crops identified for investment in the south. The livestock products with investment potentials across the zones are cattle, sheep, goat, piggery, and poultry. Fish catch and aquaculture are areas of investment in fisheries. However, the southsouth also has crayfish and shrimps as potential areas of investment. In the forestry sub-sector, timber products are viable investment options in four of the six zones. Other primary commodities identified for investment include apiary (bee keeping).

At the secondary production level, the agro-industries with some investment potential in at least three zones of the country are those for cassava processing, vegetable oil processing, fruit processing and flour milling. Tannery is specific to the north while rubber processing is common to both southeast and southsouth. In the case of commodity storage, the areas of investment potentials are grain storage, cold storage and root and tuber storage. Commodity processing has flour milling, cocoa processing, and livestock feed milling as common options to at least three of the zones. Sugar and confectioneries are common to the northwest and northeast zones while cotton ginnery is an investment option for the northeast. Investment in agricultural commodity marketing has its focus on root and tuber products marketing, grain marketing, vegetable marketing and rice marketing across the zones. Agricultural input production investment options in a descending order of importance, are fertilizer plant, improved seeds, farm implements, agro-chemicals, day-old chick/fingerlings production and animal feed production.

By and large, the investment options in the different zones reflect the agro-ecological advantages of each zone, the specific food requirements of the zone, input requirements in agriculture as well as the opportunity for linkages between the upstream and downstream sectors of agriculture in the zone.

7.3. Evaluations of Agricultural Investment Options: Partial Equilibrium Approach

The participatory assessment of commodities with high market opportunities to ignite economic growth in the Nigerian agricultural sector resulted in the short-listing of six groups of commodities namely root and tubers, cereals, grain legumes, livestock and fish, vegetables, and tree crops. As expected there are regional differences across development domains within Nigeria (Table 7.4).

The next step is to conduct an ex-ante evaluation of returns to investments for those priority commodities in order to identify those that give the highest returns to investments on research and development (R&D). The results from this analysis could inform the basis for the choice of candidate commodities for future investments in Nigeria. The partial equilibrium approach (using the IFPRI DREAM model) is well suited to make such type of assessment.

The first task is to develop a scenario that considers production and consumption of a commodity; a set of technology parameters, adoption, and costs associated with R&D investments, and the period for the assessment. In line with the UN Millennium Development Goal (MDG) and IEHA, the assessment is made for a period of 17 years between 1999 and 2015. For this analysis, investments costs are not accounted for. Therefore, the stream of returns corresponds to present value of gross benefits.

An example of technology parameters and adoption is shown for cassava and cocoa in Table 7.5. For cassava, a portfolio of technologies already available include availability of improved varieties, biological control of pests and diseases, crop management, and processing of raw materials into high quality products such as High Quality Flour (HQF). Another policy innovation is the RUSEP concept of linking farmers to agro-inputs and industries. To package these technologies into a basket of option would require a period (R&D lag) of 5 to 7 years. This period is longer in dry areas than in wet areas of Nigeria. This period would be shorter for seasonal crops such as cereals or grain legumes. The expected supply shift would be about 45% with R&D and only 5% without R&D. The expected probability of success is very high because these technologies, already available from research stations, were successfully tested in on-farm conditions. The adoption lag to reach beneficiaries of a development domain would require about five years and the expected maximum adoption level is very high, especially for those development domains located in sub-humid and humid zones of Nigeria. The description of parameters for cocoa can be done using the same patterns as for cassava. It is worth mentioning here that cocoa can not be grown in dry areas of Nigeria. Therefore, there are no technology parameters on this crop for the North West, North Central, and North East regions.

The analysis was conducted on 26 commodities for which data were readily available. For example, all the forestry commodities were not included in this analysis although stakeholders ranked them as having high potentials for markets.

7.3.1 Commodities Of High Returns To Investments In Nigeria

Results indicated that country-wide cassava gives the highest benefits to investments (Figure 7.1). The next nine ranked commodities are yam, maize, millet, groundnut, rice, sorghum, poultry, vegetables, and cowpea. The second group of priority commodities include pepper, beef, oil palm, fish, melon, tomato, soybean, onion, rubber, and cocoa. The third lower ranked commodities include ginger, pork, goat, mutton, benniseed, and cashew nut. It is interesting to compare the above results with those conducted by IFPRI (2003) for West Africa (Figure 7.2). To a large extent the priority commodities identified for Nigeria are found in West Africa probably because of the heavy economic weight of Nigeria in the sub-region.

There are regional differences in the ranking of commodities within the country, which are worth highlighting. On the basis of the total benefit from each commodity, one can make the ranking of commodities in each development domain relatively to the crop ranked one. Only the first 15 ranked crops are shown in Table 7.6. The root and tuber crops (cassava and yam) come on top in the southern zones while cereals are first in the far northern zones. The northcentral zone or middle belt is a mixture of root and tubers and cereals.

Table 7.4: Commodities with Comparative Advantage for Investments as Ranked by Stakeholders in Each Development Domain

No	Primary Production						
		North Central	North East	North West	South East	South South	South west
1	Staple crop production	<ul style="list-style-type: none"> • Rice • Maize • Sorghum • Millet • Cowpea • Cassava • Yam • Beniseed 	<ul style="list-style-type: none"> • Sorghum • Maize • Millet • Cowpea • Cassava • Rice • Beniseed 	<ul style="list-style-type: none"> • Millet • Sorghum • Maize • Cowpea • Cassava • Rice • Beniseed • Maize • Yam 	<ul style="list-style-type: none"> • Yam • Cassava • Rice • Maize • Vegetables • Cowpea • Soybean • Plantain 	<ul style="list-style-type: none"> • Yam • Cassava • Rice • Maize • Cocoyam • Vegetables • Cowpea • Groudnut • Soybean • Plantain 	<ul style="list-style-type: none"> • Yam • Cassava • Maize • Vegetables • Rice • Cowpea • Groundnut • Soybean
2	Industrial crop production	<ul style="list-style-type: none"> • Soybean • Groundnut • Cotton • Vegetables • Coffee • Oil palm 	<ul style="list-style-type: none"> • Groundnut • Soybean • Cotton • Sorghum • Vegetables 	<ul style="list-style-type: none"> • Soybean • Vegetables • Groundnut 	<ul style="list-style-type: none"> • Cocoa • Oil palm • Rubber • Groundnut 	<ul style="list-style-type: none"> • Cocoa • Oil palm • Rubber • Cashew • Orange 	<ul style="list-style-type: none"> • Pineapple • Oil palm • Rubber • Cashew • Ginger • Cocoa
3	Livestock production	<ul style="list-style-type: none"> • Cattle • Sheep • Goat • Poultry • Piggery 	<ul style="list-style-type: none"> • Cattle • Sheep • Goat • Poultry • Piggery 	<ul style="list-style-type: none"> • Cattle • Sheep • Goat • Poultry • Piggery 	<ul style="list-style-type: none"> • Poultry • Sheep • Goat • Cattle • Piggery 	<ul style="list-style-type: none"> • Cattle • Small ruminant • Rabbitry • Poultry • Piggery 	<ul style="list-style-type: none"> • Cattle • Sheep • Goat • Rabbitry • Piggery • Poultry
4	Fishery	<ul style="list-style-type: none"> • Fish 	<ul style="list-style-type: none"> • Fish 	<ul style="list-style-type: none"> • Fish 	<ul style="list-style-type: none"> • Fresh fish • Smoked fish 	<ul style="list-style-type: none"> • Aqua culture 	<ul style="list-style-type: none"> • Fish • Cray fish • Shrimps
5	Forestry	<ul style="list-style-type: none"> • Gum Arabic • Ginger • Cashew nut 	<ul style="list-style-type: none"> • Gum Arabic • Fuel wood • Gmelina 	<ul style="list-style-type: none"> • Teak • Mahogany • Gmelina • Ginger 	<ul style="list-style-type: none"> • Timber • Teak 	<ul style="list-style-type: none"> • Timber 	<ul style="list-style-type: none"> • Ginger • Cashew nut

Table 7.5: Technology parameters and adoption for the ex-ante assessment of returns to investments in research and development (R&D) in Nigeria

A - cassava							
Region Group	Region	R&D Lag (years)	Supply Shift		Probability of success (%)	Adoption	
			w/o R&D (%)	with R&D (%)		Adoption lag (years)	Maximum adoption level (%)
	North West	7	5	45	70	5	80
	North Central	5	5	45	80	5	95
	North East	7	5	45	70	5	70
Nigeria	South East	5	5	45	95	5	95
	South South	5	5	45	95	5	95
	South West	5	5	45	95	5	95

Technologies: improved variety, control of pest and disease, crop management, processing and strategies for linking farmers to the market.

B - cocoa							
Region Group	Region	R&D Lag (years)	Supply Shift		Probability of success (%)	Adoption	
			w/o R&D (%)	with R&D (%)		Adoption lag (years)	Maximum adoption level (%)
	North West	0					
	North Central	0					
	North East	0					
Nigeria	South East	5		20	50	7	50
	South South	5		30	60	7	60
	South West	5		30	70	7	80

Technologies: improved variety, control of pest and disease, crop management, improved marketing power of producers.

7.3.2. Analysis By Commodity

The analysis by commodity reveals interesting and contrasting advantages of the development domains under consideration. For root and tubers and in decreasing order of importance regions with a comparative advantage for cassava are Southsouth, Northcentral, Southeast, and Southwest. Results for yams are Northcentral followed by Southsouth and Southwest (Figure 7.3). The middle belt or Northcentral is the Nigerian basket for root and tubers.

Regions of a comparative economic advantage for cereals are Northcentral, Northwest, Southwest, and Southsouth in decreasing order of importance (Figure 7.4). The far northern regions are well suited for millet with Northwest in the first position. Likewise sorghum will be first promoted in Northwest, followed by the other two northern regions. The same trend was observed for benniseed. The Northcentral region dominates rice production while the Southeast region yields lower economic returns.

The general pattern is that grain legumes should be promoted in the three northern zones (Figure 7.5) although cowpea shows some economic benefits in the southern zones of Nigeria. Leafy vegetables can be grown through out the country (Figure 7.6). The other types of vegetables gave the highest returns in the drier regions of the north.

As expected, tree crops of the humid zones also yield higher economic returns in Southsouth or Southeast (Figure 7.7). That is the case for oil palm and rubber. Southwest is specialised in cocoa while cashew nut is grown in Northeast and ginger in Northwest.

The group of livestock products shows various gradients (Figure 8.8). Beef dominates the three northern regions. That same strong trend was observed for mutton but not for goat although the northern regions gave more two-third of returns to R&D for that commodity. Pigs and fish production are dominant in the southern regions. Poultry are the only livestock product that shows an even distribution of benefits across regions.

In summary, the analysis per commodity shows tremendous opportunities of investments on the basis of the comparative of each development domain for commodities.

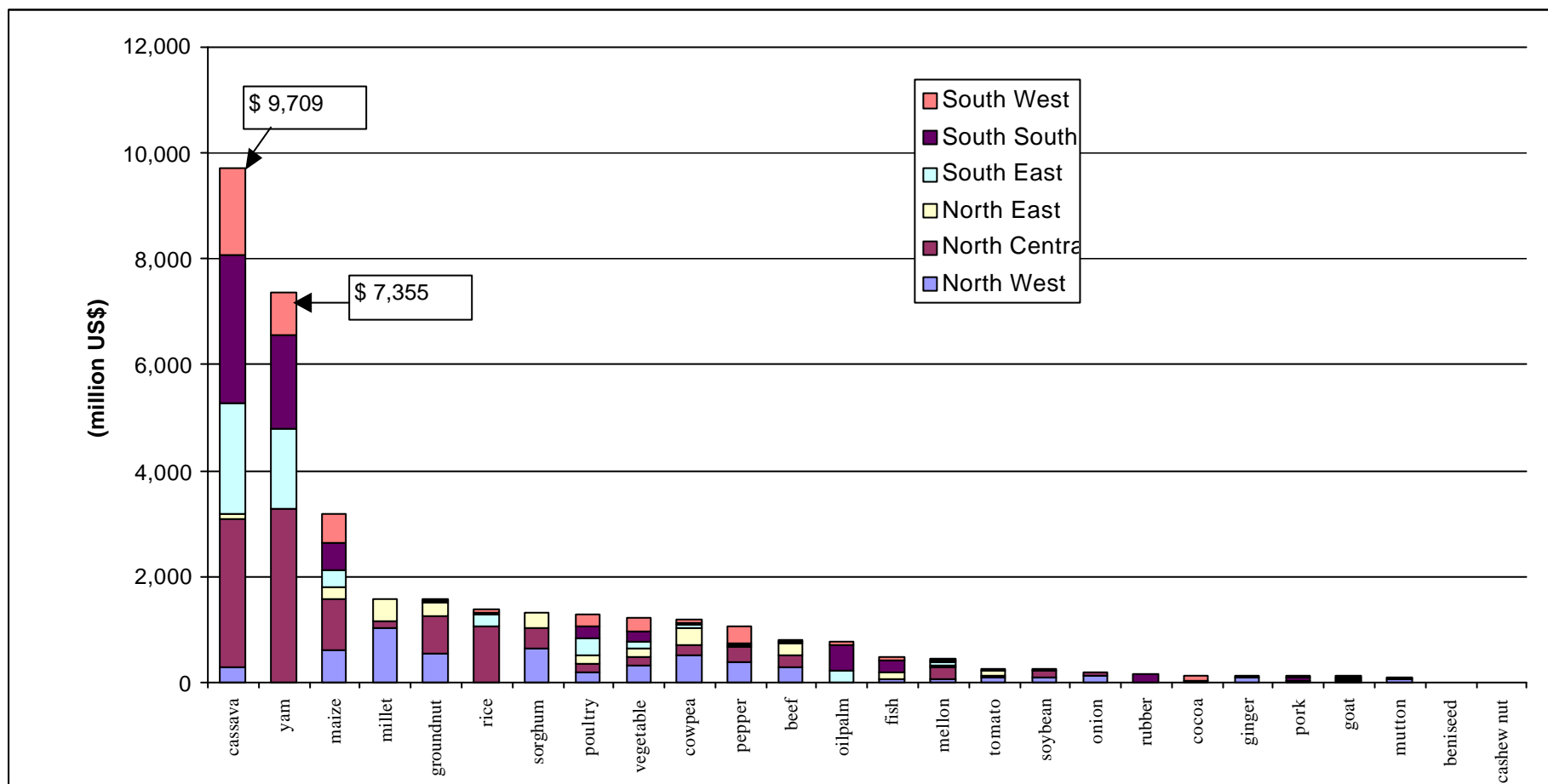


Figure 7.1: From DREAM analysis: identifying for investments in research and development in Nigeria – based on streams of benefits to producers and consumers by 2015 as a result of existing portfolio of technologies.

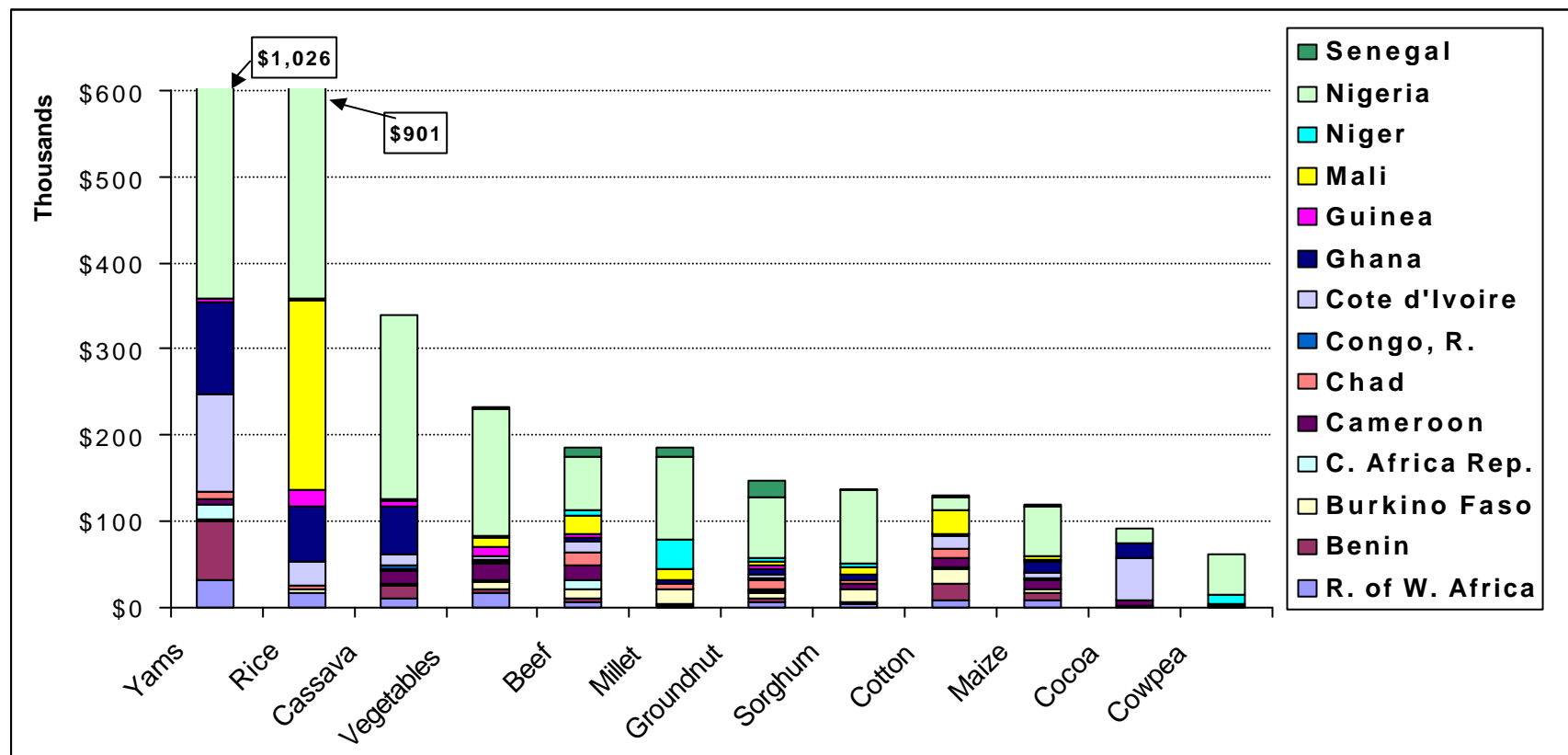


Figure 7.2: From DREAM analysis: identifying for investments in research and development in Nigeria – based on streams of benefits to producers and consumers by 2015 as a result of a one time 1% increase in productivity (IFPRI 2003)

Table 7.6. Commodity Ranking by Total Benefit in each Development Domain of Nigeria

	Northwest		Northcentral		Northeast		Southeast		Southsouth		Southwest		Nigeria	
Rank	Crop	Relativity	Crop	Relativity	Crop	Relativity	Crop	Relativity	Crop	Relativity	Crop	Relativity	Crop	Relativity
1	millet	1	yam	1	millet	1	cassava	1	cassava	1	cassava	1	cassava	1
2	sorghum	0.64	cassava	0.85	cowpea	0.75	yam	0.72	yam	0.63	yam	0.48	yam	0.70
3	maize	0.62	rice	0.32	sorghum	0.66	poultry	0.16	maize	0.18	maize	0.34	maize	0.30
4	groundnut	0.54	maize	0.29	groundnut	0.58	maize	0.16	oilpalm	0.18	pepper	0.19	millet	0.26
5	cowpea	0.52	groundnut	0.22	maize	0.57	oilpalm	0.12	fish	0.09	vegetable	0.14	groundnut	0.20
6	pepper	0.40	sorghum	0.12	beef	0.56	rice	0.11	poultry	0.07	poultry	0.14	rice	0.15
7	vegetable	0.32	pepper	0.09	vegetable	0.38	vegetable	0.07	vegetable	0.06	cocoa	0.06	sorghum	0.11
8	beef	0.29	melon	0.08	poultry	0.36	melon	0.03	rubber	0.06	rice	0.06	poultry	0.09
9	cassava	0.29	beef	0.07	fish	0.31	cowpea	0.02	pork	0.03	cowpea	0.04	vegetable	0.07
10	poultry	0.20	cowpea	0.06	cassava	0.22	beef	0.01	cowpea	0.01	oilpalm	0.04	cowpea	0.05
11	onion	0.15	poultry	0.05	tomato	0.20	fish	0.01	pepper	0.01	fish	0.03	pepper	0.05
12	tomato	0.11	vegetable	0.05	melon	0.06	groundnut	0.01	melon	0.01	tomato	0.02	beef	0.03
13	soybean	0.10	millet	0.04	goat	0.06	goat	0.00	goat	0.01	groundnut	0.02	oilpalm	0.03
14	ginger	0.09	soybean	0.04	pepper	0.05	pork	0.00	rice	0.01	melon	0.02	fish	0.03
15	mutton	0.06	onion	0.01	mutton	0.05	pepper	0.00	cocoa	0.01	beef	0.01	melon	0.02

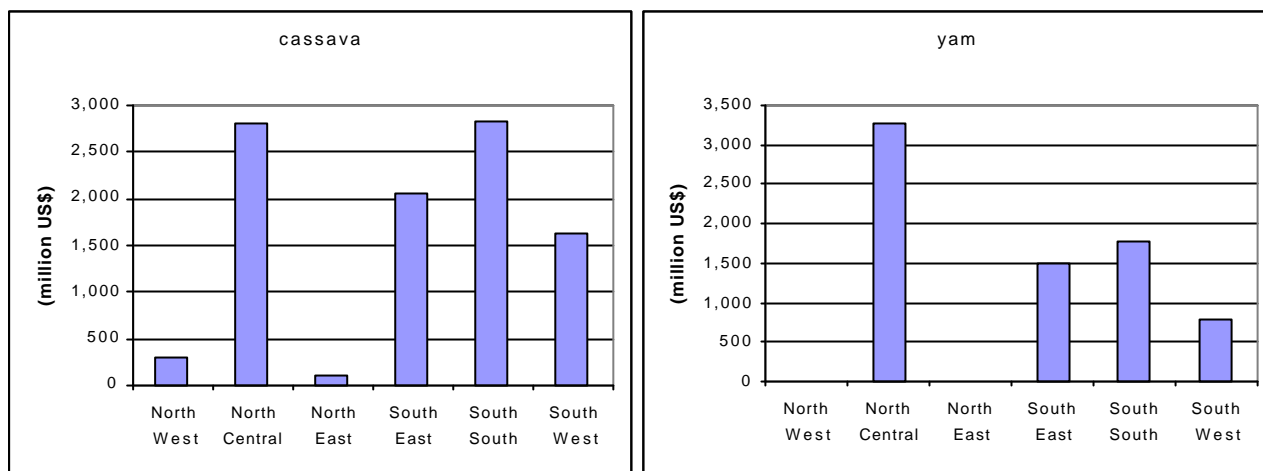


Figure 7.3: Ranking of Development Domains for Root and Tuber Crops

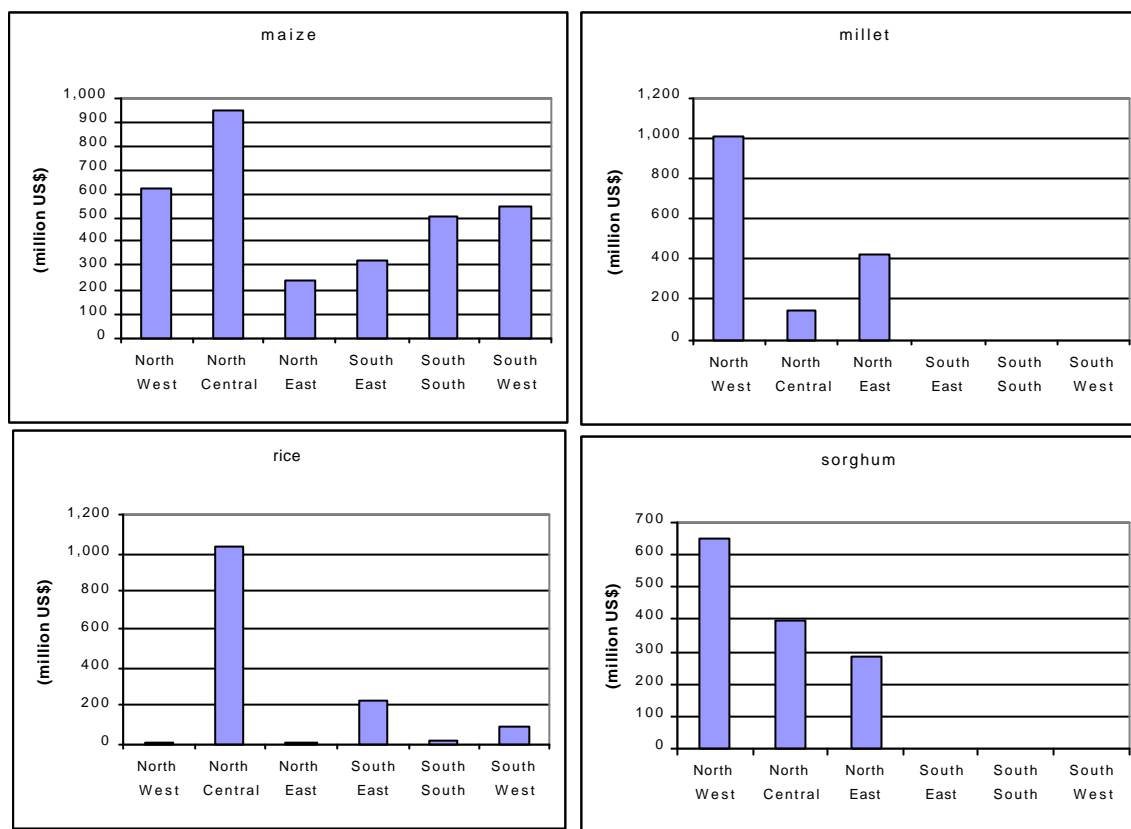


Figure 7.4: Ranking Development Domains for Cereals

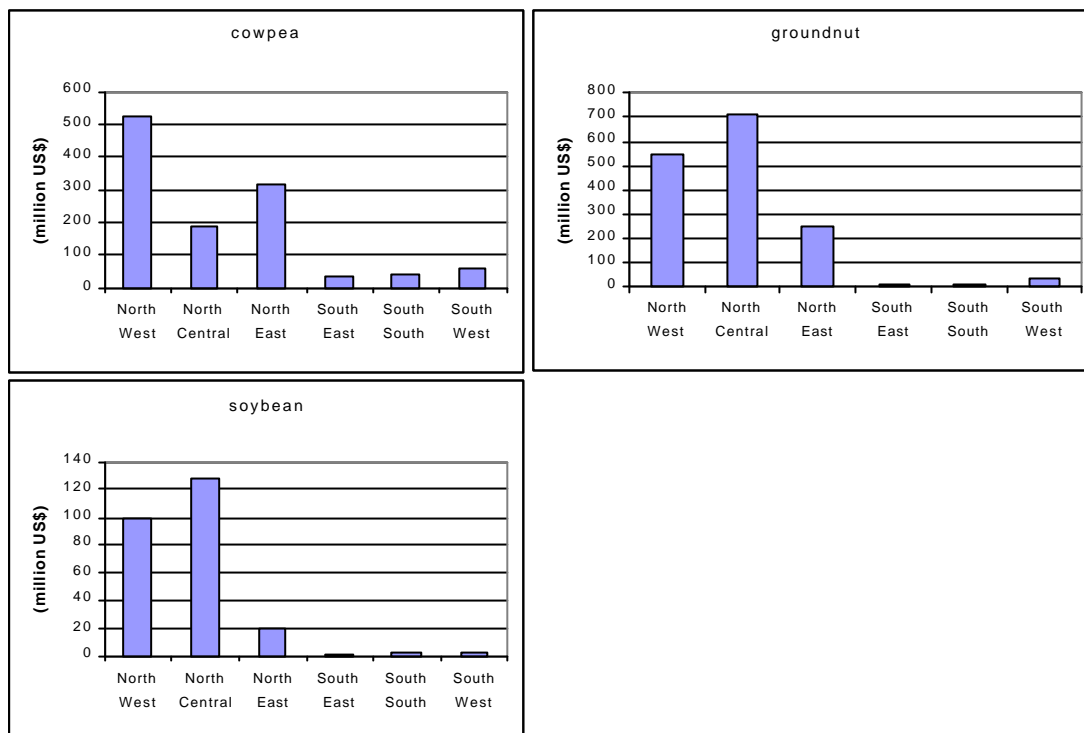


Figure 7.5: Ranking of Development Domains for Grain Legumes

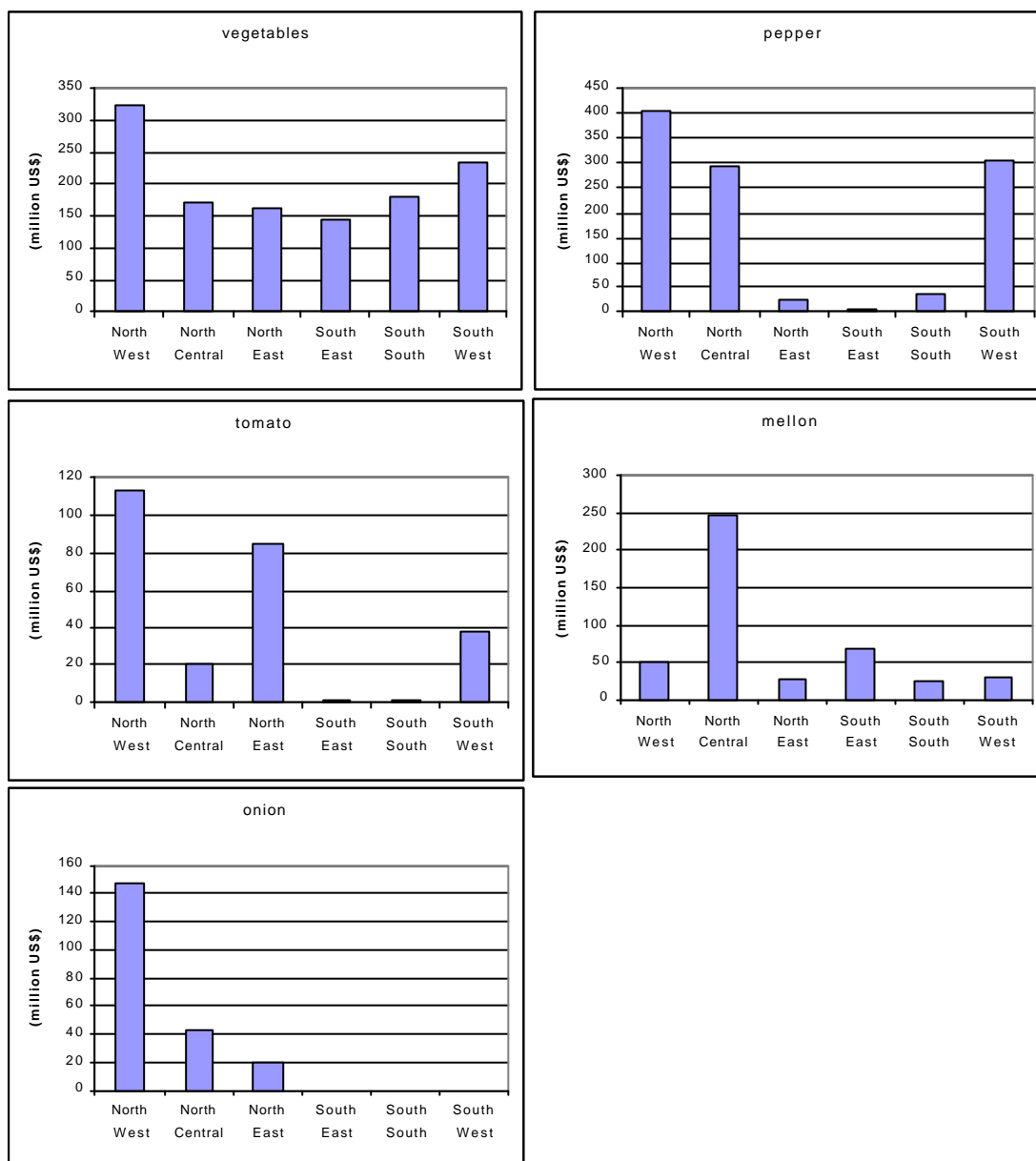


Figure 7.6: Ranking of Development Domains for Vegetables

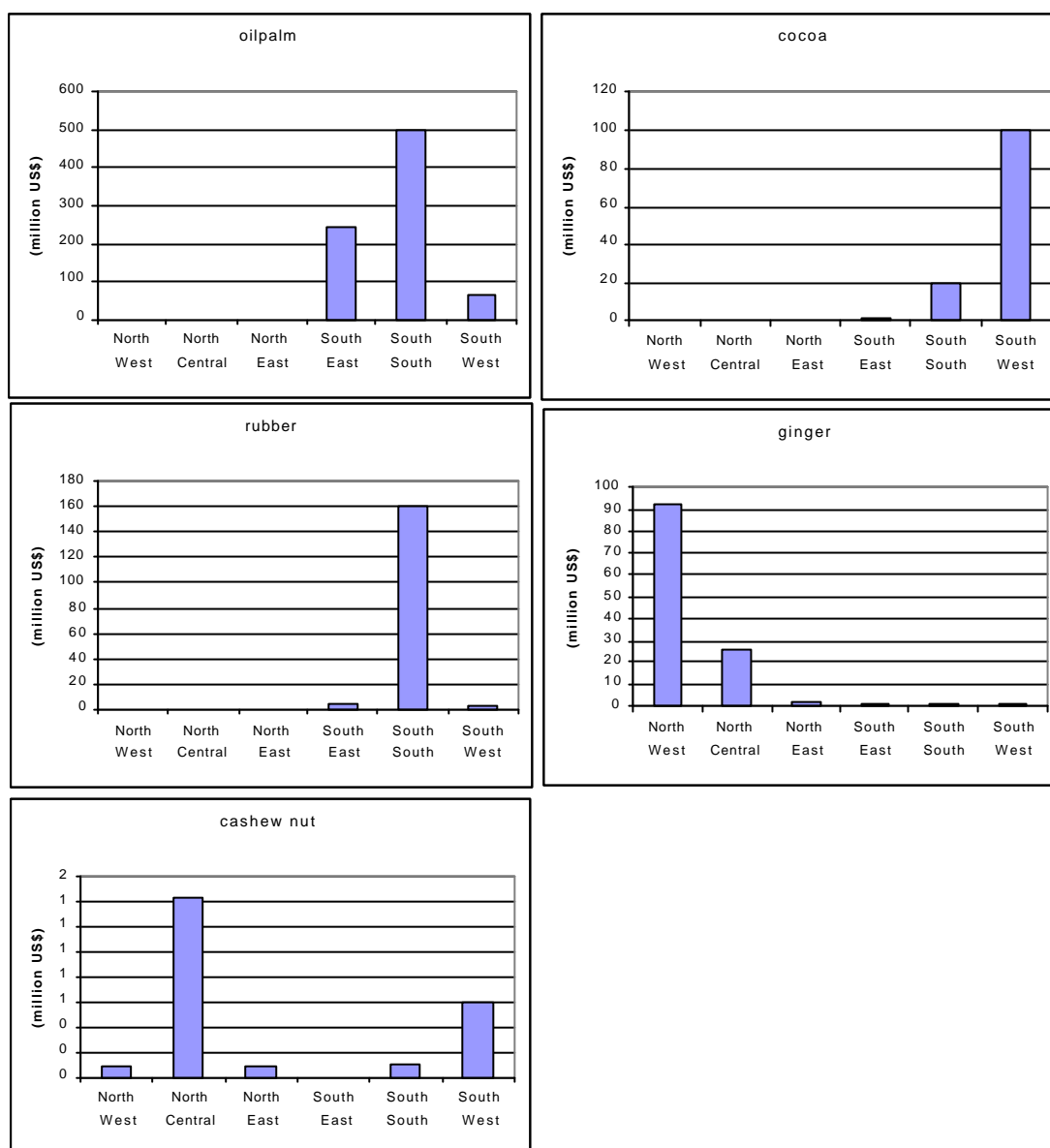


Figure 7.7: Ranking of Development Domains for Tree Crops

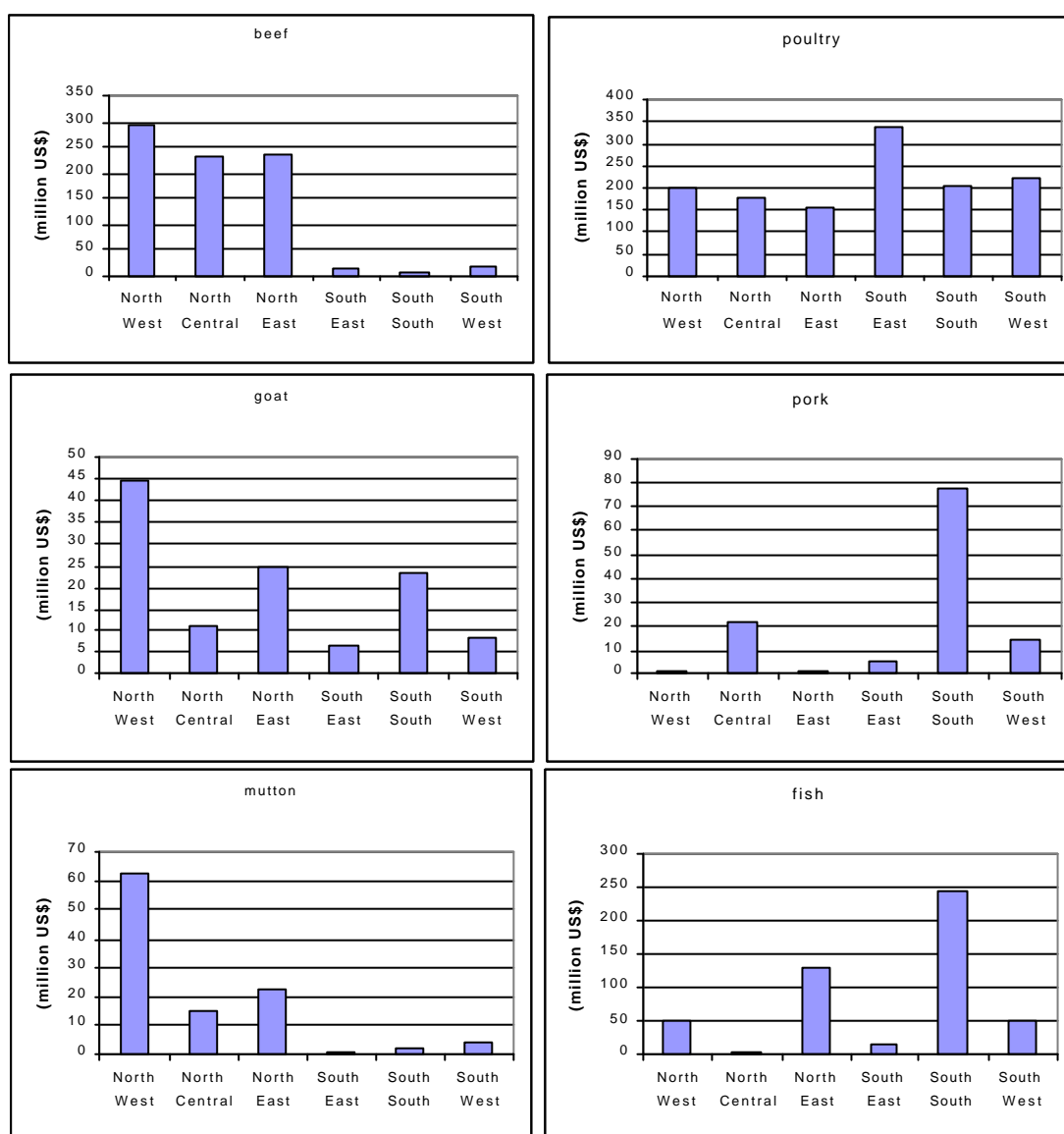


Figure 7.8: Ranking of Development Domains for Livestock Products

CHAPTER EIGHT

RECOMMENDED INTERVENTION STRATEGIES

This concluding chapter focuses on those intervention strategies that arise from the preceding chapters of this report and that the Study Team feels could assist in rapidly developing Nigeria's agriculture sector. Such strategies, when implemented, are intended to particularly:

- ✓ Accelerate both private and public domestic and foreign investments in the sector;
- ✓ Increase agricultural productive performance by improving the sector's competitiveness and commercialization;
- ✓ Mitigate negative impacts of commercialization on gender and equity;
- ✓ Enhance food security in Nigeria;
- ✓ Sustain environmental management;
- ✓ Create a conducive policy environment for developing the commodity sector; and
- ✓ Focus investments in a few but well-defined development hubs.

The level to which the above intervention objectives are attained will depend very much on the intensity of investment in the selected development domains and the implementation of those government policies affecting them. Details of recommended strategic interventions in each of these areas are discussed below.

8.1 Strategies for Accelerated Investment in Nigeria's Agriculture

Developing intervention strategies for increasing investment in Nigeria's agriculture is best done on a commodity-by-commodity basis. In this section of the study, the commodities used are those that have been selected from each development domain based on a DREAM-model analysis that previously considered not only their domestic demand levels but also their commercialization potential in the regional and international markets. Adopting this suggested approach to arrive at workable strategic options requires that we combine five pragmatic considerations:

- First, identifying the key constraint(s) on known sections of the commodity continuum that hinder(s) the complete development of each commodity system;
- Then, selecting for development support those principal commodities identified by the DREAM-model analysis in each of the six geopolitical zones;
- Thirdly, pinpointing the specific aspect(s) of the commodity continuum on which the intervention(s) would be most cost-effective and most impacting;
- Fourthly, isolating the specific policies whose systematic implementation within the specified period could eliminate or minimize the identified constraint(s) so that USAID/Nigeria or any other intervening agency can convince the Government of Nigeria (GON) to ensure their timely and assiduous implementation; and
- Finally, determining the outcome indicators that would best highlight the desired impacts of the implemented intervention(s).

Results of analyses in Chapter Six show that the first five key constraints (in descending order of importance) that continue to hinder foreign and domestic agricultural investments in the various geopolitical zones are:

- (i) *For the Northcentral:* technical, infrastructural, financial, environmental, and political constraints;
- (ii) *For the Northeast:* technical, infrastructural, economic, financial, and microeconomic policy constraints;
- (iii) *For the Northwest:* infrastructural, technical, socio-cultural, financial, economic constraints;
- (iv) *For the Southeast:* infrastructural, economic, financial, socio-cultural, and political constraints;
- (v) *For the Southsouth:* infrastructural, environmental, labor, land-tenure, and financial constraints; and
- (vi) *For the Southwest:* technical, financial, macro-economic policy, socio-cultural, and infrastructural constraints.

Thus, in descending order of importance, Nigeria as a whole has the following five most critical constraints that hinder foreign and domestic investment in her agriculture: infrastructural, financial, technical, economic, and macroeconomic policy/socio-cultural.

In the case of commodities with the highest domestic consumer demand and the greatest potential for commercialization/trade internationally, especially within the West Africa sub-region, results of the analyses in Chapter Seven show that the following are the most important (in descending order) in the various development domains:

- *For the country as a whole:* cassava, yam, maize, millet, groundnut, rice, sorghum, poultry, vegetables, cowpea, pepper, beef, oil palm, and fish;
- *For the Northcentral:* yam, cassava, rice, groundnut, maize, pepper, melon, and beef;
- *For the Northeast:* millet, cowpea, maize, beef, sorghum, groundnuts, and pepper;
- *For the Northwest:* maize, sorghum, groundnuts, cowpea, vegetables, beef, and pepper,
- *For the Southeast:* cassava, yam, poultry, maize, oil-palm, rice, and vegetables;
- *For the Southsouth:* cassava, oil-palm, fish, cocoa, yam, rubber, maize, and pineapple; and
- *For the Southwest:* cassava, cocoa, maize, pepper, poultry, and vegetables.

These commodities could form the basis for investment with expected high returns in Nigeria.

There are, however, some other commodities with great international-trade potential and that are very commercially important in certain development domains that did not show up in the partial equilibrium analysis because of their few zonal-specific distribution and comparatively little total national output.

These include:

- Gum Arabic in Northcentral and Northwest zones;
- Prawns, shrimps and plantain in the Southsouth zone;
- Dairy and associated hides and skins in the Northeast and Northcentral zones; and
- Cotton in Northcentral, Northeast, and Northwest zones.

8.2 Strategies for Increased Commercialization

Once a commodity has been selected for investment activity support, its commercialization has to be encouraged. Such increased commercialization is achievable through the adoption of any one or all of the following four suggested modules (Ikpi, 2002):

- Module 1: The integrated commodity marketing system module;
- Module 2: The public-private sector agro-industry investment module;
- Module 3: The cooperative commodity enterprise investment module; and
- Module 4: The Songhai-Project-agricultural-investment module.

Module 1: The integrated commodity marketing system module

This module requires a symbiotic link or association being formed between large operators (producers and/or processors of a named commodity) and small/medium enterprises (SMEs) in the same commodity sub-sector. The module is necessary because small-scale and medium-scale commodity-enterprise operators in the country find it financially difficult to provide the type and size of marketing infrastructure, equipment, and management staff needed to operate an assured integrated marketing system for disposing of their produce. It, therefore, becomes necessary that they form a symbiotic link or association with already existing large and successful commodity-enterprise operators who already have well-established marketing and distribution facilities within and outside the country. Such an arrangement will ensure a successful implementation of the marketing component of any selected commodity sub-sector through the provision of a ready-to-use integrated marketing system.

The implication here is for USAID/Nigeria or any other donor agency in the country to select some known large-scale operators in a given commodity sub-sector that they may have chosen to support investment activities in, and then link them with small and medium-scale enterprise (SME) operators in the same commodity sub-sector within a given geopolitical zone. Promoting such links between SMEs and large-scale operators will create very desirable commercial synergies that would greatly improve productivity and competitiveness in the sub-sector.

Module 2: The public-private sector agro-industry investment module

This module is essentially a private-sector-driven initiative in which a State government initiates a commodity agro-industrial/marketing investment by leading in the provision of the basic infrastructure and the “warehousing” of it for a limited period before handing the entire investment over to selected private sector stakeholders who, within the period of government warehousing, showed sufficient dedication and commitment to the successful running of the project. Such included stakeholders must be selected from the various sub-components of the marketing continuum, namely: raw material collection and delivery, processing/semi-processing, packaging, storage, transportation, and final sale/trade.

Two existing good examples that are already operating in the country are:

- (i) *The Akamkpa Model Agro-Industrial Village* where the Cross River State Government has successfully established a modern agro-processing facility as a model to process and/or semi-process pineapples (into pineapple chunks and pineapple juice) and cassava (into cassava chips and pellets) produced within the State for both domestic consumption and export; and
- (ii) *The Maigatari Model Commodity Free Trade Zone and Export Free Zone* created by the Jigawa State Government in the Maigatari international border town - right next to the Nigeria/Niger Republic official border. In the 7km-by-7km Export Free Zone, the Jigawa State Government has so far constructed ten model processing plant industrial houses that are to be rented by the private sector within a walled enclosure in the town. In the Commodity Free Trade Zone, various marketing facilities (like sheds, watering holes for livestock, public toilets, etc) have been provided by the government for use by traders who come there from not only Jigawa State but also other neighboring Nigerian States (Bauchi, Taraba, and Kano) and the Niger Republic during their market day on Thursdays. In both cases, the Jigawa State Government is warehousing the initial investment, maintenance, and oversight of the facilities until an agreement is worked out for handing over the entire investment facility to the private sector.

In these Cross River and Jigawa model cases, the State governments are expected to recover the cost of providing the facilities from the private sector operators who are using and will be expected to take them over ultimately. The length of time the facilities are actually warehoused will depend on how long the private sector (especially the companies that use them) takes to pay up the cost of construction or when they decide to take over and start paying back in installments.

If this module is selected by USAID/Nigeria or any other donor agency in the country and used for supporting increased investment activities in a given commodity sub-sector, it will require the Mission identifying or supporting the development of such facilities and encouraging the State government concerned to warehouse the facilities for a given period before handing it over to private-sector operators.

Module 3: *The cooperative enterprise module*

This module is recommended purely for areas where there is a spirit of natural cooperation exhibited among certain commodity farmers. The module requires the members forming and registering an association, through which they establish simple, jointly owned, and low-scale cassava processing and marketing facilities for their produce. The members could also use it to purchase farm inputs at reduced prices through quantity discounting. Where it is established, the cooperative model could become a powerful force for ensuring effective low-scale processing and distribution of farmer members' produce. Under the module, members may own their individual farms and production resources, but they collectively purchase their inputs and sell their outputs through the jointly owned marketing facilities. In a cooperative enterprise module, proceeds from sales of members' output are shared according their measured contribution to the common sale basket.

Adopting this module will require donor agencies identifying and supporting already existing groups of farmers. The secret of success in this module is that the number of cooperating operators should not be large so that commitment can easily be achieved between the associating members. Providing small recoverable loans to such groups will be a form of micro-credit to a type of non-governmental organizations.

Module 4: *The Songhai-Project investment module*

This module, named after a private-sector-operated agricultural project in Porto Novo, Benin Republic, involves the identification and use of really dedicated and knowledgeable agricultural investors to establish integrated, resource-recycling, multi-enterprise farm facilities/centers in the country for short-term training of different commodity farmers who, after completing their training, set up and/or operate their own agro-enterprises with the understanding that they can sell their produce (raw, processed, or semi-processed) through these centers. For this to happen, the centers have to be built around some already existing and successful farm, such as Zartec Farms in Ibadan, Oyo State, the Obasanjo Farm at Sango Ota in Ogun State, or the Nyako farm (Agricole Internationale) in Gombe State, etc. The idea is to encourage young agriculture graduates from the many Nigerian universities who come out of school each year to set up on their own after a one-to-two-month practical-exposure attachment to any of these

farm facilities. The success of this module would depend on the provision of micro-credit to these young farmers on completion of their attachment. The assured market for the products of the young farmers through the nationwide marketing facilities that would be established under the module should provide a means of reducing graduate unemployment while also ensuring increased food production and national food security.

It is important to note here that the success of each of the above four modules is very private-sector-dependent. Each is a demand-driven initiative that guarantees ready acceptance and ease of implementation wherever adopted. The fact that the intended beneficiaries are the engines of implementation ensures minimum conflict between the project management and the operators. Donor agencies in the country could select one of the already existing farm centers to support for the training of future young farmers who can be expected to be more commercially oriented under a competitive environment. Whichever of the above modules is adopted by a donor agency wishing to support increased investment in Nigeria's agriculture, it will require a pragmatic hands-on involvement with the beneficiary farmers. That way, measurable impacts will be easy to identify and ascertain at any given point in time.

8.3 Strategies for Mitigating Negative Impacts of Commercialization on Gender and Equity

Owing to its envisaged positive effect on income generation and resource control, commercialization usually tends to promote negative impacts on gender and equity considerations. In particular, given the current largely micro-enterprise nature of Nigeria's agriculture, the contributions of increased commercialization will effectively contribute to economic growth, domestic savings accumulation and capital formation, employment generation, and structural definition of the economy. (Ikpi, 2000c) These are all areas that usually cause class and gender struggles and equity imbalance. In order to prevent any possible negative impacts of increased commercialization in the sector, recommended strategies in section 8.2 above need to be implemented bearing in mind the following complementary strategies that donor agencies could adopt so as to mitigate or at least ameliorate them:

- Promoting the facilitation of more women involvement in the post-harvest, economic and marketing activities of commercialized agriculture through the organization and funding of various supporting social activities such as child care and group discussions to develop better social awareness of women's economic roles in society;
- Assisting women to get organized into marketing groups that can effectively carry out the commercialization of key agricultural commodities by providing such organized groups increased access to credit on a competitive basis with men; and
- Facilitating the establishment of other women empowerment groups that will promote an early start to improve girls' access to education and training in modern technical skills as well as in leadership.

For the above-suggested strategies to be effectively implemented, it will be necessary for any donor agency promoting agricultural development in Nigeria to encourage (through the setting up of deliberate programs) the training of officials in many public departments, banks and other lending institutions that have anything to do with agriculture and micro-enterprise development to recognize the economic potential of women entrepreneurs. Furthermore, implementing the above strategies will require encouraging the Nigerian government to build up networks and ensure appropriate co-ordination between all relevant government and non-government departments and institutions in the field of agribusiness promotion and development (such as credit, technical and managerial training, choice of technology, input procurement, legal counseling, marketing, and management).

8.4 Strategies for Enhanced Food Security

Analysis of stakeholder input into the choice of commodities necessary for ensuring food security in the country shows that the following commodities should be produced, processed and marketed in Nigeria: cassava, yams, maize, millet, groundnuts, rice, sorghum, poultry, vegetables, cowpea, pepper, beef, oil-palm, fish, and melon. Increased production together with greatly reduced post-harvest losses in these crops could have a positive effect in the food security situation of the country. To achieve this, the study recommends three main strategies that can enhance food availability and security:

- Increasing agricultural productivity to reduce the gap between actual yields and potential yields offered by research institutions. The results from a yield gap analysis on selected commodities shows that crop yields could be increased up to 6.5 times the current achievements in farmers' fields (see Table 8.1);

- ❑ Intervening in the post-harvest processing and preservation activities of the commodity continuum that will reduce major losses in crops like cassava, yams, vegetables, and cowpea. Current estimates show that post-harvest losses in these crops range from 35% in cowpea (due to poor handling and packaging and pest attack) to as high as 55% in cassava (due to delays in processing and poorly-developed marketing infrastructure);
- ❑ Promoting the establishment, hosting and management of an easily accessible and comprehensive national database/center that could store data at household and national levels on all aspects of food production, domestic consumption, food processing/semi-processing, and commercialization/trade on every food commodity of the country. Such a database Center will be charged with the responsibility of constantly analyzing and updating data and information for the purpose of monitoring the status of food security at the household, State, and national levels in order to facilitate easy inter-state comparisons using an index of food security and a battery of food security indicators that are developed and commonly accepted for all States in the country; and
- ❑ Building capacity of government officials from the various States of the country in monitoring the status of food security of their States by providing hands-on training for them on the methods of data collection and analysis in food security using software and economic models that fit their development zones' specific needs.

Table 8.1: Yield gaps of selected commodities.

Crop Name	Actual yield (t/ha)	Potential yield (t/ha)	Yield gap (%)	Development Zone
Millet	1.1	5.4	391	NW, NE
Maize	2.8	7	150	NW
Sorghum	1.14	5	339	NW
Rice	3	5	67	NC
Sesame	0.55	2	264	NC
Yam	11.36	30	164	NC, SE, SS
Cassava	12	45	275	SW, SS, SE, NC
Cowpea	1.4	4	186	NW, NE
Groundnut	1.15	3.5	204	NW, NE
Soybean	1.53	4	161	NC, NW
Vegetables (leafy)	4.28	6.1	43	SW, SS, SE, NC
Melon	1.1	2.5	127	NC
Tomato	6.9	18	161	NW, NE
Onion	15	18.5	23	NW, NE
Ginger	6.55	50	663	NC
Cocoa	0.3	1	233	SW

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

8.5 Strategies for Sustainable Environmental Management

Increased investment in the agriculture sector of Nigeria and the resulting commercialization of products will most likely pose increased threat to environmental damage either through land degradation, pollution of the ecosystem by the effluent of processed agricultural commodities, or the exhaustion of agricultural resources. Sustaining the agriculture environment will require adopting the following strategies:

- Promotion and adoption of proper cultural practices associated with various commodities recommended by developers of improved agricultural technology packages for increasing Nigeria's agricultural productivity;

- Adoption of post-harvest processing technologies that minimize waste and control pollution of the environment; and
- Use of crop and/or livestock mix enterprises that prevent erosion and minimize soil degradation.

8.6 Sectoral Policies for Specific Priority Commodities

There is the need to design policies for a specific commodity in order to attract investments towards that particular commodity along the continuum from production to consumption. Promoting investment into commodities through sectoral policies could involve the following strategies:

- Promotion and creation of lobbying groups to look after the interests of the commodity. A mixture of actors with a stake at the commodity will constitute the lobbying group;
- Design and adoption of grades and standards that favour the utilisation of existing products and the development of new products with added value; and
- Creation of an enabling macro-economic policy that facilitates the commercialisation of products; therefore contributing to an appeal of private investments.

8.7. Regional Development Hubs

The implementation of the above strategies would yield remarkable results if investments were geographically concentrated in well-identified high-potential areas. *Three* regional development hubs along major agro-ecological zones seem to emerge from the priority commodities identified in Chapter 7 for consideration by USAID/Nigeria or any other development investor, namely:

- The *northern development hub* could be built on grain legumes and cereals. In this connection, cowpea, groundnut, soybean, maize, and sorghum are emerging as leading commodities. Rotating these commodities will be environmentally sound, especially if coupled with livestock. Tree crops such as gum Arabic or ginger and livestock hides and skins offer high potentials for export. This zonal hub will greatly benefit from national research centers located at the extreme northwest such as the Institute of Agricultural Research (IAR) and at the extreme northeast, the Lake Chad Agricultural Research Institute (LCARI).
- A mixture of cereals and roots and tubers characterizes the *central development hub*. Rice for cereals and yam for roots and tubers form the leading commodities for the zone that could benefit from research centers such as the National Cereals Research Institute (NCRI) located in the middle belt of this zonal hub.
- The *southern development hub* includes many states of southern Nigeria. Cassava and yam are the dominant commodities. Cocoa, fish, and plantain offer additional opportunities for export, food security, and income generation. National Root Crop Research Institute (NRCRI) and Cocoa Research Institute of Nigeria (CRIN) are the national research institutes that can back up the implementation of the strategy for this region.
- The above major development hubs can further disaggregated in sub-hubs on the basis of the geographic and economic comparative advantage of a priority commodity.

8.8. Recommended Future Studies

Three future in-depth studies are recommended in this section as action plans to be implemented by USAID/Nigeria and other development donor agencies in the country. The studies center on three major intervention areas that are considered critical to the attainment of the stated strategic objectives in the country's agriculture sector, namely:

- A *sub-sector concentration analysis study* that will identify meaningful interventions for optimal project impacts along the major commodity continuum sections;
- A *downstream agriculture activities' study* that specifies which products and processes are needed for increased high value-added outputs of the selected commodities; and
- An *integrated monitoring and evaluation program design* that will develop a strategic knowledge management and evaluation system with well-defined impact indices for each selected priority commodity in the regional hubs of the country.

These three areas of intervention are discussed individually below.

8.8.1 Subsector Concentration Analysis

In order to meaningfully implement the above-recommended strategies, there is a need for an in-depth study that should focus analysis on the specific commodity development sections in each selected commodity project that USAID/Nigeria is implementing. Such a study will:

- Identify the portion of the commodity continuum (production, processing, packaging, storage and/or quality control) that needs appropriate intervention;

- Include detailed structure-conduct-and-performance model analysis for each of commodity sector selected for development concentration;
- Identify specific input requirements that will support the regional hub development approach recommended above for selected commodity sectors;

8.8.2. Downstream Agricultural Commodity Activities

Primary agricultural production activities encompassing crop planting and harvesting constitute upstream agricultural commodity activities from which primary commodities emerge. Following these are some essential secondary or post-harvest activities that constitute downstream activities. These secondary activities are important because they add value to the primary product, improving its quality and rendering it less perishable. In general, downstream commodity activities improve the market opportunities for agricultural products and promote their commercialization, enhancing not only its competitiveness in the market but also the rate of return on their investment.

Key downstream commodity activities include: storage, processing into intermediate or final (finished) products, and marketing/distribution through domestic and/or export trade. Key intermediate supporting services for these downstream activities include adequate infrastructure (physical, economic, and social), efficient financial institutions, adequate human capital, relevant local organizations (such as community-based organizations, farmer organizations, etc.), transport services and commodity grading and quality control services. Availability of primary products, efficient storage and processing technologies and efficient marketing systems with modern market information system are pre-requisites for successful downstream activities.

Having identified priority primary commodities that can be produced in the various zones of the country in this AIN study, a logical follow-up study would be to examine the nature and state of existing downstream activities currently in practice with respect to these priority commodities in the various zones, identify available technologies, infrastructure, institutions, organizations and services that support these downstream activities, evaluate them for adequacy, identify bottlenecks and constraints associated with them and propose policy, institutional and organizational frameworks for improved performance. It is a well-known fact that wealth creation in a country comes about returns to investments in the secondary or manufactured sectors.

Specifically, the study of downstream activities for the identified priority commodities will have the following objectives:

- (i) To identify and critically evaluate available technologies for commodity storage, processing and marketing/trade with a view to identifying weak links and bottlenecks in them.
- (ii) To examine policies, institutions and organizations that support downstream activities with a view to identifying bottlenecks in them.
- (iii) To carry out an investment opportunity analysis of these downstream activities in relation to the priority commodities already identified in the various zones.

Following the analysis of data, requisite technological infrastructural, policy, institutional and organizational components required to support development projects for the priority commodities already identified in the various zones will be recommended.

8.8.3 Strategic Knowledge Management and Evaluation System

This study recommended the adoption of an integrated production-to-consumption chain approach centered on the most profitable commodities identified during the course of this study. The integrated projects would be science-based. Therefore, they would be located strategically in areas where they can be backed up by national research centres within each regional hub.

Equally important to the success of an integrated project is the development of a Strategic Knowledge Management and Evaluation System (SKMES) within each integrated project. The SKMES would constitute a separate but integrated module that aims at evaluating the economic, financial, technical, institutional, environmental, and social performance of the integrated project. The SKMES would assist the project in:

- The development of performance monitoring and evaluation indicators that are in line with the objectives of economic growth of IEHA.

- The constitution of benchmarks against which progress can be measured.
- The monitoring of project performances according to agreed milestones and activities.
- The measurement of benefits generated by the project in the short, medium and long term.

An important issue that emerged from the completed study is related to the availability and quality of data used in the strategic analysis of investment options. Stakeholders perceived several commodities to be important in some of the development domains such as plantain and banana and shrimps in the Southsouth zone, or gum Arabic in the Northwest zone and Northeast zones and cotton in the Northwest. Forest products did not enter the ex-ante evaluation of returns because of lack of data. The rigorous evaluation of benefits also requires not-often used data such as elasticity of production and consumption, probability of success, spillover parameters for benefits, etc. These data are not always readily available. One major task for SKMES would be a continuous development and refinement of databases required for the performance monitoring and evaluation of integrated projects. SKMES would also identify and recommend appropriate statistical programmes and software packages for easy and effective monitoring and evaluation of projects.

As an integrated component of projects, SKMES would ensure that the project implements steps that lead to success. Therefore, SKMES would have to carry out periodic training sessions in favour of all staff involved in the implementation of the integrated project to improve on skills and expertise within the project.

REFERENCES

- Adams, C.S. (1992). Recent developments in econometric methods. An application to the demand for money in Kenya. AERC Spcaial Paper 15. September
- Ajakaiye Olu (1997). The Structural Adjustment Program and Changes in the Structure of Production in Nigeria 1986-1994 NCEMA Monograph Series No. 9. Ibadan
- Ahmed, A. (1988): "Strategies for Foreign Investment Promotion in Nigeria" in *Giant Strides*. VBO International Limited, Vol. 2.
- Ajibola, B. (1988): "Legal Protection of Foreign Investment in Nigeria." In *Giant Strides*. Lagos: VBO International Limited, Vol. 2.
- Akpokodje Godwin, Frederic Lancon, and Olaf Erenstein (2001). Nigeria's Rice Economy: State of the Art. WARDA. Bouake, Cote d'Ivoire
- Alston, J.M., G.W. Norton, and P.G. Pardey. 1995. Science Under Scarcity: Principles and Practices for Agricultural Research Evaluation and Priority Setting. CAB International (CABI), Wallingford, U.K.
- Alston, J. M. P.G. Pardey, S. Wood, and L. You. 2000. Strategic technology investments for LAC agriculture: a framework for evaluating the local and spillover effects of R&D. International Food Policy Research Institute, Washington, D.C
- Alston, J.M. and W.K. Wohlgenant. 1990. Measuring research benefits using linear elasticity equilibrium displacement models. In: J.D. Mullen and J.M. Alston, *The Returns of the Australian Wool Industry from Investment in R&D (Appendix 2)*, Rural & Resource Economics Report No. 10, New South Wales Department of Agriculture and Fisheries, Sydney, Australia.
- Anon (2000): "IMF-Nigeria Ratify Memorandum on Economic Policies." Reported in *Nigerian Tribune*, August 9.
- ARD, Inc. (2002). Nigeria Environmental Analysis Final Report. Vermont, USA.
- Aremu, J.A. (1997): *Foreign Private Investment: Issues, Determinants, Performance and Promotion*. CBN Research Department Seminar paper No.4.
- Babalola, J.A. and Adegbite, M.A. (2001): "The Performance of the Nigerian Capital Market Since Deregulation in 1986" *CBN Economic and Financial Review*, Vol. 39 No.1, March..
- Balogun, E.D. and Otu M.F. (1991): "Credit Policies and Agricultural Development in Nigeria." *CBN Economic and Financial Review*, Vol. 29 No.2, June.
- Buxton M. Boyd (2001). An Assessment of the Dairy and Feed Industries in Nigeria. A Consultant Report to Land O'Lakes. USAID Abuja, Nigeria.
- Cardoso, Eliana (1993). Private Investment in Latin America. Economic Development and Cultural Change 41(4), 833-848.
- CBN (1999): *Infrastructure Expenditure Policy and Private Sector Output in Nigeria, 1970-1998*.
- CBN (2000): *Statistical Bulletin*, Vol. 11 No. 2, December.
- CBN (2001): *Annual Report and Statement of Accounts*. CBN, Abuja.
- CBN/World Bank (1996). *Nigeria: Prospects for Development (a.k.a. vision 2020)*. Proceedings of a Workshop held at Abuja.
- Central Bank of Nigeria (CBN) (1998): *Issues in Agricultural Input Policy: An Empirical Evaluation of Fertilizer Production, Distribution and Price Subsidy in Nigeria*.
- Chemonics International Inc. (2002). Agribusiness Development Assistance Project in Nigeria. Export Opportunities for Sesame and Cashew, Prawn and Shrimp Production, Hides and Skins in Nigeria. Powerpoint presentation. Nikkon Hotel, Abuja, Nigeria. November 2002.
- Chete, L.N. and Akpokodje, G.A. (1997): "Macroeconomic Determinants of Domestic Private Investment in Nigeria: An Empirical Exploration." *CBN Economic and Financial Review*, Vol. 39 No. 1, March.
- Dalil, A.A. (1988): "The Historical Survey and Development of Foreign Investment Policy in Nigeria." In *Giant Strides*, Vol. 2, Lagos: VBO International Limited.
- Dornbusch, Rudiger and Alejundro Reynoso (1989): Financial factors in economic development, American Economic Review, Papers and Proceedings 6(79), 204-209
- Ekpo, A.H. (1997): " Foreign Direct Investment in Nigeria: Evidence from Time Series Data." *CBN Economic and Financial Review*, Vol. 39 No. 1, March.
- Eleazu, U. (1988): "Strategies for Attracting Foreign Investment in Nigeria." In *Giant Strides*, Lagos: VBO International Limited, Vol. 2.
- Federal Environmental Protection Agency (FEPA) (1999): *National Policy on the Environment*, FEPA, Abuja.

- Federal Ministry of Agriculture and Rural Development (FMARD) (1999): *Report of the National Committee on Marketing Problems of Farmers in Nigeria*.
- Federal Ministry of Environment (2002): *Sustainable Development in Nigeria: Ten Years After Rio (UNCED)*, National Assessment Report (main version). Prepared for the World Summit on Sustainable Development, Johannesburg, South Africa, August/September, 2002.
- Federal Office of Statistics (FOS) (1999): *National Accounts of Nigeria, 1981–1998*, FOS, Abuja.
- FOS (1999): *Annual Abstract of Statistics*. FOS, Abuja.
- Froot, Kenneth and Paul Krugman (1990). Market-based External Debt Reduction for Developing countries: Principles and Prospects. Unpublished, Cambridge Massachusetts, National Bureau for Economic research.
- Greene, J. and D. Villaneuva (1991). Private Investment in Developing countries: An Empirical Analysis IMF Staff Paper 38: 33-58.
- Idachaba, F.S. (1998): *Instability of National Agricultural Research Systems in Sub-Saharan African: Lessons from Nigeria*.” ISNAR Research Report No. 13, The Hague, Netherlands.
- IFDC (2001): *Agricultural Input Markets in Nigeria: An Assessment and A strategy for Development*. IFDC, USA.
- IFPRI (2003): IEHA Analysis & Knowledge Management System (AKMS): Results from the First Technical Group Meeting (14-16th January 2003) IFPRI, IITA, ILRI, IFDC Technical Group IFPRI, Washington D.C. USA
- Ikpi, A.E. (2000): *Nigeria's Agricultural Sector Assessment: Issues of Technology Development and Transfer*. Prepared for USAID/AFR/SD, Washington, DC, USA
- Ikpi, A.E. (2002): “Trade Facilitation, Market Development and Agro-enterprise Support in the 2nd Fadama Development Project in Nigeria”, a Report prepared as input into the World Bank's Preparation Mission Report on FADAMA II, Abuja, Nigeria
- Ikpi, A.E., and Olayemi J.K. (ed.) (1995): *Sustainable Agriculture and Economic Development in Nigeria*. African Rural Social Sciences Research Networks (ARSSRN), Winrock International, U.S.A.
- IMF
- Iwayemi, A (2000): *JFA-PRESA: National Review Workshop on Investment for Poverty Reducing Employment (IPRE) Study*. Draft Final Report, Prepared for the International Labor Organization (ILO)
- Iwayemi, A. (1995): “External Debt and Capital Flows in Nigeria” In Iwayemi, A. (ed.). *Macroeconomic Policy Issues in an Open Economy: A Case Study of Nigeria*, NCEMA, Ibadan, Nigeria
- Iwayemi, A. (ed) (1995): *Macroeconomic Policy Issues in an Open Developing Economy: A Case Study of Nigeria*, NCEMA, Ibadan.
- Jerome, Afeikhena, and Associates (1999): “Private Sector Investment.” *Jobs for AFRICA/ PRESA Nigeria Investment for Poverty-Reducing Employment (IPRE) Study*. Interim Report.
- Kalegha, J.O. (1996): “Trade Policy.” . In Awoseyila A.P. (ed.) *Nigeria: Prospects for Development (a.k.a. vision 2020) Proceedings of a CBN/World Bank Collaborative Study Workshop*, held at Sheraton Hotel and Towers, Abuja, April 15 – 17.
- Mamman, I. (1988): “Nigeria's Foreign Trade Policy”. In *Giant Strides*. Lagos: VBO International Limited, vol. 2.
- Nasko, M.G. (1988): “Agriculture.” In *Giant Strides*. Lagos: VBO International Limited vol. 2.
- Nigeria (2001): *New Agricultural Policy*. FMARD, Abuja.
- Nigeria Investment Promotion Commission (NIPC) (2003): *Agricultural Sector Profile*. Unpublished report.
- Nigerian Institute of Social and Economic Research (NISER)(2001): *The State in Nigerian Development: NISER Review of Nigerian Development, 2000*. NISER, Ibadan.
- _____ (2001): “Structure of Agricultural Production” in *NISER Review of Nigerian Development, 2000*. NISER, Ibadan
- _____ (2001): “The State in Nigerian Agricultural Development in *NISER Review of Nigerian Development 2000*. NISER Ibadan.
- Njoku, P.C. (1998): “Nigerian Agriculture and the Challenges of the 21st Century.” Faculty Lecture, Faculty of Agriculture, University of Nigeria, Nsukka.
- Nwachukwu, I.O.S. (1988): “Foreign Policy Strategies for Attracting Foreign Investment”. In *Giant Strides*. Lagos: VBO International Limited (1988), Vol. 2.
- Obayomi, W. (1996): “The Business Climate: Legal Framework. In Awoseyila A.P. (ed.) *Nigeria: Prospects for Development (a.k.a. Vision 2020) Proceedings of a CBN/World Bank Collaborative Study Workshop*, held at Sheraton Hotel and Towers, Abuja, April 15 – 17.

- Ogunfowora, O., Olayemi, J.K., Mabawonku, A.F. and Okunfulure O.E. (1985): *A Study of Commercial Agriculture in Nigeria*,. A study Commissioned by the Federal Department of Agricultural Planning, Lagos.
- Ojikutu, A. (1988): "Strategies for Effective Development of Small-Scale Industries." In *Giant Strides*. Lagos: VBO International Limited, Vol. 2
- Okigbo, B. (1988): "Large-Scale Agriculture and Integrated Agro-Industries." In *Giant Strides*. Lagos: VBO International Limited, Vol. 2
- Okunmadewa, F. and Olayemi, J.K. (1999): *Nigeria: Globalization, Policy Changes and Agricultural Research and Development*. Commissioned Technical Report Prepared for ISNAR, The Hague.
- Olayemi, J.K. (1988): "Agricultural Policies and Programs in Nigeria." Unpublished paper.
- Olayemi, J.K. and Akinyosoye, V.O. (1989): *A Review of the Nigerian Economy and the Agricultural Sector*. FACU-IFAD Research Report.
- Olayemi, J.K. and Dittoh, Saah (1995): "Macroeconomic Policies and the Agricultural Sector". In Iwayemi, A. (ed.) *Macroeconomic Policy Issues in an Open Developing Economy: A Case Study of Nigeria* NCEMA, Ibadan.
- Olayemi, J.K. (1995): *Issues in Nigerian Food Security*. Working paper. Development Policy Centre, Ibadan.
- Olorunshola, J.A. (2001): "Industrial Financing in Nigeria: A Review of Institutional Arrangements." *CBN Economic and Financial Review*, Vol. 39 No. 1, March.
- Omoniyi, S.E. (1996): "Role of Private Investment Flows, Aid and Debt Relief. In Awoseyila A.P. (ed.) *Nigeria: Prospects for Development (a.k.a. Vision 2020) Proceedings of a CBN/World Bank Collaborative Study Workshop*, held at Sheraton Hotel and Towers, Abuja, April 15 – 17.
- Onyenweaku, C.E. (2000): "Policy Issues and Strategies for Agricultural Production in Nigeria." Paper Presented at the National Workshop on Enhancing Research and Development in Agriculture and Root Crops Towards Poverty Alleviation and Rural Development in Nigeria. NRCRI, Umudike.
- Oyejide, T.A. Ogunkola E.O. and Ndung'u, N.S. (2002). *Trade, Investment and Growth in Africa: Patterns, Trends and Puzzles*. Unpublished report.
- Rama Martin (1990). Empirical Investment Equations in Developing countries. Policy, Planning and Research Working Papers Series 563 World Bank, Washington D.C.
- Salako, H.A. and Adebuseyi, B.S. (2001): "Determinants of Foreign Direct Investment in Nigeria: An Empirical Investigation." *CBN Economic and Financial Review*, Vol. 39, No. 1, March.
- Serven L. and A. Solimano (1991). Adjustment Policies and Investment Performance in Developing Dountries: Theory, country experiences and policy Implications Policy, Planning and Research Working Papers. Series 606 World Bank, Washington D.C.
- VBO International Limited (1988): *Giant Strides*, Vol. 2. Lagos: VBO International Limited.
- World Bank (2002): *World Development Report 2002: Building Institutions for Markets*.
- Wood, S., L. You, and W. Baitx. 2000. DREAM User Manual 2000.

APPENDICES

Appendix 4.1: Agricultural Sector Policies

Policy		Objectives	Policy Strategies
1.	1. Commodity Pricing Policy	Remunerative prices and income for farmers. Stable prices and income for farmers. Competitiveness of Nigerian agricultural commodities in the world market. Agricultural imports not to enjoy undue comparative price advantage over local substitutes. Parity in agricultural prices compared to non-agricultural prices.	Market information expansion and access with emphasis on sub-regional and regional markets and the markets of major trading partners. Operationalisation of the Multi-Commodity Development and Marketing Companies.
2.	Agricultural Trade Policy	Promotion of agricultural export and local production for import substitution.	In addition to the existing policy strategies, WTO issues will be integrated into the trade policy to take advantage of available caveats such as those within market access (trade ceiling bindings,, tariffication, tariff rate, quotas and tariff commitments), domestic support (subsidy to resource-poor or low-income producers, and green box measures), and export competition (capped export subsidies and export restriction on importing members' food security.
3.	Exchange Rate	Realignment of exchange rate	Strict enforcement of foreign exchange regulations.
4.	Agricultural Land	Nationally acceptable land tenure system. Optimal utilization of available agricultural land Sustainable land use management.	Implementation of the new Land Use Policy to promote sustainable use of agricultural land.
5.	Food Production (i) Crops:	Self-sufficiency. Technical and economic efficiency of production.	The thrust of the policy will be the promotion of community seed development, seed industry development and provision of incentives to the private sector to support out-grower seed production. Rehabilitation and expansion of production capacities to meet local demand and for export. New strategy for fertilizer subsidy administration will be at the producers' level. Rehabilitation, maintenance and supervision of existing large dams, irrigation canals and pumping facilities to be undertaken. Encouragement of the construction of small dams, wash-bores and tube-wells, in addition to pumping of surface water for irrigation.

Policy		Objectives	Policy Strategies
	(ii) Livestock	Self-sufficiency in livestock production . Enhancement of nutritional status of the populace. Efficiency in use of bye-products and stabilization of income from livestock production and processing. Provision of veterinary public and animal health services.	Capacity expansion and modernization of the National Veterinary Research Institute Vom to produce vaccines to meet local and regional demands. Promotion of the manufacture of veterinary drugs for Nigeria and West African sub-region. Upgrading of local livestock breeds through the open nucleus-breeding program. Sedentarisation of nomadic pastoralists and promotion of range management.
	(iii) Fisheries	Self-sufficiency in fish production. Application of improved technology and management practices in fish production, processing, storage and marketing. Promotion of fisheries export. Fisheries research and development. Fisheries man-power development and training. Fisheries infrastructure development. Aquaculture development.	Aquaculture development. Fish seed and fingerlings production and stocking of inland water bodies. Provision of fisheries inputs subsidy. Intensification of monitoring, control and surveillance of Nigeria's international waters, including the exclusive economic zone.
6.	Industrial Raw Materials Crops	Increased production. Productivity and production improvement. Modernization of the structure and organization of industrial crop production.	Strengthening the National Agricultural Industrial Crop Production Program. Promoting the agricultural commodities development and marketing companies. Timely supply of production inputs such as seeds, seedlings, fertilizers, credit, agro-chemicals, technology support and extension service.
7.	Support for Agricultural Extension	Dissemination of useful and practical information relating to agriculture. Practical application of modern agricultural technology.	Integration of the state extension with the ADP extension system for greater effectiveness. Strengthening the agricultural extension service, including the use of demonstration farms and adoption of integrated production and pest control.

Policy		Objectives	Policy Strategies
8.	Agricultural Credit	Availability of adequate investment funds to agriculture. Accessibility of funds at the right time, at affordable rate of interest to make agriculture profitable.	Merger of NACB & PBN to form the NACRDB and expanding the mandate to include savings mobilization. Integration and linkage of rural financial institutions to the formal banking sector. Regulating and supervising the growth of non-bank financial institutions. Promotion self-help groups for savings mobilization and credit delivery.
9.	Agricultural Insurance	Protection of Nigerian farmers against the effect of natural hazards through the operation of mechanisms that ensure quick indemnity. Improvement in the availability of agricultural loans and improvement in loan recovery.	Insurance cover to be extended to at least 50% of farmers involved in all agricultural and rural developmental activities to mitigate the risks.
10.	Agricultural Produce Marketing	Effective distribution of agricultural produce to stabilize supply and price. Encouraging export of agricultural commodities.	Promotion of organized market for Nigeria's agricultural commodities through a functional Commodity Exchange market and operational Buyer-of Last-Resort mechanism for market assurance through the three Multi-Commodity Development Companies approved by government. Streamlining and invigoration of produce inspection and the establishment of a mechanism for quality assurance.
11.	Agricultural Commodity Storage	Reduction of intra - and inter-seasonal price variability. Ensuring food security.	Maintenance of national strategic food reserve through encouragement of State Buffer Stock Food Storage Program. Promotion of the use of simple but effective on-farm and off-farm storage facilities. Operationalizing the National Food Reserve Program and strengthening and modernizing the Strategic Grain Reserve Scheme.
12.	Agricultural Commodity Processing	Processing of commodities and accelerating the growth of the agricultural sector. Preservation of commodities to reduce waste and reduce seasonal price fluctuations.	Promotion of SMEs through increased participation of Commercial banks and improvement in the quality, preservation, packaging and presentation.

Policy		Objectives	Policy Strategies
13.	Agricultural Research	Development of improved and high yielding production materials. Development of appropriate technologies.	Provision of enabling infrastructure such as laboratories, renovations and up-grading of laboratories and provision of modern information technology (e-mail, internet, telephone). Application of biotechnology in genetic improvement research and promotion of natural resources management research. Effective collaboration between the research institutes and the universities and development of a strong outreach program beginning with the host communities. Strengthening and adequately funding the research system and REFILS.
14.	Agricultural Cooperatives	Evolving a virile system that serves an effective vehicle for social and economic development. Using cooperatives as a machinery for rural transformation.	Increasing cooperative education and enlightenment to mobilize and promote group/cooperative action and democratic ideals in the management of cooperative societies. Formation of farmer-managed commodity associations.
15.	Water Resources Development	Development of both underground and surface water resources for agricultural purposes. Erosion, flood control, water shed management for sustainable agricultural production. Pollution control in water bodies.	Articulation of a systematic way of developing small dams for small scale irrigation. Completion of outstanding downstream irrigation infrastructures. Provision of down-stream facilities. Formation/strengthening of Water Users and Fadama Users Associations as grassroots organizations for irrigation development.
16.	Agricultural Mechanization	Provision of mechanical power to reduce drudgery in agriculture. Reduction of cost of production arising from high cost of labor	The zero tariff regime on imported agricultural machinery to be maintained: - Universities, Polytechnics and Research Institutes to be supported to develop and fabricate suitable equipment for use especially by the small-scale farmer. - NCAM to be expanded and modernized as a center of farm machinery and equipment development and standardization.
Policy		Objectives	Policy Strategies
17.	Rural Infrastructure	Improvement of the quality of life of rural dwellers to stem and reverse rural-urban drift. Promoting equitable distribution of public sector investments between rural and urban areas. Creation of infrastructural base which is conducive for profitable investment in the rural areas.	Articulating and implementing rural development through accelerating the provision and maintenance of rural infrastructures such as: - rural water supply; - rural markets; - rural electricity;

		Promotion of sustained and orderly development of the vast resources available in the rural areas.	<ul style="list-style-type: none"> - rural telephony - rural institutions. - Rural transport and travel. <p>Mechanism to mobilize and empower the rural population to create wealth through both improved agricultural production and skills acquisition for non-agricultural enterprises.</p>
18.	Agricultural Statistics and Data Bank	<p>Re-organization of various government agencies and departments to provide on a continuous basis accurate and timely data on agricultural output, prices, incomes, inputs, production costs, and so on.</p> <p>Adoption of a system of agricultural census that will secure, prepare, tabulate and realize annual agricultural data on all aspects of agriculture on a fairly standard format throughout the states on a set date within each year; and</p> <p>Inculcation of statistics and record keeping culture in agricultural production.</p>	<p>Strengthening of agricultural data management and information dissemination.</p> <p>Enhancing capacity in policy analysis, socio-economic research, market information service and program monitoring and evaluation.</p> <p>Strengthening the institutional capacity for coordinating data collection at the State and Local Government (primary) levels.</p>
19.	Agricultural Investment and Management Advisory Services	<p>Encouragement of active participation of private investors in all facets of agricultural development, and</p> <p>Provision of a conducive investment climate on a continuous basis for private entrepreneurs.</p>	<p>Improving information flow through strengthening the Agricultural Trade Information Centre and creation of Investment Promotion nodes throughout the country.</p>
20.	Agricultural loan terms		<p>There was a liberalization of agricultural loan terms so that small-scale farmers could obtain loans of up to ₦20,000 naira without tangible collateral.</p> <p>In 1988, the grace period for the repayment of commercial bank loans and advances to investors in long-gestation cash crop plantation was increased from 4 to 7 years while that of investors in mechanized large-scale farms was increased from 5 to 7 years.</p>

Policy		Objectives	Policy Strategies
21.	Rural bank deposit		Also in 1988, the minimum share of total deposit generated by rural banks which must be given as loans and advances in the rural localities was raised from 40 to 45 percent.
22.	The Nigerian Agricultural and Cooperative Bank (NACB) Now known as the Nigerian Agricultural, Cooperative and Rural Development Bank (NACRDB).	This specialized bank was established in 1973, mainly to finance agricultural development projects and allied industries. In its operations, the bank usually interacts with States' Ministries of Agriculture. It also sources its funds from government subventions, credit short-falls on agricultural loans by commercial and merchant banks through the CBN, and loans from international finance institutions like the IBRD, ADB, IFAD, etc. Following a recent major reorganization, the name of the bank has been changed to the Agricultural, Cooperative and Rural Development Bank (NACRDB).	
23.	National Agricultural Insurance Company (NAIC)	This was established in 1987 to operate and administer the Nigerian agricultural insurance scheme. The idea of the scheme was first mooted in 1984 as a strategy for tackling the problem of small farmers' inability to satisfy the collateral requirements of banks when asking for loans. It was expected that the insurance scheme would serve a number of complementary purposes. It would enhance the confidence of commercial banks in giving loans to small farmers. The insurance certificate would serve as collateral, and funds mobilized from the scheme would be utilized for agricultural investment. NAIC, has expanded its scope of coverage from the original rice, maize, poultry, cattle and tangible fixed assets (like farm building and farm machinery and equipment) to include groundnut, oil palm, sugarcane, plantain, rubber, citrus, forestry, fishery bee keeping, snailery, piggery etc.	

Policy		Objectives	Policy Strategies
24.	The Agricultural Credit Guarantee Scheme (ACGS)	<p>The Agricultural Credit Guarantee Scheme (ACGS), established in 1977, took off in April 1978 under the management of the CBN, while a board of directors was constituted for policy making. The scheme was designed to encourage banks to increase lending to the agricultural sector by providing some form of guarantee against risk inherent in agricultural lending. In case of default, the lending banks is expected to exhaust all legal means of loans recovery, including realization of any security pledged for loans, before the Fund pays 75 percent of guaranteed loans in default. The authorized capital of the Fund was contributed by the Federal Government (60 percent) and the CBN (40 percent). Interest earnings from the Fund's investment in government securities have boosted its capital base.</p> <p>The scheme covers the production of all crops, fish farming, fish captures, animal husbandry, storage, farm machinery and hire services, an integrated agricultural projects incorporating production and processing, provided the primary production element accounts for no less than 50 percent of the raw materials required by the business. Collaterals are required for lending under the scheme. However, this requirement (collateral) is waived for farmers borrowing N20,000 and below. For a farmer in this category, the only requirement is an introduction by a person of repute in the community confirming that the borrower was a genuine farmer. Loans under the scheme were at concessionary interest rates until 1987. Following the deregulation of interest rates in 1987, farmers, like other borrowers, were to borrow at going market interest rates.</p>	

Appendix 5.1: Indices of Agricultural Investment Levels, Annual Growth Rates and Variability

Indicators		1981-85	1986-90	1991-95	1996-2000
A	Mean Annual Values (N'million)				
1.	<i>Gross fixed capital formation (at 1984 purchasers value):</i>	8,093.4	4,300.8	5,648.8	6,399.0
	• Total GFCF	424.6	309.3	686.6	873.5
	• Agricultural-sector GFCF	5.1	6.9	12.2	13.7
	• Agriculture's share of total (%)				
		1,123.0	943.4	2,415.7	21,113.5
2.	<i>Public capital expenditure (N'million):</i>	43,64.0	11,521.0	60,516.8	292,869.7
		20.5	7.6	3.8	7.2
	• On infrastructure				
	• On non-infrastructure				
3.	• Infrastructure's share of total (%)	608.4	910.0	1913.6	8579.9
		1.1	41.7	174.9	0.0
	<i>Annual flow of foreign net private investment:</i>	0.2	4.6	9.1	0.0
	• All sectors				
4.	• Agricultural sector	5,488.8	10,396.4	57,929.9	134,383.4
	• Agriculture's share of total (%)	125.3	219.7	1045.6	1209.0
		2.4	1.6	1.9	0.9
	<i>Cumulative foreign investment:</i>				
	• All sectors				
	• Agricultural sector				
	• Agriculture's share of total				
B	Average Annual Growth Rates (%)				
1.	<i>Gross fixed capital formation (at 1984 purchasers value):</i>	-27.2	5.6	-1.0	6.4
	• Total GFCF	-29.9	24.5	3.6	7.1
	• Agricultural-sector GFCF	-3.8	17.7	4.7	0.6
	• Agriculture's share of total				
2.	<i>Public capital expenditure:</i>	-38.3	15.3	54.0	23.4
	• On infrastructure	0.2	35.7	41.2	12.5
	• On non-infrastructure				
3.	<i>Annual flow of foreign net private investment:</i>				
	• All sectors	88.9	-27.7	79.1	1.5
	• Agricultural sector	-	155.7	-58.1	0.0
4.	<i>Cumulative foreign investment:</i>				
	• All sectors	15.6	36.3	78.6	4.5
	• Agricultural sector	1.3	39.5	25.6	0.0
	• Agriculture's share of total	-12.4	17.8	-21.1	-4.3

Indicators		1981-85	1986-90	1991-95	1996-2000
C.	Annual Variability (%)				
	<i>Gross fixed capital formation (at 1984 purchasers value):</i>				
	• Total GFCF	50.7	23.7	6.8	13.2
	• Agricultural-sector GFCF	61.5	74.5	5.6	13.2
	• Agriculture's share of total	21.7	49.9	9.8	3.7
	<i>Public capital expenditure:</i>				
	• Infrastructure	69.8	23.6	63.2	39.7
	• Non-infrastructure	15.6	61.3	57.6	43.8
	<i>Annual flow of foreign net private investment:</i>				
	• All sectors	85.8	60.1	54.1	61.0
	• Agricultural sector	92.7	63.2	72.3	-
	<i>Cumulative foreign investment:</i>				
	• All sectors	27.3	75.7	74.8	9.6
	• Agricultural sector	15.0	58.3	35.2	-
	• Agriculture's share of total	29.0	54.9	40.0	9.0

Sources: Computed with data extracted from: (1) CBN (2000): (2) FOS (2000) (3) Iwayemi (1995)

Appendix 5.2: Determinants of Private Investment Flow into Agriculture

	Investment Variable	Nature of Effect on Investment
1.	Size of domestic public investment	Public and private investments are normally complementary, that is positively correlated.
2.	Adequacy of domestic credit flows to the private sector	Adequate credit has positive effect on private investment and vice versa.
3.	Adequacy of foreign exchange	Since the bulk of capital goods and some raw materials are imported, foreign exchange shortage will impinge adversely on private investment.
4.	Real Naira devaluation	This induces a rise in foreign prices measured in domestic currency, thereby boosting investment in tradeables and shrinking that of non-tradeables. On balance, real devaluation is expected to have a negative effect on private investment as a substantial proportion of capital and intermediate goods are obtained offshore.
	Investment Variable	Nature of Effect on Investment
5.	Economic instability	Because long-term private investment expenditure is largely irreversible, that is installed capital assets in the agricultural sector can seldom be easily transferred to another uses or other sectors without considerable loss, private investors will be unwilling to commit large expenditure to long-term fixed investment when there is economic instability.
6.	Domestic rate of inflation	Accelerating domestic inflation increases the riskiness of long-term investment, reduces the average maturity of commercial lending, distorts the information content of relative prices and, therefore, discourages private investment.
7.	External debt burden	High external debt burden impairs the country's credit worthiness and the high debt service charge diverts funds from domestic public investment. Hence, external debt burden correlates negatively with private investment.
8.	Terms of trade	Adverse terms of trade adversely affects investment in the sector, and vice-versa.
9.	Domestic price stability	Price stability attracts private investment, and vice versa.
10.	Size of domestic market for the products of investment	Large market size attracts investment, and vice versa.
11.	Rate of return on investment	The higher the rate the higher is the flow of private investment, and vice versa.
12.	Availability of inputs and raw materials	Adequate availability promotes investment, and vice versa.
13.	Domestic investment	Domestic investment (public and private) is positively correlated with foreign investment flow.
14.	Labor and production costs	Low labor and production costs attract investment, and vice versa.

15.	Social stability	Social stability enhances investors' confidence, reduces investment risks and, therefore, promotes private investment.
16.	International product differentials	Investment flows in the direction of countries that produce dissimilar products as trade between them tends to be higher than between countries producing similar products.
17.	Regulatory environment	Favourable and conducive regulatory environment inspires investors' confidence and, therefore, promotes investment flow.
18.	Functional infrastructural facilities	Adequate infrastructural facilities (e.g. roads, energy, telecommunication, security) lower the cost of production and marketing as well as the cost of operating business, and, to that extent, increase the rate of return on investment and promote private investment.
19.	Exchange rate volatility	This creates foreign exchange risk and uncertain investment climate.
20.	Real interest rate	Real interest rate affects the cost of capital. Low real interest rate attracts higher investment. But it may also adversely affect savings, thereby hampering capacity to invest.
	Investment Variable	Nature of Effect on Investment
	Investment Variable	Nature of Effect on Investment
21.	Macroeconomic stability	This inspires confidence in a country's economy, reduces the risk of investment and promotes private investment, particularly long-term investment.
22.	Political stability	This also engenders confidence in the economic climate and reduces risks and uncertainties of investment
23.	Openness of the economy	Openness of the economy, sometimes measured as the ratio of total export and import value to the GDP, is determined largely by trade policies, and the more open an economy, the more it attracts foreign private investment in internationally tradeable goods due to the potential for participation in international trade.
24.	Existence of protectionist policies	These are expected to attract investment for the production of locally traded goods.
25.	Multi-and bilateral international agreements	These may promote increased flow of trade between nations, protect their citizens' investments and generally create goodwill which engenders confidence of foreign investors.
26.	Per capita real income	This is supposed to attract private investment as it is correlated with size of market and effective demand for the product of investors.
27.	Corruption	This creates a bad international image for a country, tends to increase investors' cost of doing business and, therefore, discourages private investment, particularly foreign private investment.
28.	Institutional inefficiencies and bottlenecks	These cause undue delays in business transactions, increase the cost of doing business and, therefore,

	and bottlenecks	increase the cost of doing business and, therefore, discourage private investment.
--	-----------------	--

Source: Collated from many sources, including VBO International (1988); Balogun and Otu (1991); Chete and Akpokodje (1997); Ekpo (1997); Iwayemi (1995; 2000); Salako and Adebisuyi (2001); and, NIPC (2003).

Appendix 6.1: Summary of Investment Constraints

Sources	Technical	Infrastructural	Economic	Financial	Political	Social	Policy	Institutional	Environmental	External environment	Labor market
FGN (2002)			<ul style="list-style-type: none"> •Pervading poverty (70%) •Mismanagement 		<ul style="list-style-type: none"> •Instability •Poor governance 	<ul style="list-style-type: none"> •Ignorance •Corruption •Over-population 			<ul style="list-style-type: none"> •Degradation 		
CBN (1998)	<ul style="list-style-type: none"> •Low productivity •Poor technological base 	<ul style="list-style-type: none"> •Poorly developed infrastructure 	<ul style="list-style-type: none"> •High cost of production •Poor access to market information •Inadequate public-sector investment 	<ul style="list-style-type: none"> •Inadequate access to credit •Inadequate financial services 			<ul style="list-style-type: none"> •Political instability/uncertainty 	<ul style="list-style-type: none"> •Weak legal and regulatory framework 	<ul style="list-style-type: none"> •Poor soil nutrient management 		<ul style="list-style-type: none"> •Inadequate human capital
IFDC (2001)		<ul style="list-style-type: none"> •Poor infrastructure 	<ul style="list-style-type: none"> •Lack of market and management information 			<ul style="list-style-type: none"> •Physical insecurity of life and property 	<ul style="list-style-type: none"> •Macro-economic instability •Policy uncertainty 	<ul style="list-style-type: none"> •Weak regulatory framework 			<ul style="list-style-type: none"> •Lack of human capital
Idachaba (1998)					<ul style="list-style-type: none"> •Political instability 		<ul style="list-style-type: none"> •Macro-economic instability 	<ul style="list-style-type: none"> •Instability of national research system 		<ul style="list-style-type: none"> •Unconducive external environment 	
Ikpi (1999)		<ul style="list-style-type: none"> •Inadequate basic infrastructure 	<ul style="list-style-type: none"> •Poor investment climate •High business risk 	<ul style="list-style-type: none"> •Poor access to credit 			<ul style="list-style-type: none"> •Poor policy environment 	<ul style="list-style-type: none"> •Market fragmentation •Under-developed property rights 			

Sources	Technical	Infrastructural	Economic	Financial	Political	Social	Policy	Institutional	Environmental	External environment	Labor market
Chete and Akpokodje (1997)				<ul style="list-style-type: none"> •High external debt service •Inadequate credit 			<ul style="list-style-type: none"> •Macro-economic uncertainty 				
Balogun and Otu (1991)	<ul style="list-style-type: none"> •Inadequacy of viable technology •Subsistence production system •High production hazards 			<ul style="list-style-type: none"> •Weak base of credit supply 	<ul style="list-style-type: none"> •Political interference 			<ul style="list-style-type: none"> •Complex procedures for investment approval 			
Babalola and Adegbite (2001)							<ul style="list-style-type: none"> •Macro-economic instability •Multiple taxation 	<ul style="list-style-type: none"> •Poorly developed capital market 			
Salako and Adebusi (2001)		<ul style="list-style-type: none"> •Poor infrastructure 	<ul style="list-style-type: none"> •Uncertain economic environment 		<ul style="list-style-type: none"> •Political instability 		<ul style="list-style-type: none"> •Unwieldy institutional framework •Unstable exchange rate regime •Investor-unfriendly policies 			<ul style="list-style-type: none"> •Low external credit rating 	

Aremu (1997)	<ul style="list-style-type: none"> •Technological underdevelopment •Over-dependence on imported raw materials and equipment 	<ul style="list-style-type: none"> •Poor state of infrastructure 			<ul style="list-style-type: none"> •Political instability 	<ul style="list-style-type: none"> •Corruption 	<ul style="list-style-type: none"> •Frequent changes in policies and regulations 	<ul style="list-style-type: none"> •Stringent regulations and approval procedures. •Administrative delays 		<ul style="list-style-type: none"> •Poor country image •Unfavourable perception of investment climate 	<ul style="list-style-type: none"> •Inadequate skill •Low productivity
Sources	Technical	Infrastructural	Economic	Financial	Political	Social	Policy	Institutional	Environmental	External environment	Labor market
Iwayemi (1995)					<ul style="list-style-type: none"> •High country risk factor •Excessive political control 	<ul style="list-style-type: none"> •Corruption and mismanagement 	<ul style="list-style-type: none"> •Poor macro-economic environment •Low credibility of policies 			<ul style="list-style-type: none"> •Lack of confidence in the economy 	
NIPC (2003)	<ul style="list-style-type: none"> •Low level of technology 		<ul style="list-style-type: none"> •Uncompetitiveness of agricultural products due to high cost and low quality •Unattractive investment •Low commercialization of agricultural business 		<ul style="list-style-type: none"> •Political instability 	<ul style="list-style-type: none"> •Social instability •Corruption and indiscipline •Insecurity to life and property 	<ul style="list-style-type: none"> •Macroeconomic policy instability •Policy ineffectiveness •Excessive trade barriers 	<ul style="list-style-type: none"> •Deficient legal and regulatory framework •Weak regional integration •Deficient marketing system 			
Obayomi (1996)	<ul style="list-style-type: none"> •Poor and declining quality of export products 					<ul style="list-style-type: none"> •Dishonest business practices 		<ul style="list-style-type: none"> •Deficient legal and regulatory framework •Administrative lapses 		<ul style="list-style-type: none"> •Unstable world prices. 	

FGN-IMF Joint Memoran dum on Economic Policies (2000)			•High cost of doing business		•Political instability	•Corruptio n	•Poor policy implementatio n •Frequent changes in policies •Inconsistent trade and foreign exchange policies •Weak fiscal/ monetary discipline	•Demoralize d bureaucracy		•Lack of confidence in the economy	
---	--	--	---------------------------------	--	---------------------------	-----------------	---	---------------------------------	--	--	--

Appendix 6.2: Causes of Persistence of Constraints in the Different Zones of Nigeria

No	Constraints (Nature)	Causes of Persistence of Constraints					
		North Central	North East	North West	South East	South South	South west
1	Technical-power failure, poor technology, poor quality of raw materials, inadequate supply of fertilizer.	Low support from government, inadequate training, over-dependence on foreign supply poor government policy, low investment	Lack of awareness, lack of government support, poor local technology, lack of machines	Low level of awareness, ineffective policy, poor road maintenance, poor government policy, corruption	Bad government, neglect from government, insecurity, corruption. Lack of technological know how, poor agricultural policies.	Inadequate effort to improve technology, lack of government assistance, increases in prices of inputs, lack of adequate research, conservation	Government policy, poor implementation, non- prioritization.
2	Infrastructure- irregular water supply, erratic power supply.	Inadequate supply, poor infrastructure, poor government policy, poor maintenance culture, absence of godfather in government,	Government neglect, poor governance, inefficiency of institutions.	Poor leadership, ineffective policy, inadequate funding, little government concern.	Poor political leadership, interest vested in alternative sources, lack of government attention.	Bad governance, government neglect, corruption, poor prioritization of government spending, low supply capacity, lack of maintenance culture	Ineffective government policy, greed, poor financing, population increases, bad administration.
3	Economic -low returns on investment, inadequate funding	Frequent change of government, corrupt leaders, bad fiscal policy, poor funding of economy.	Hig tax levies, bad roads, poor resource management, high cost of production, unstable economic policies, general economic problems.	High inflation , poor governance, ineffective policy, low investment, lack of credit, economic instability, depreciation of the naira, high cost of production.	Bad governance, political instability, ineffective and inconsistent policies, diversion of credit from the agricultural sector.	Government neglect	Ineffective government policy, inadequate credit, poor administration, under-funding

4	Financial- insufficient credit to farmers, high risk of lending, inadequate financial institutions.	lack of transparency, no inadequate financial facilities, poor credit policy, poor capital base, inadequate assistance from government, risks and uncertainties of agricultural lending.	High rate if interest, lack of credit facilities, lack of awareness of credit sources, unfavorable financial institution policies.	High loan repayment default rate, poor policy, lack of trust, poor leadership, poor government interaction, poor funding, ineffective policy implementation.	Banks reluctance to lend to farmers, unfavorable economic climate, high crime rate, corruption, lack of mutual trust, inadequate allocation of funds to agriculture..	Unstable exchange rate, high interest rate, government bureaucracy, corruption, banks refusal to give loan to agriculture, , lack of government assistance, low returns from farming, discrimination against agriculture.	Ineffective policy, high interest rate, corruption, poor agricultural funding, poor credit supply, under investment, inefficient banking system.
5	Political-political crises, lack of trust, poor leadership.	Government inaction, personal gains, political instability, buyers, poor governors.	Political instability, military intervention, poor governance.	Poor governance, greed, poor leadership, inefficient policy, militocracy, resource control.	Political instability, poor leadership, greed, weak policies.	Frequent changes of government, diverse geopolitical groups, non-participatory governance, lack of political reforms	Ineffective policy, political instability.
6	Health- malaria, inadequate health facilities.	Government inaction.	Inadequate health facilities, poverty, bad governance.	Ineffective policies, limited resources, poor government intervention, high veterinary cost.	Poor leadership, inconsistent policies, policy instability, poor environmental management.	Inadequate health facilities, lack of good drugs, no permanent solution e.g. malaria vaccines.	Ineffective policy.
7	Macro economic policy- massive importation of food, inconsistent export policies, weak import policies.	No government commitment, frequent change in government policy.	political instability, unstable policy.	Poor banking policy, ineffective policy, high taxes, bad government policies.	Policy inconsistencies, corruption, adverse domestic economic environment, vested interest in trade	Inconsistence and non- cohesion of policy from policy makers.	Ineffective policy.

8	Micro economic policy- poor input and commodity storage, inadequate input supply, poor marketing facilities	Lack of commitment, frequent change in government policy.	Lack of awareness, lack of credit facilities, lack of government support	Government neglect, ineffective policies, poor government intervention, poor policy implementation, non-availability of credit.	Policy inconsistency, poor leadership, poor management.	Lack of attention to micro economic policies.	
9	Institutional- inefficient banking system, bureaucracy, and inadequacy of policies.	lack of institutional reforms, poor regulatory mechanism for institutions.	Cumbersome loan processing procedure, inefficient banking services.	Wrong policy, bureaucratic bottlenecks, poor governance.	Inconsistent and ineffective policy, high interest rate, high crime rate, corruption, bureaucracy.	Perceived risky nature of agriculture, long gestation period of agricultural investment.	Corruption, lack of clear-cut policy.
10	Land tenure- land fragmentation,	Communities do not want to lose their land, rapid growth in population, land fixed in size, inadequate skill	Greed, bureaucracy, high monetary demand by landowners.		Political instability, policy inconsistency, land tenure system, traditional and cultural practices.	Rigid cultural norm, weak enforcement of land policy.	Gender discrimination cultural norm, land scarcity.
11	Labor –high cost of labor	Inadequate skill training scheme, rural-urban drift, urban wage increases	High wages, poor technology	Labor shortage, high cost of living, low mechanization, high rural urban migration,	Inadequate labor supply, high wage rate, bad governance, rural urban migration.		Labor supply instability, lack of skilled labor, poor technology.

Appendix 6.3: Gainers from Persistence of Constraints and Nature of Gains.

No	Gainers from Constraints	Nature of gains from the constraints					
		North Central	North East	North West	South East	South South	South west
1	Technical- Foreign suppliers, importers, foreign investors, bankers, middlemen, generator dealers, government officials/policy makers, fraudsters and quacks, politicians, local investors, transporters.	Hard currency, buy cheap products.		Monetary, financial, employment.	Financial kick back on supplies/import	No allocation of funds for purchase of tools. Organizing seminars and making farming calendars.	Financial under market advantage.
2	Infrastructure- Generator importers, merchants, foreign firms, , importers, transporters, top government officials, politicians, contractors, marketers.	Monetary		Monetary, Financial	Financial	High charges, foreign trips, monetary, buying cheaply and selling at high prices.	Financial, hike in charges/fares.
3	Economic – Government, middle men, importers, spare part dealers, politicians, fuel dealers, foreigners, multinationals, policy makers, , government officials, bankers, technical partners, fertilizer merchants..	Diverting of funds, declaration of huge dividends at the end of the year, finance.	Revenue, high transport charges.	Monetary, financial, high import prices.	Financial, Monopolistic over gains, promotion.	Monetary	Financial.
4	Financial- Government officials, financial institutions, financially advantaged farmers, politicians, policy makers, importers, foreigners, private moneylenders,	Monetary, buy at cheap rates, make money from other ventures.	Profit, illegal wealth amassing.	Monetary, financial, High interest rate.	Financial, risk aversion, High interest rate.	Monetary, Profit, Increased output.	Financial.
5	Political- Politician, military, policy makers, political thugs, corrupt government officials, relatives/associates of government	Export of their commodities, bought commodities	Power, Financial, Illegal wealth.	Power/Political control, financial.	Financial, recognition.	Monetary, self-enrichment with project funds.	Power, financial.

	officials, buyers, American government.	at cheap rates, embezzlement, financial.					
6	Socio cultural- elites, criminals, investors, religious leaders, fraudsters, touts, political leaders, middlemen.	Secure of land permanently.	Income.	Power, Financial, Relevance, Money, Goods.	Financial looting of materials.	Cheap goods.	Financial.
7	Health- Foreign investors, politicians, smugglers, quacks in health profession, fraudsters, private investors, pharmaceutical companies, fake drug manufacturers and vendors, private owners of health facilities.	More patronage, drugs available.		Financial, high veterinary cost	Financial	Monetary, high financial gains from sales of drugs.	Financial.
8	Macro economic policy- government, importers, foreigners, financial houses, smugglers, local entrepreneurs, customs officials.		Revenue.	Monetary	Financial, Materials.	Economic gains.	
9	Micro economic policy- Middlemen, government, financial institutions, businessmen, policy makers, importers, fraudsters.			Monetary, Recognition.	Financial	High profit.	
10	Institutional- Institutions, foreigners, local moneylenders, policy makers, , bureaucrats, corrupt government officials.	Monetary, personal enrichment.	High interest rates.	Political recognition, Power.	Financial, Irredeemable collateral.	Farmers	Middlemen
11	Environmental- Policy implementers, saboteurs, landowners, processors, fishermen.	Financial.		Financial.	Financial, Free health care.	Monetary.	
12	Land tenure- land owners, land speculators, estate agents, governments	Exploitation of tenants	Inflation of prices and rents	Acquisition of land at cheap rates	Seizure of land	High rent income	High tax on land

13	Labor –foreigners and their agents, employers of labor, skilled workers, labor union leaders	Big contracts, high wage, income.	High Income,	High Income,	Financial, reward, cheap labor.	-	High wages.
----	--	-----------------------------------	--------------	--------------	---------------------------------	---	-------------

Appendix 6.4: Losers from Persistence of Constraints and Nature of losses

No	Losers from Constraints	Nature of losses from the constraints.					
		North Central	North East	North West	South East	South South	South west
1	Technical- Farmers marketers, Nigerian investors, women, road users, masses, the economy, government, processors.	Foreign exchange, low wages, poverty, high cost of products, inadequate supply of inputs	Low level of production, , low income, , use of local unproductive technology, high production cost.	High cost of transportation, spoilage of produce, low productivity, low technical skill, output, employment, low return on investment	Loss of agricultural produce, loss of employment, low income, low standard of living, low return on investment,	Reduced output, monetary, reduction in land area, poor economy.	Low profits, unemployment, indiscipline, high input cost, loss of market, financial losses.
2	Infrastructure- Marketers/traders, Nigerian investors, women, farmers, transporters, consumers, unemployed, processors, common man/poor people.	Loss of investments, poor output, enduring poverty, low return on investment, unemployment, inadequate input supply	Loss of income, reduced profit, health hazards, slow development.	Low profit, poor technical skill, low productivity, low returns, high transport cost.	Poor living standard, capital flight, financial loss, high cost of input, high death rate .	High cost of transportation, inability to expand business, low returns, spoilage of farm produce, poor quality of produce, poor access to markets	Production losses, spoilage, high cost of production, poor market access.

3	Economic – Marketers farmers, investors, women, the economy, entrepreneurs, ordinary citizen.	Chronic poverty, poor farm yields.	High marketing cost, high transport cost, lack of fund for investment, slow rate of developmental, low returns on investment	High production cost, monetary loss, low productivity, employment loss, low returns on investment.	Business failure, financial loss, lack of capital to invest.	High cost of input, high cost of production, low output.	Business stagnation, low purchasing power.
4	Political- Investors, citizens/masses, women, entrepreneurs, farmers,	Low output, financial, loss of confidence in government/economy.	loss of human rights political instability.	Insecurity, lack of freedom political instability,	Loss of investments, low return on investment,	Instability in government, extra investment in product line.	-
5	Socio cultural- Marketers, women, masses, farmers, entrepreneurs, exporters, youths.	Unemployment.	Loss of properties, income and lives, socio political and economic instability.	Insecurity, lack of freedom of speech, loss of property,	Loss of lives and property, collapse of businesses, financial loss.	Loss of property, monetary loss.	Production losses.
6	Health- Farmers, marketers, , women, masses, manufacturers, low income earners, , government.	Inadequate health care, unhealthy citizenry.	Sickness, diseases, low productivity, physical and mental instability.	Sickness, loss of lives, financial loss, low productivity.	Financial loss, collapse of enterprise, high cost of production, high cost of health care..	Poor health, reduction in output, loss of man-hours due to sickness l.	High cost of health care
7	Macro economic policy- Marketers/traders, investors, women, farmers, entrepreneurs, consumers, private sector, government.		Low profit increased marketing cost, retarded economic growth.	Low investment, , financial loss, loss of employment,	Loss of market share, financial loss.	Unhealthy and risky investment climate	-

8	Institutional- farmers, women, investors, workers, government, masses.	Low income	Low production	Inadequate production technology, low investment, loss of employment.	Financial loss, loss of employment.	Monetary loss, low production, low capacity utilization.	Unemployment
9	Environmental- Women, , masses, farmers, entrepreneurs, processors, government,	Loss of aesthetic beauty, loss of life, ill health.	Destruction of farms.	Loss of soil fertility low productivity.	Financial loss, loss of soil fertility, loss of arable land, poor return on investment returns.	Monetary loss.	Environmental pollution, health hazards.
10	Land tenure- Women, landowners, society, entrepreneurs, processors, prospective farmers.	High cost of investment, unemployment, and high Cost of land	High cost of investment, insufficient land for farming.	Financial loss	Lack of a adequate access to land, inability to expand farm.	Lack of land for farm expansion, inability to mechanize due to small farm size, high cost of land acquisition,	High cost of land.
11	Labor – Farmers, indigenous investors, women, workers businessmen, youths.	Low labor efficiency high cost of production.	High cost of production, high cost of investment.	Low returns, financial loss, high cost of production.	Financial loss, loss of farm labor.		Low supply of labor, poor output, production losses.

Appendix 6.5 Effects of Constraints to Investment in Nigeria's Agriculture

Effect	Technical	Infrastruc-	Economic	Financial	Political	Socio-	Health	Macro-	Micro	Institut-	Environ-	Land	Labor
(1) Low output/ productivity or low level of production	all zones	NE, SS SW	NW, SS	all zones	NC	NC, NW	NC, NE NW, SS SE	NW	NC, NE SW	NW, SS SW	SS	NC, SS SE, SW	NE, SS SE, SW
(2) High cost of investment/ production or high inputs cost	NW, SS SE,SW	NC, NW SS, SE SW	NC, NW SS, SE	NW,SS	SS, SE	SS, SW	-	all zones	NS, NW SS, SE	NC, SS SE	NC, NW SE,SS	NE, NW SE, SW	all zones
(3) Low returns to investment/low attractiveness to investors	NC, NE NW, SE	NC, NW SE	NC, NE NW, SS	-	NC, SW	-	SS	NE, NW	-	SE	NE	SE	-
(4) Low or poor level of investment	-	-	NW	SS, SW	NW, SE	NW, SE	NW	NC, NE	NE, NW SS, SE	NW	-	NW	-
(5) High prices of produce	-	NC	SE,SW	-	-	-	-	-	-	-	-	-	SE
(6) Collapse of business or its abandonment	NC	-	SS	NC	NE	SS,SE	-	-	-	NE	-	-	-
(7) Poor access to credit/	-	-	-	NC, NE	-	-	-	SW	-	NE, NW	-	-	-

insufficient working capital				SE						SS, SE			
(8) Low capacity utilization	-	-	SE	SW	-	-	-	-	-	-	-	-	-
(9) Poor investment climate	-	-	-	-	SS	NC, SW	-	SS	-	-	-	-	-
(10) Spoilage of products or production losses	NC,NE NW,SW	NC,SW	-	-	-	-	-	-	-	NC	-	-	-
(11) Poor quality of products	-	NE,NW	SW	SE	-	-	-	-	SW	-	-	-	-
(12) Poor economic growth	-	-	-	NC SE	NC, NE	-	-	SE	NC	NC	-	-	-
(13) Loss of fund invested	-	-	-	-	-	NE	-	SS	SW	SW	-	-	-
(14) Loss of life	-	-	-	-	SW	NE	-	-	-	-	-	SS	-
(15) Loss of property	-	-	-	-	SW	NE	-	-	-	-	-	SS	-
(16) Loss of confidence on economy	-	SS	-	SE	-	SS	-	-	-	-	-	-	-

(17) Excessive importation/ Dumping of fake/sub- Standard products	SE	NE	-	-	-	-	-	-	-	-	-	-	-
(18) Uncompetitiveness of product in the world market	-	-	SS	-	-	-	-	-	-	-	-	-	-
(19) High marketing cost	-	NE	-	-	-	-	-	NE	-	-	-	-	-
(20) High transport cost	-	SS	-	-	-	-	-	-	-	-	SE	-	-
(21) Fatigue	NE	-	-	-	-	-	-	-	-	-	-	-	-
(22) Insecurity/ violence	-	-	-	-	NE, NW	NE, NW	-	-	-	-	-	-	-
(23) Poverty and suffering	SS	SS	-	-	SS	-	-	-	SS	-	-	-	-
(24) Poor commercialization and distribution of goods	-	SE	-	-	-	-	-	-	SE	-	-	-	-
(25) Relegation of agriculture to the background	-	-	-	-	SW	-	-	-	-	-	-	-	-
(26) Poor urban and rural	-	-	-	-	-	SE	-	-	-	-	-	-	-

development

(27) Misdirected priorities in investment	-	-	-	-	-	SE	-	-	-	-	-	-	-
(28) Capital flight	-	-	-	-	-	NW	-	-	-	-	-	-	-
(29) Sickness/poor health	-	-	-	-	-	- SE, SW	NE, SS	-	-	-	NC	-	-
(30) Destruction of natural production resources and loss of biodiversity	-	-	-	-	-	-	NE, NW SS,SE SW	-	-	-	-	-	-
(31) Difficulty in farming	-	-	-	-	-	-	NE	-	-	-	-	-	-
(32) Difficulty on acquiring land	-	-	-	-	-	-	-	NC, NE SS,SE SW					
(33) Conflicts and ethnic rivalry	-	-	-	-	-	-	-	SS	-	-	-	-	-

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

Appendix 7.1: Reasons for Attractiveness of Enterprises to Foreign Investors by Zones

	Reasons	NC	NE	NW	SE	SS	SW	NIG ERIA
I.	Input Production/Supply Enterprises							
	High demand	X	X	X	X	X	X	5
	Availability of raw materials	X	X	X				
	High rate of returns		X		X	X		3
	Culturally adapted						X	1
	Limited Expertise						X	1
II.	Staple Crops Production Enterprise							
	Security of labor	X						1
	Land fragmentation	X						1
	Poor processing facilities	X						1
	High demand		X		X	X	X	4
	Available manpower		X					1
	Poor market access			X				1
	Corruption			X				1
	High rate of return				X	X		2
	Good land resources					X		1
	Culturally adapted						X	1
	Lack of mechanization						X	1
III.	Industrial Crops Production Enterprises							
	High demand	X		X	X	X		4
	Low level of investment		X					1
	Low yield		X			X		2
	Market availability			X	X	X	X	4
	Labor availability			X				
	High rate of return				X		X	2
	High export potentials			X				1
	Good land resources				X	X		2
IV.	Livestock Production Enterprises							
	Scarcity of land	X						1
	Poor market facilities	X						1
	Suitable environment		X		X	X		2
	Major economic activity	X			X			2
	High rate of returns			X	X	X	X	4
	Market availability			X	X		X	3
	Labor availability			X				1
	Availability of facilities						X	1
V.	Fisheries Enterprises							
	High rate of returns	X	X		X	X	X	5
	Poor market	X						1
	High demand		X	X	X	X		4
	Abundant water resources				X	X		2
VI.	Forestry Enterprises							
	High rate of returns	X			X	X	X	4
	Availability of (high demand) of market	X			X	X		3
	Availability of best product		X					1
	Poor market access			X				1
	Opportunities for export				X	X		2

VII.	Commodity Processing							
	High demand	X			X	X		3
	Availability of raw materials	X		X	X	X	X	5
	Availability of market	X		X				2
	Lack of local investors		X					1
	High export opportunity		X					1
	Availability of labor			X				1
	High returns				X	X	X	3
VIII.	Agricultural Storage							
	High demand	X					X	2
	Low awareness	X				X		
	Export in regional markets		X					
	Poor market access			X		X		
	High perishability of agricultural products				X	X		2
	High returns				X		X	2
	Poor infrastructure						X	1
IX.	Agricultural Transport							
	Inadequate spare parts	X						1
	Inadequate attention	X						1
	High local demand		X	X	X	X	X	5
	Poor market access			X				1
	High competition			X				1
	Poor infrastructure				X	X	X	3
	High returns				X	X	X	3
X.	Commodity Marketing							
	High rate of returns	X			X	X	X	4
	High level of awareness	X						1
	High local demand		X		X	X	X	4
	Poor market access			X				1
	High competition			X				1
XI.	Agro-industry/Management							
	Availability of raw materials	X	X	X	X	X	X	6
	High local demand		X	X	X			3
	Labor availability			X				1
	High returns					X		1
XII.	Commodity Export							
	Improved government policy on export	X						1
	Abundant resources		X		X	X	X	4
	High rate of returns			X	X	X		3
	Large market			X			X	2
	Low tariff			X				1
XIII.	Support Services							
	Skilled manpower			X				1
	Low awareness				X	X		2
	More governmental intervention						X	2

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

Source: Field Survey, February/March, 2003.

Appendix 7.2: Reasons for Attractiveness of Enterprises to Domestic Investors by Zones

	Reasons	NC	NE	NW	SE	SS	SW	NIGERIA
I.	Input Production / Supply Enterprises							
	High demand	X	X	X	X	X		5
	High capital requirement	X		X	X	X		4
	Availability of raw materials	X	X					2
	High rate of returns			X				1
	Limited number of operators						X	1
II.	Staple Crops Production							
	High demand	X	X	X	X	X	X	6
	Conducive agroclimatic conditions	X						1
	Availability of raw materials			X			X	2
	Availability of good land				X	X		2
	High rate of returns				X	X		2
III.	Industrial Crops Production Enterprises							
	High demand	X		X		X	X	4
	Availability of processing facilities	X			X	X	X	4
	High rate of returns		X	X	X	X	X	5
	Large industrial demand		X		X	X	X	4
	High rate of returns		X		X			2
	Conducive agroclimatic conditions			X				1
	Availability of good land					X	X	2
	Low business potentials					X		1
	High production potentials						X	1
IV.	Livestock Production Enterprises							
	Conducive agroclimatic conditions	X			X	X	X	4
	Easy of operation	X						1
	High demand		X	X	X	X	X	5
	High rate of returns		X		X	X		3
	Availability of raw materials			X				
V.	Fisheries Enterprises							
	High returns	X		X		X	X	4
	Lack of storage facilities	X						1
	High demand			X	X	X		3
	Abundant water resources		X		X	X		3
	High technical and capital		X			X		2

	requirements							
VI.	Forestry Enterprises							
	Abundant resource endowment	X	X					2
	High demand		X					1
	Low returns			X				1
	High production cost			X				1
	Land fragmentation				X	X		2
	Low awareness					X		1
	High rate of returns						X	1
	Available opportunities						X	1
VII .	Agricultural Commodity Processing							
	High demand	X	X	X	X	X		5
	Availability of raw materials	X	X	X		X	X	5
	High rate of returns			X	X		X	3
	Huge capital requirements				X	X		2
VII I.	Agricultural Storage							
	High rate of returns	X		X	X	X	X	4
	Poor storage facilities	X			X	X		3
	Poor local technology		X					1
	High demand		X		X		X	3
	Poor market			X				1
	Low level of awareness			X				1
	Poor infrastructure						X	1
IX.	Agricultural Transport							
	Poor infrastructure	X			X	X		3
	Security of spare parts	X						1
	High rate of returns		X	X	X	X	X	5
	High demands		X	X	X	X		4
	High rate of returns		X		X			2
	Capital intensive						X	1
X.	Agricultural Commodity Marketing							
	High rate of returns	X	X	X	X	X	X	6
	High demand	X	X	X	X	X		5
	Poor infrastructure						X	1
XI.	Agro-industrial/Manufacturing							
	Availability of raw materials	X	X	X	X	X	X	6
	High demand		X	X				2
	Labor availability			X				1
	High production cost			X				1
	High rate of returns				X	X		2
XII .	Commodity Export							
	Slight improvement in policy	X						1

	Abundant resources		X		X	X		3
	High rate of returns			X	X	X	X	4
	High demand			X			X	2
	Low tariff			X				1
XII I.	Support Services							
	Skill or manpower			X				1
	Less awareness				X	X		2
	More government intervention						X	1

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth;
SW=Southwest

Source: Field Survey, February/March, 2003.

Appendix 7.3: Priority Primary Commodities for Investment Across Zones in Nigeria
(Rank 1=highest)

Ranks Assigned								
	Primary Commodities	NC	NE	NW	SE	SS	SW	NIGERIA
I.	Staple Crops							
	Rice	7	1	3	2			3.25
	Maize	3	2	1	4			2.5
	Millet	5	3	4				4.0
	Cowpea	6	4	2				4.0
	Sorghum		5	5				5.0
	Cassava	2	6	6	1	1	2	3.0
	Yam	1	7	7	3	2	1	3.5
	Sweet potato				5			5.0
	Cocoyam				6			6.0
	Melon				7			7.0
	Plantain					4		4.0
	Guinea corn	4						4.0
II.	Industrial Crops							
	Groundnut	4	1	1				2.0
	Cotton		2					2.0
	Vegetables	5	3	5		3	4	4.0
	Tea/Coffee		5					5.0
	Oil palm	2	5		1	1	2	2.2
	Rubber				2	2	3	2.3
	Cocoa				3		1	2.0
	Cashew				4	4		4.0
	Orange				5			5.0
	Pineapple			3	6	5		4.6
	Ginger				7	6		6.5
	Pepper				7			7.0
	Benniseed	3		2				2.5
	Sesame			4				4.0
	Gum Arabic			4				4.0
	Garlic			6				6.0
	Tobacco			7				7.0
	Soyabeans	1		8				4.5
III.	Livestock							
	Poultry	1		4	2		2	2.25
	Piggery	2		3	3	1		2.25
	Cattle	3	1	1	4	3		2.4
	Sheep and Goat	4	2	2	1	2	1	2.0
	Rabbitry				5	4		4.5
IV.	Fishery							
	Fish catch	1	1	1		1	1	1.0
	Aquaculture	2	2		1	4	2	2.2
	Cray fish					2		2.0
	Shrimp					3		3.0
	Smoked fish			2				2.0
V.	Forestry							
	Timber	1			1	1	1	1.0
	Gum Arabic			1				1.0
	Cargo						2	2.0
VI.	Others							

	Apiary			1	1			1.0
	Sugar cane			2				2.0

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth;
SW=Southwest

Source: Field Survey, February/March, 2003.

Appendix 7.4: Investment Priorities in Downstream Agricultural Activities

	Secondary Commodities	NC	NE	NW	SE	SS	SW	NIGERIA
I.	Agro-industries							
	Yam processing	1					1	1.0
	Cassava processing	2			3	1	2	2.0
	Vegetable oil processing	3	3	1	1			2.0
	Ginger processing			6				6.0
	Fruit processing			8	2	3	3	4.3
	Flour mill		4	4	4			4.0
	Tannery		2	3				2.5
	Textiles			2	8			5.0
	Breweries			5			4	5.0
	Gum Arabic processing			7	7			7.0
	Oil palm processing					2		2.0
	Cocoa processing					4		4.0
	Rubber processing				5	5		5.0
	Timber processing					6		6.0
	Baking				6			6.0
	Shoe manufacturing				7			7.0
	Starch company				9			9.0
	Tomato processing		1					1.0
	Cotton ginnery		5					5.0
	Sugar cane processing		6					6.0
	Tea and coffee		7					7.0
II	Commodity Storage							
	Grain storage	1	1	1	1	1	1	1.0
	Cold storage				2	2	2	2.0
	Root and tuber storage	2			3		3	3.0
	Fruits storage				4			4.0
	Oil palm storage				5			5.0
	Vegetable storage				6			6.0
	Flour mill	2	1	1			1	1.3
	Hide and skin		2					2.0
	Meat curing		3					3.0
	Vegetable oil		4				5	4.5
	Livestock feed mill		5	3			4	4.0
	Tea and coffee		6					6.0
	Sugar and confectioneries		7	4				5.5
	Palm kernel processing				1			1.0
	Fruit juice processing				2		3	2.5
	Cocoa processing				3	2	2	2.5
	Plantain chipping				4			4.0
	Fish processing					1		1.0
	Gum Arabic			5				5.0
	Tomato processing	3		2				5.0
	Ginneries			6				6.0
	Ginger processing			7				7.0
	Root and tuber processing	1						1.0
	Soyabeans processing	4						4.0
	Agricultural Commodity Marketing and							

	Distribution							
	Root and tuber products marketing	1			1		1	1.0
	Soyabean marketing	2						2.0
	Rice marketing	3					3	3.0
	Grain marketing		2	1	2		2	1.8
	Vegetable marketing		3	2	2		4	3.0
	Processed livestock products		1					1.0
	Dairy products			3				3.0
	Poultry			4				4.0
	Agricultural Input Production							
	Fertilizer	2	1	1	1	1	1	1.2
	Improved seeds	1	2	2	3		2	2.0
	Farm implements	3	3	3	4	2	4	3.2
	Agro-chemicals				2		3	2.5
	Day oil chick/fingerlings production				5		5	5.0
	Animal feeds			4			6	5.0

Key: NC=Northcentral; NE=Northeast; NW=Northwest; SE=Southeast; SS=Southsouth; SW=Southwest

Source: Field Survey, February/March, 2003.