

WEL COME

MDC - I

Farming Based Livelihood Systems (2+1)

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Multidisciplinary Course (MDC)

Course No.: MDC - I

Course Title: Farming Based Livelihood Systems

Credit Hours: 3 (2+1)

❖ **Objectives**

- 1. To make the students aware about farming-based livelihood systems in agriculture**
- 2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood**

THEORY

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems, Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckery etc.), Horticultural crops, Agro-forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming- based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

-: Suggested readings :-

- 1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.**
- 2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7.**
- 3. Carloni, A. 2001 Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.**
- 4. Dixon, J., Gulliver, A. and Gibbon, D. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington, DC, USA.**
- 5. Evenson, R. E. 2000. Agricultural Productivity and Production in Developing Countries. In FAO, The State of Food and Agriculture, FAO, Rome, Italy.**
- 6. Reddy, S. R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.**
- 7. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.**

Status of agriculture in India and different states

- India's agriculture sector plays a vital role in economic growth of the nation. However, the contribution of this sector has steadily declined due to the rise in contribution of manufacturing and services sectors.
- In 1950-51, 69 percent of India's total workforce was engaged in agriculture, contributing 53 percent to the national income.
- The Economic Survey 2023-24 indicated that the Indian agriculture sector provides livelihood support to about 42.3 per cent of the population and has a share of 18.2 per cent in the country's GDP at current prices.
- Agriculture employment continues to be a significant source of livelihood in India.
- Agriculture sector has registered an average annual growth rate of 4.18 per cent over the last five years at constant prices.

- Indian agriculture, which began around **11,000 years before** present (BP) with the domestication of animals and early cultivation of plants, has made significant progress over the millennia.
- Historically, **food shortage in pre-independent India** caused serious impacts **as agriculture was monsoon-dependent** and unfavourable rains and natural calamities resulted in crop failures.
- **Post-independence**, Indian agriculture achieved several landmarks primarily due to **science-led agricultural development**.
- In the history of independent India, there has been multi-fold increase in the production of all the commodities, in spite the **net sown area remaining almost constant**.

- The country has witnessed a **rainbow revolution** in the agricultural commodities viz., **Foodgrain (Green revolution)**, **Milk (White revolution)**, **Oilseeds (Yellow revolution)**, **Fisheries (Blue revolution)**, **Fruits/Honey (Golden revolution)**, **Eggs (Silver revolution)**, **Potato (Round revolution)**, **Meat (Pink revolution)**, **Fertilizers (Grey revolution)**.
- Thus, the concept of Rainbow revolution is an integrated development of crop cultivation, horticulture, forestry, fishery, poultry, animal husbandry and food processing industry.
- A blend of science, technology, extension and policy has contributed in this journey of transforming the country from food scarce to food surplus nation.
- India's **food grain production** is **increasing** every year. Foodgrain production hit an all- time high of **329.7 million tonnes** in 2022-23.

- India **exports** more than **7%** of its **total food grains**, contributing to its position as a significant player in the global agricultural market.
- India is **among the top producers** of several crops such as wheat, rice, pulses, sugarcane and cotton. Within the crop sector, India is **second highest producer of fruits and vegetables**, contributing significantly to the economy. India currently showed a record production of **351.9 million tonnes of horticultural products from 28.1 million ha area**.
- The **productivity of horticulture crops has increased by 50 percent** over the past two decades; it now stands at **12.5 tons per hectare (t/ha)**. Crops such as spices, plantation crops, and aromatic crops contribute significantly to the development of the country's horticultural sector. However, the **productivity is found to be lower** in the case of most crops, as compared to other top producing countries such as China, Brazil and the United States.

- The **livestock and fisheries** sectors of the economy have been playing a vital role in improving the socio-economic conditions of farmers, especially those operating at a small and marginal scale.
- The **contribution of the livestock sector to the GVA** in agriculture has risen from 24.32% in 2014-15 to **30.38%** in 2022-23, reflecting its growing significance in the agricultural landscape.

Crops	Percent share
Total Cereals	49.61
Total Pulses	13.64
Total Food-grains	63.26
Total Fruits	2.29
Total Vegetables	3.48
Total Oil Seeds	14.65
Total Fibers	5.97

- India is the **world's largest milk-producing country**, with a record production of 230.6 million tons in 2022-23.
- Globally, it is also the largest producer of buffalo meat, the second-largest producer of goat meat, and the third-largest producer of eggs and fish. **India stands eighth in the world for overall meat production (9.8 mT).**
- Poultry contributes significantly to the overall growth of the livestock sector, with a sustained increase observed in egg and poultry meat production.
- India's annual fish production has increased to a record 17.4 mT in 2022-23. It presently holds the distinction of being the world's **second-largest aquaculture producer** and **fourth-largest capture fishery producer**.
- **Inland fisheries** currently contribute about **three-fourths** of the total fish production, with the remainder coming from marine capture fisheries.

- Allied activities such as livestock and fisheries are performing better indicating that greater emphasis should be placed on them to boost farmers' income.
- Small farmers need to move to high-value agriculture such as fruits, vegetables, poultry, and dairy.
- Around 85 percent of the operational holdings in the country are small and marginal.
- Increasing demand for industrialization, urbanization, housing and infrastructure is forcing conversion of agricultural land to non-agricultural uses. The scope for expansion of the area available for cultivation is limited.
- Medium holdings are getting converted frequently into small and marginal holdings.

Table: Agricultural land use in India

Geographical Area	=	328.74 million ha
Net sown area	=	141.01 million ha
Area Sown more than once	=	78.15 million ha
Gross Cropped Area	=	219.16 million ha
Net Irrigated Area	=	77.92 million ha
Gross Irrigated Area	=	120.38 million ha

Table: Land holding (2015-16)

No. of holdings: '000 number, Area operated: '000 ha

Category of holding	Number of Holdings	Area
Marginal (< 1.0 ha)	100251 (68.45)	37923 (24.03)
Small (1.0 to 2.0 ha)	25809 (17.62)	36151 (22.91)
Semi-medium (2.0-4.0)	13993 (9.55)	37619 (23.84)
Medium (4.0-10.0 ha)	5561 (3.80)	31810 (20.16)
Large (10.0 ha & above)	838 (0.57)	14314 (9.07)
All holdings	146454 (100.0)	157817 (100.0)

Figures in parentheses indicate percentage share out of total holdings/area

Challenges in Indian Agriculture:

- ❑ **Climate Change:** Increasing temperatures and erratic rainfall patterns are impacting crop yields.
- ❑ **Land Degradation:** Soil erosion, salinity, and reduced fertility are concerns in many areas.
- ❑ **Water Scarcity:** Over-extraction of groundwater and inefficient irrigation practices pose serious challenges.

Status of Agriculture in Different States:

1. Gujarat:

Gujarat is a leading agricultural state, particularly known for its **cotton and groundnut production**. The state's diverse climate and soil conditions support the cultivation of a variety of crops, including wheat, rice, and pulses. Gujarat also has a significant **horticulture sector, producing fruits like mangoes and bananas**. The state's dairy industry is robust, with the famous **Amul cooperative** headquartered here. Gujarat's progressive agricultural policies and infrastructure contribute to its agricultural prosperity.

2. Punjab:

Punjab, often called the “**Food Basket of India**” and “**Granary of India**,” is renowned for its **extensive wheat and rice cultivation**. However, issues like soil degradation and water scarcity are becoming critical. Punjab also grows significant quantities of **maize and barley**. The dairy sector is strong, with substantial milk production. Punjab's agriculture is characterized by **mechanization and high yields**, making it a crucial player in ensuring national food security.

3. Haryana:

Similar to Punjab, Haryana is a major producer of wheat and rice. The state has also seen diversification into horticulture and dairy farming.

4. Uttar Pradesh:

Uttar Pradesh is the **largest agricultural state** in India. It is a leading producer of sugarcane, wheat, rice, potatoes and various fruits and vegetables. The **fertile Gangetic plains and favorable climate allow for double cropping** in most parts of the state, contributing immensely to agricultural production. Rice-wheat is the dominant cropping system practised here.

5. Maharashtra:

This state has a **mix of traditional and modern farming practices**. It is known for its production of cotton, sugarcane, soybeans, and horticultural crops. However, it faces challenges with drought and water management. The state's dairy industry is well-developed, contributing to its agricultural output. Additionally, Maharashtra's progressive farming techniques and irrigation projects enhance its agricultural productivity.

6. Madhya Pradesh:

Madhya Pradesh, known as the "**Heart of India**," is a leading agricultural state with significant production of **soybeans and pulses**. The state's diverse topography and climate support the cultivation of wheat, rice, and maize. MP is also a major producer of oilseeds, particularly soybeans, contributing to India's vegetable oil industry. Horticulture is another vital sector, with the state producing various fruits and vegetables, bolstering its agricultural output and rural economy.

7. Tamil Nadu:

Known for its diversity, Tamil Nadu produces both food and cash crops like rice, sugarcane, and cotton. The state has been proactive in adopting technology and sustainable practices.

8. Karnataka:

Karnataka stands out for its diverse agricultural activities, notably the cultivation of **coffee and spices in the Western Ghats** region. The state is also a major producer of silk, earning it the title of India's "**Silk State.**" Millets, rice, and sugarcane are other significant crops grown in Karnataka. Its favorable climate and varied geography enable the cultivation of a wide range of horticultural crops, including fruits and vegetables, supporting the state's agricultural economy.

9. Andhra Pradesh:

Andhra Pradesh is a key agricultural state, prominently producing rice, making it one of India's top rice producers. The state's favorable climate supports the cultivation of various crops, including **tobacco**, cotton, and chilies. Andhra Pradesh is also known for its horticulture, particularly the production of mangoes, bananas, and citrus fruits. The state's extensive coastline supports a thriving fishing industry, contributing to its diverse agricultural and allied activities.

10. Kerala:

Agriculture in Kerala is characterized by **spices, coconut, and rubber**. The state is focusing on organic farming and sustainable practices.

11. West Bengal:

The state excels in rice production and has significant aquaculture activities. It also has a growing focus on organic farming. The state also excels in growing jute, earning it the nickname "**Jute Bowl of India.**" [Tea plantations in Darjeeling](#) produce world-famous tea. The state's agriculture is diversified with fruits, vegetables, and flowers, playing a vital role in its economy.

12. Odisha:

Primarily known for rice, Odisha is also focusing on diversifying its agriculture with horticulture and aquaculture initiatives.

13. Assam:

Assam, located in northeastern India, is famous for its **tea** plantations, particularly in the Assam Valley, producing some of the finest teas in the world. The state's agriculture also includes the cultivation of rice, jute, and oilseeds. Horticulture and fishery sector also well developed.

Income of Farmers and Rural People in India

- The income of farmers and rural people in India is a critical aspect of the agricultural economy and the overall development of the country.
- Farming forms the backbone of the rural economy in India.
- However, income levels among farmers and rural households vary widely due to several factors, including landholding size, access to technology, government support, and market conditions.

❖ Average income of farmers in India

According to the Economic Survey, the average monthly income of a farmer in India was estimated to be around ₹10,218 from all the sources during 2018-19. However, this figure varies significantly across regions, types of crops, and the size of landholdings. Small and marginal farmers earn much less than large-scale farmers.

- **Income disparities between different states** in India are significant. States like **Punjab, Haryana, and Maharashtra**, which have better irrigation facilities, infrastructure, and access to markets, tend to have higher average farmer incomes compared to states like Bihar, Uttar Pradesh, and Madhya Pradesh.
- **Rural-urban income inequality** is also a growing concern, with **urban areas generally offering higher income opportunities** due to better access to **non-farm employment, education, and healthcare**.

❖ Sources of income

(1) Agriculture allied activities

Agriculture is the **primary** source of income for a significant portion of **rural** population. Small and marginal farmers rely on mixed source of income such as crop cultivation and allied activities such as livestock, dairy farming, poultry, *etc.*

(2) Non-agricultural income

Many rural people also rely on non-agricultural sources of income such as rural industries, handicraft, construction, service sectors and government schemes like MGNREGA, which provides guaranteed employment for 100 days in a year.

(3) Government initiatives

The PM-KISAN scheme provides farmers with Rs. 6000 annually. Other initiatives include subsidies for seed, fertilizer, irrigation, *etc.*

❖ Key factors influencing farmers' income in India

(1) Land holding:

The income of farmers in India is often linked to the size of their landholdings. **Small and marginal farmers** tend to have low income due to the limited scale of production. These farmers are often trapped in cycles of **low income and debt**. **Large farmers**, on the other hand, generally have **higher incomes** due to **economies of scale, access to modern technology, and better market linkages**.

(2) Market access and prices:

Income levels are heavily influenced by farmers' access to local and national markets. **Fluctuations in crop prices** due to **supply-demand imbalances**, weather conditions, or international trade can lead to income volatility.

The minimum support price (MSP) set by the government for certain crops helps stabilize income, but only a fraction of farmers is able to benefit from MSP schemes due to logistical and infrastructure limitations.

(3) Type of crops:

Farmers' income is also impacted by the types of crops they grow. Crops like **rice, wheat, and pulses** are **staple food crops** that often provide modest income, while **high-value crops like fruits, vegetables, and cash crops such as cotton, sugarcane, and tobacco** can generate higher returns. The shift from traditional crops to cash crops, or diversification into horticulture, dairy, and poultry farming, can enhance farmers' incomes.

(4) Weather and climatic conditions:

India's agricultural income is highly dependent on the **monsoon season** and the overall climate. **Irregular rainfall, droughts, floods, and other climate change-induced impacts** often lead to crop failure, which can significantly reduce farmers' income. **Farmers in rainfed areas are particularly vulnerable**, and the unpredictability of weather patterns poses a major risk to their income.

(5) Government support and subsidies:

The Indian government provides several support schemes aimed at improving farmers' income, such as the **Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)** scheme, which provides direct income support to farmers.

There are also **subsidies** for fertilizers, electricity, and irrigation, which help reduce production costs, but the **effectiveness of these schemes often depends on proper implementation and equitable distribution.**

(6) Debt and financial stress:

Many farmers in India depend on **loans** to finance their agricultural activities. However, high levels of indebtedness are a significant concern, as **interest rates on informal loans (from moneylenders) can be very high.** This **debt trap** is a major factor contributing to **rural** distress and **low-income** levels.

❖ Challenges to increase farmers' income

(1) Low productivity: Indian agriculture often faces low productivity due to **outdated farming practices**, inadequate access to modern machinery, and limited research and development.

(2) Fragmented landholdings:

The average size of landholding in India is very small, which limits the ability of farmers to adopt efficient farming practices and invest in modern technology.

(3) Dependence on monsoons:

Despite advances in irrigation, a large portion of Indian agriculture still relies on the monsoon, making income susceptible to **weather fluctuations**.

(4) Marketing and storage issues:

Poor storage facilities and insufficient access to organized markets often result in **post-harvest losses**, which reduce the overall income of farmers.

Livelihood: Definition, Concept, Livelihood pattern in urban and rural areas, Agricultural livelihood systems (ALS) framework, Different indicators to study livelihood systems

In everyday language **‘livelihoods’** refers to a **‘means of living’**. All activities involved in finding food, searching for water, shelter, clothing and all necessities required for human survival at individual and household level are referred to as a livelihood.

A livelihood comprises the **capabilities, assets and activities** required for a means of living (Chambers and Conway, 1992).

A Livelihood can be defined as the activities, the assets and the access that jointly determine the **living** gained by an individual or household (Ellis, 1998).

The household, rather than the individual, is commonly adopted as the basic unit of analysis when considering the economic situation of society. **Household** may be defined as a small group of persons who share the same living accommodation and resources.

❖ Concept of livelihood

- The concept of livelihood goes beyond the income generation.
- It focuses on a more holistic understanding of the way people secure the essentials of life, such as food, water, shelter, clothing, and access to education and healthcare.
- It also includes social, cultural, and environmental dimensions.
- The main difference between livelihood and poverty line is that livelihood is a broad concept that includes a person's capabilities, assets, and activities, while the poverty line is a specific income level below which a person is considered to be living in poverty.
- Livelihood analysis can provide a more comprehensive understanding of poverty than traditional poverty measurements that only consider income and expenditure.

❖ Key components of livelihood

(1) Assets:

Assets include **tangible** (*e.g. land, livestock*) and **intangible** (*knowledge, skill, social network, etc.*) resources that individuals or households have access to.

(2) Activities:

The specific actions that individuals or households undertake to meet their needs, such as farming, trading, labouring, or working in industries, *etc.*

(3) Capabilities:

The **ability** of individuals or households to use their **assets** effectively to generate income and secure their livelihood. This can include knowledge, skills, health, and access to services.

❖ **Livelihood pattern in urban and rural areas**

- ✓ People in **rural** areas engage in a variety of activities that are often tied to the **traditional way of life**.
- ✓ People in **urban** areas engage in a **wide range of activities** because of the many opportunities and facilities available in these densely populated places.
- ✓ Livelihoods in rural areas are primarily based on **primary activities, such as farming, fishing, forestry, and crafts work**.
- ✓ Income of rural people varies with geography, climate, resources, and economic development.
- ✓ **Processing** agricultural products into value-added goods, such as making jams, pickles, or milling grains into flour, provides additional income for rural communities.
- ✓ Various **government initiatives and support programs** aimed at **rural** development can also contribute to the income of people in rural areas.

- ✓ Livelihoods in urban areas are based on **secondary and tertiary activities**, such as **manufacturing, services, and trade**.
- ✓ Urban people may be **self-employed or employed** in government offices, multinational companies, banks, hospitals, educational institutes, or training and business concerns.
- ✓ Due to the abundance of diverse opportunities in urban environments, residents often have a variety of income sources.
- ✓ Rural areas have limited educational facilities, whereas urban areas usually have a lot of schools, colleges, universities, and places for vocational training.
- ✓ The lifestyle of people in urban and rural areas differs significantly due to various factors, including the **environment, infrastructure, and economic opportunities**.
- ✓ Rural life is slower, often centered around traditional work like farming. **Urban life is fast-paced and busy**, with modern jobs and a dynamic atmosphere.

- ✓ **Access to amenities** also differs. Rural areas have fewer modern facilities, contributing to a simpler lifestyle, whereas cities provide numerous conveniences.
- ✓ Rural areas typically have smaller populations, lower **population densities** with open space and slower population growth rates due to limited job opportunities, fewer educational and healthcare facilities, lifestyle preferences and migration to urban centers.
- ✓ **Urban areas are characterized by larger populations, higher population densities** with crowded living spaces and higher population growth rates due to factors like **migration, job opportunities, and better access to education and healthcare.**
- ✓ **Community structure** also differs in rural and urban areas. Rural people have a strong sense of community with close-knit relationships and **informal social interactions**, whereas more diverse population with **formal and business-oriented social interactions** in urban areas.

Aspects	Rural Livelihood	Urban Livelihood
Primary Activities	Agriculture, fishing, forestry, artisanal work	Industry, services, retail, small enterprises
Land and Natural Resources	Heavily dependent on land and natural resources	Limited dependence on natural resources, more industrialized
Income Stability	Seasonal and climate-dependent; often low and fluctuating	More diverse opportunities but often unstable in the informal sector
Migration Patterns	Out-migration to urban centers or other rural areas for work	Migration within or to other urban areas for better opportunities
Government Support	Schemes like MGNREGA, agricultural subsidies, rural development programs	Urban employment schemes, social security programs, housing subsidies

❖ Sustainable Livelihood (SL)

A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets while not undermine the natural resource base.

Sustainable Livelihood means how individuals and communities can maintain and improve their means of living in a manner that is environmentally sustainable, economically viable, and socially equitable.

❖ **Agricultural Livelihood System (ALS)**

The Agricultural Livelihood System (ALS) refers to the **integrated and holistic approach** to managing agricultural activities that contribute to the economic and social well-being of individuals and communities. This system is vital in **rural areas** where **agriculture is a primary source** of income, food security, and cultural identity.

ALS encompasses the various agricultural-based activities and strategies employed by households and communities to secure their livelihoods. It includes the farming activities, income diversification strategies, access to markets, inputs, and support services that shape the living conditions of individuals who depend on agriculture for their sustenance.

❖ Sustainable Livelihood Framework

According to Solesbury (2003), the sustainable livelihoods framework presents the key factors that influences people's livelihoods decisions, outcomes, and relationships between these. **The livelihoods framework is a way of understanding how households derive their livelihoods using their assets and capabilities to develop livelihood strategies composed of a wide range of activities.**

It provides a holistic and multidimensional approach to assess and understand the various dimensions of livelihoods. It emphasizes the multiple interactions between the various factors which affect livelihoods.

It considers the different **assets or capitals** that households possess, including human, financial, physical, natural, and social capital. The framework also takes into account how households cope with shocks and stresses. It also considers the impact of livelihood strategies on livelihood outcomes and livelihood sustainability.

The Sustainable Livelihoods Framework is a tool that can help **analyze the causes of poverty and develop strategies to alleviate it**. It is used for planning new development activities and assessing the impact of present development activities and interventions. It can be used as a practical tool for policymakers and researchers to inform interventions and prioritize resources for sustainable development.

Sustainable livelihoods framework

Key

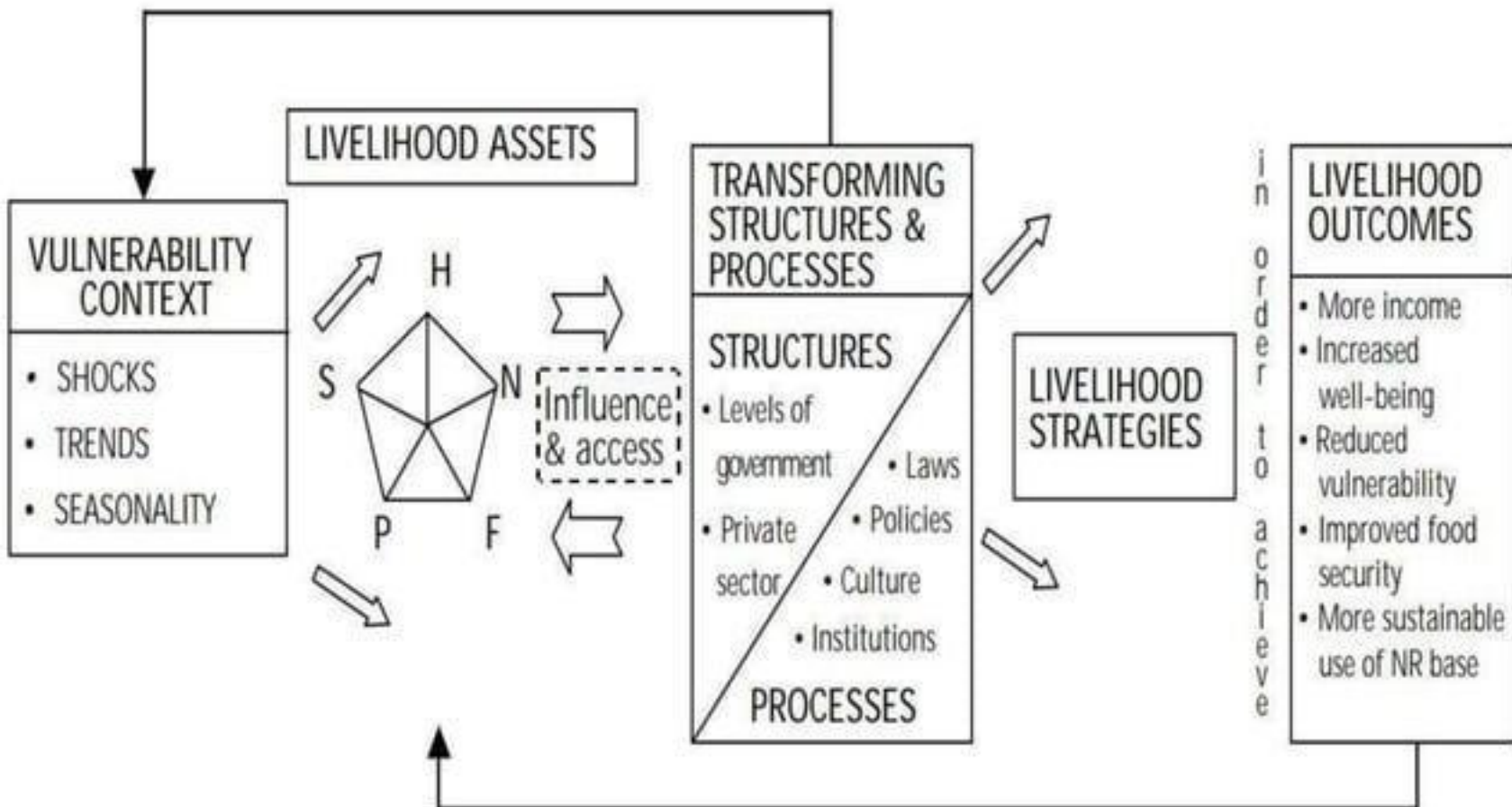
H = Human Capital

S = Social Capital

N = Natural Capital

P = Physical Capital

F = Financial Capital



❖ Vulnerability context

Vulnerability context means the external environment in which the households live. People's livelihoods are fundamentally affected by trends, shocks and seasonality over which they have little or no control.

(1) Trends: Trends influence the choice of livelihood strategies. Population trends, economic trends, resource trends, new technologies, *etc.*

(2) Shocks: Shocks are sudden happenings over short periods such as conflict, economic shocks, health shocks and natural shocks such as earthquakes. Shocks can destroy assets directly. *e.g.* selling of livestock in case of drought or economic crisis.

(3) Seasonality: Seasonality is a periodic change such as seasonal fluctuations in prices, rainfall, production, health, employment opportunities, *etc.*

Vulnerability context can be changed by support and policies. *e.g.* compensation for crop losses by the government.

❖ Assets

- ❑ Livelihood assets refer to the various resources possessed by individuals and households which enable them to pursue and sustain their livelihoods.
- ❑ Livelihood assets can be divided into five core categories (types of capital). The livelihood asset pentagon lies at the core of the livelihood framework. It depicts important inter-relationships among various assets. e.g. if someone has more access to land, he may be financially rich.
- ❑ Livelihood assets play a crucial role in determining livelihood patterns as well as in reducing rural poverty. They also influence their ability to cope with risks, shocks, adverse situations and explore different livelihood options.

(a) Human capital

- Human capital includes knowledge, education, skills, health, and ability to work.
- They make it possible for people to pursue different livelihood strategies and achieve their livelihood objectives.

(b) Natural capital

- Natural assets refer to the **natural resources available** to individuals *viz.*, land, water, forest, fisheries, biodiversity, *etc.*
- There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production (trees, land, *etc.*).
- Natural capital is especially important to those who derive all or part of their livelihoods from direct use of resources.
- There is a **close relationship between natural capital and vulnerability context**. *e.g.* fires that destroy forests, floods and earthquakes that destroy agricultural land.

(c) Financial capital

- Financial assets include income, economic condition, savings, access to credit, and type of work, *etc.* Money can be used for direct achievement of livelihood outcomes. *e.g.* Food purchase to reduce food insecurity.

(d) Physical capital

- Physical assets encompass **tangible** assets like infrastructure, equipment, tools, *etc.* needed to support livelihood. (**Intangible** assets means non-physical assets with monetary value, *e.g.* Brand, copyright, patent, trademark, *etc.*).
- Insufficient physical capital (producer goods) limits people's productive capacity.

(e) Social capital

- Social capital includes social resources such as **social networks, relationships, and community support** which help them to achieve their goals. *e.g.* membership in formal groups (self help groups, cooperatives), village or caste groups, *etc.*
- **Social capital has a direct impact upon other types of capital.** *e.g.* Social capital can help increase people's incomes and rates of saving (financial capital).

Those with more assets are more likely to have greater livelihood options with which to pursue their goals and reduce poverty.

People's ability to escape from poverty is dependent upon their access to **assets**. *e.g.* legal ownership rights, community institutions regulating access to common resources, *etc.* Many livelihood programmes in India have helped the poor to create assets. *e.g.* Awas Yojna enables poor people to build their houses.

❖ Transforming structures and policies

- ❑ Transforming structures are institutions and organisations (private and government) that set policies and legislation, services, trade, *etc.* that shape livelihoods. They operate at all levels, from household level to international level) global, national, regional, district and local levels).
- ❑ Processes determine the way in which structures and individuals operate and interact. *e.g.* policies and legislations.
- ❑ If **structures** can be thought of as **hardware**, **processes** can be thought of as **software**.
- ❑ They determine peoples' access to various types of capitals, livelihoods strategies, *etc.* Transforming structure and policies support people to be more resilient to the negative effects of trends, shocks and seasonality. *e.g.* Relief policies, well-functioning markets. Some institutions can restrict people's choice of livelihood, *e.g.* some rigid cast or social systems prevent women from doing some activities.

❖ Livelihood strategies

- Livelihood strategies are the **combination of activities that people choose to achieve their livelihood goals**.
- The choice of strategies is a **dynamic process** in which people combine activities to meet their changing needs.
- For example, farming households also include non-farm activities to diversify income and meet household needs.
- People's choice of livelihood strategies is greatly **influenced by their access to assets as well as the policies**, institutions and processes that affect their ability to use these assets to achieve positive livelihood outcomes.
- **Migration**, whether seasonal or permanent, is also one common livelihood strategy.

❖ Livelihood outcomes

- Livelihood outcomes are the **achievements or outcomes that the people gain through their livelihood strategies.**
- Examples of livelihood outcomes are increased income, **increased well-being** (e.g. self-esteem, physical security & health, access to services, maintenance of cultural heritage), **improved food security, reduced vulnerability, more sustainable use of natural resources.**
- Livelihood outcomes help **understand peoples' priorities** for particular strategies, results of these strategies and how people respond to new priorities and constraints.

❖ Different indicators to study livelihood systems

- The success of the livelihood interventions can be assessed by understanding their contribution to livelihood outcomes that people consider important. *e.g.* Rise in income, increased livestock, education to children are some easily monitored outcomes.
- Livelihood status can be measured using various approaches. One approach is to **construct a scale/score** to measure livelihood status based on multiple indicators such as income, vulnerability, risk, health, nutrition, education, and other household objectives. Various livelihoods indices can be calculated using the score of different indicators.

Economic efficiency indicators:

(1) Net cropped area: Proportion of net sown area in the total cropped area, represents the extent of utilization of land resources for farming activities.

(2) Net irrigated area: Area under assured irrigation reflecting the irrigation potential of the region.

(3) Grain yield of food crops: Total food grain production of cereals and pulses per unit area. **Productivity** of output indicates the efficiency of all the resources used in its production.

(4) Fertilizer use: Right quantity, method, and timing of fertilizer **usage based on soil test** are crucial in the optimum usage of fertilizers. It not only economizes production but also results in sustainability.

(5) Productivity of land: Income earned from agriculture and its related activities per unit cultivated area represents the productivity of land in monetary terms. It varies depending on the type of crops being cultivated, livestock components being reared, technologies being used, *etc.*

(6) Productivity of labour: It reflects the per capita income of the agricultural labourers earned from agriculture and its related activities. It is a crucial element in economic growth.

Ecological security indicators:

(7) Forest cover: Forest cover plays an important role in **ecological balance**. It has a greater influence on the hydrological cycle and carbon concentration.

(8) Human density

(9) Density of livestock: The number of individuals and livestock component per unit of geographical area represents the density of the human and livestock population, respectively. The extent of pressure exerted by human and livestock population have a direct effect on natural resources like land, water, *etc.* and ecological balance.

(10) Degraded land: The extent of degradation of natural resources influences social cost to be borne by the society.

(11) Rainfall variability: Agriculture mainly depends on rainfall, and its variation has greater influence on net cropped area. Net irrigated area depends on availability of groundwater, and its recharge which further depends on rainfall pattern. **Optimum rainfall with uniform distribution** is considered as the robust indicator of ecological balance.

(12) Pressure on ground water: It indicates the availability of ground water for future generations. Recharge of groundwater mainly depends on rainfall. Excess utilization of groundwater as compared to recharge, leads to tremendous pressure on groundwater.

(13) Cropping intensity: **Growing a greater number of crops per unit area** is a feasible alternative for attaining food and fodder security. Higher cropping intensity leads to more productivity from arable land.

Social equity indicators:

(14) Availability of food grains

(15) Availability of milk: In addition to food security, nutritional security is of immense importance in attaining development. Availability of food and milk to adults, children, pregnant women as per the recommendation of ICMR is crucial in determining the development of any region. Malnutrition and malnourishment have a negative bearing on development.

(16) Literacy of rural female: Gender equity is crucial in the development of any region. Both genders (male and female) should have equal opportunities in terms of access to resources, ownership of resources, decision making, *etc.*

(17) Rural electrification: Energizing pump sets is essential for the effective and efficient usage of groundwater, a major source of irrigation. It is essential to run small cottage industries, handicrafts, agro-based industries. It is also essential for performing usual activities at home, for education of children, people residing in remote areas having poor road connectivity, *etc.* Proper supply of power has a greater influence on the economic growth of the region.

(18) Village road connectivity: Proper road connectivity is essential for the marketing of produce from any production activity. **Transportation alone forms more than 50 percent of the marketing costs.** It is considered as the key factor in determining infrastructural development in the region.

(19) Mortality rate of infants: This is a key factor reflecting the overall physical health of the community and eventually influencing regional socio-economic development.

(20) Availability of ground water: Adequate ground water is crucial for agricultural growth. It is considered the major source of irrigation and its availability varies depending on various factors having a positive bearing on its recharge.

Farming systems, Farming-based livelihood systems and Prevalent Farming systems in India contributing to livelihood

Over the history of human settlements on the planet earth, agriculture has transformed in tune with the growing population and its needs. The transformation has been quite remarkable since the end of World War II. Food and fibre productivity soared up due to adoption of new technologies viz., high yielding varieties (HYV), from mechanization, increased fertilizer and pesticide use, specialized farming practices, water resource development and improved irrigation practices and Government policies that favoured maximizing production. It was in the early 1960s, the Green Revolution took shape in developing countries, including India. It led to the attainment of self-sufficiency in food grain production.

While the green revolution led to dramatic production increase, the increase in production was not sustainable. Moreover, it has also adversely affected human health and environment due to excessive and inappropriate use of chemical fertilizers and pesticides.

Adverse effects of modern high-input agriculture:

- **Overuse of natural resources**, causing depletion of groundwater, and loss of forests, wild habitats, and of their capacity to absorb water, causing waterlogging and increased salinity.
- Contamination of the atmosphere by ammonia, nitrous oxide, methane and the products of burning, which play a role in ozone depletion, global warming and **atmospheric pollution**.
- Contamination of food and fodder by residues of pesticides, nitrates and antibiotics.
- **Contamination of water** by pesticides, nitrates, soil and livestock water, causing harm to wildlife, disruption of ecosystems and possible health problems in drinking water.
- Build-up of **resistance** to pesticides in pests and diseases including herbicide resistance in weeds.
- Damage of farm and natural resources by pesticides, causing harm to farm workers and public, **disruption of ecosystems and harm to wildlife**.
- **Erosion of genetic diversity** – the tendency in agriculture to standardize and specialize by focusing on modern varieties, causing the displacement of traditional varieties and breeds.
- New **health hazards for workers** in the agrochemical and food processing industries.

Added to the above adverse effects, increasing population, decreasing per head land holding, increasing cost of farm inputs, more dependence upon monsoon rain, natural calamities, global climate change and global competition are the major challenges faced by Indian agriculture. This situation creates intense pressure on available natural resources. Our generation has been willing to use the resources of the future to meet our own short-term goals.

Sustainable agriculture has emerged as an alternative agricultural system that addresses the many issues/constraints faced by resource poor farmers and ensures environmental sustainability. Sustainable agriculture refers to the capacity of agriculture over time to contribute to overall welfare by providing sufficient food and other goods and services in ways that are economically efficient and profitable, socially responsible, while also improving environmental quality (Crosson, 1992).

This system involves a combination of inter-related soil, crop and livestock production practices in conjunction with the discontinuation or the reduced use of external harmful inputs. It emphasizes on the natural processes such as nutrient cycling, biological nitrogen fixation, soil regeneration, natural enemies of pests, etc. Farming system is one of the several approaches of sustainable agriculture.

What is a system ?

A system is defined as a set of components that are interrelated and interact among themselves. A system is a group of interacting components, operating together for a common purpose, capable of reacting as a whole to external forces.

For example, the human body is a system-it has a boundary (*e.g.*, the skin) enclosing a number of components (heart, lungs) that interact (the heart pumps blood to the lungs) for a common purpose (to maintain and operate the living body). Collection of unrelated items does not constitute a system.

Farm

A farm is organized economic unit in which crop and animal production is carried out with purpose of producing economic net returns. It is an area of land, including various structures, devoted primarily to the practice of producing and managing food, fibers and fuel.

Farming

The term farming covers a wide spectrum of agricultural production work. At one end of this spectrum is the **subsistence farmer**, who farms a small area with limited resource inputs, and produces only enough food to meet the needs of his family. At the other end is **commercial intensive agriculture**, including industrial agriculture. Such farming involves large fields and/or numbers of animals, large resource inputs (pesticides, fertilizers, *etc.*) and a high level of mechanization. These operations generally attempt to maximize financial income from grain, produce or livestock.

Farming system

A farm is a system in that it has inputs, processes and outputs. The type and amount of inputs, processes and outputs may vary depending on the type of farming.

Input	Process	Output
Labour	Ploughing	Wheat
Capital	Sowing	Potato
Seeds	Spraying	Milk
Animal	Fertilizer application	Crop waste
Fertilizer	Harvesting	Wool
Pesticide	Grazing	Eggs
	Milking	

Farming system represents an appropriate combination of farm enterprises (cropping systems, horticulture, livestock, fishery, forestry, poultry, *etc.*) and the means available to the farmer to raise them for profitability. It interacts adequately with environment without dislocating the ecological and socio-economic balance.

Or

A farming system is defined as a complex interrelated matrix of soil, plants, animals, power, implements, labour, capital and other inputs controlled in part by farming families and influenced to varying degrees by political, economical, and institutional and social forces that operate at many levels.

Mixed farming

Mixed farming is defined as a system of farming on particular farm which includes crop production, raising livestock, poultry, fisheries, bee keeping, *etc.*, to sustain and satisfy as many needs of the farmer as possible. **Subsistence is important objective of mixed farming while, higher profitability without altering ecological balance is important in farming systems.**

Concept of farming system

Farming system consist of several enterprises like cropping system, dairying, piggery, poultry, fishery, bee, keeping, *etc.* **These enterprises are interrelated and interact with one another.** The byproducts and wastes of one enterprise are used as inputs in other enterprises. For example, the waste of dairying like dung, urine, refuse, *etc.* is used for preparation of FYM, which is an input in cropping systems. The straw obtained from the crops is used as fodder for cattle which are used for different field operations for growing crops.

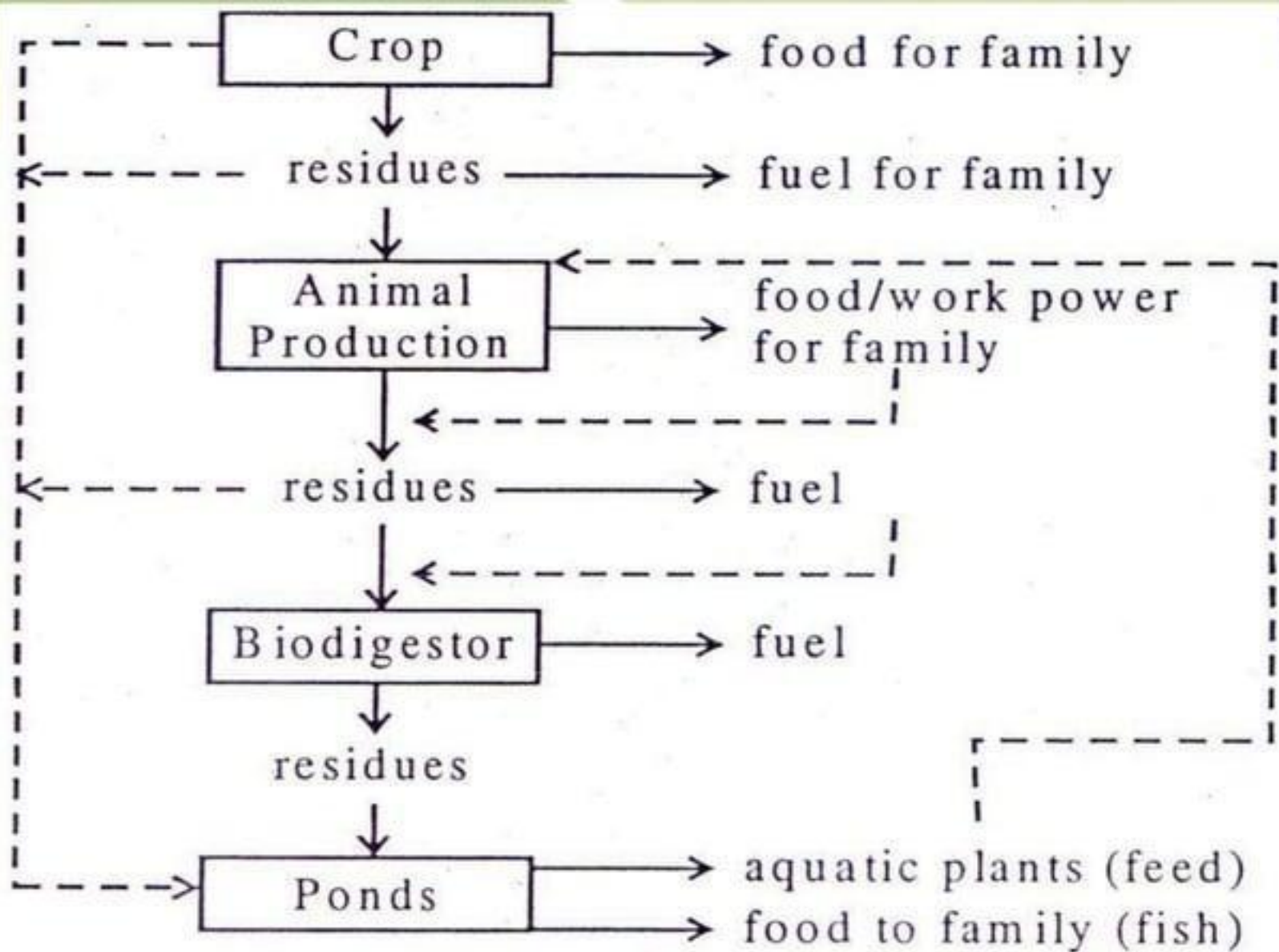


Fig.: Farming system

In farming system, the farm is viewed in a holistic manner. A combination of more than one enterprise when carefully chosen, planned and executed, gives greater dividends than a single enterprise, especially for small and marginal farmers.

It is a **resource management strategy** to achieve economic and sustain agricultural production to meet diverse requirement of the farm household. Sustainability is the objective of the farming system where the production process is optimized through efficient utilization of inputs without impairing on the quality of environment.

Advantages of farming system

(1) Productivity: Farming system provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises.

(2) Profitability: The system as a whole provides an opportunity to make use of produce or waste material of one enterprise as an input in another enterprise at low cost. Thus, by **reducing the cost of production**, the profitability and benefit cost ratio works out to be high.

(3) Soil health: Soil health is a key factor for sustainability. It is getting deteriorated and polluted due to faulty agricultural management practices *viz.*, excessive use of inorganic fertilizers, pesticides, herbicides, irrigation, *etc.* In farming system, **organic manures and waste recycling maintain soil health for longer time.**

(4) Balanced food: In farming system, diversification of enterprises provides **opportunity to produce different sources of nutrition namely proteins, carbohydrates, fats and minerals, etc.** from the same unit land. This helps in solving the **malnutrition** problem prevalent among the marginal and sub-marginal farming households.

(5) Environmental safety: In farming system, **eco-friendly practices** like efficient use of byproducts, recycling of waste, biocontrol measures for pests and diseases, *etc.* bring down the application of huge quantities of fertilizers, pesticides and herbicides, which pollute the soil water and environment. Integrated Farming System (IFS) greatly reduces environmental pollution.

(6) Income or cash flow round the year: In single enterprise like crop activity, income is expected only at the time of disposal of economic produce. IFS enables cash flow round the year by way of **sale of products from different enterprises**. This **enhances the purchasing power of the farmer** and provides an opportunity to invest in improved technologies for enhanced production.

(7) Saving energy: Availability of fossil fuel has been declining at a rapid rate. In farming system, effective recycling of organic wastes to generate energy from **biogas plant** can mitigate energy crisis to certain extent.

(8) Meeting fodder crises: In IFS, every inch of land area is effectively utilized. Practices like **alley cropping, growing fodder legumes along the borders, inclusion of fodder in cropping systems** help to produce sufficient fodder for livestock component of the farming system.

(9) Solving timber and fuel crises: The current production level of fuel wood and timber wood is insufficient to meet the current demand. **Agro-forestry** component in farming system would increase timber and fuel wood production and reduce deforestation, which will help to preserving our natural ecosystem.

(10) Employment generation: Various farm enterprises *viz.*, crop + livestock or any other allied enterprise in the farming system would increase labour requirement significantly and would help to solve the problem of under employment. An IFS provides enough scope to employ family labour round the year.

(11) Scope for establishment of agro-industries: Surplus production from different components of IFS in the region provides opportunity for value addition establishment of agro-industries.

(12) Enhancement in input use efficiency: An IFS provides good scope for resource utilization in different components leading to greater input use efficiency and benefit-cost ratio.

Principles of farming system:

- 1) Minimization of risk
- 2) Recycling of wastes and residues
- 3) Integration of two or more enterprises
- 4) Optimum utilization of all resources
- 5) Maximum productivity and profitability
- 6) Ecological balance
- 7) Generation of employment potential
- 8) Increased input use efficiency
- 9) Use of end products from one enterprise as input in other enterprise

Farming-based livelihood systems:

Farming-based livelihood systems refer to livelihood strategies adopted by **rural households** which are centred on **agriculture and related activities**. In these systems, **agriculture is the primary means of livelihood** and in addition, households also include allied sectors such as **animal husbandry, fisheries, forestry, and non-farm rural activities** to enhance their income and reduce risk.

Prevalent farming systems in India:

India's farming systems are diverse due to variations in agro-climatic conditions, socio-economic factors, and cultural practices. The major farming systems prevalent in India include:

(1) Crop-based farming systems:

- ✓ **Rice-wheat system:** Common in northern states like Punjab, Haryana, and Uttar Pradesh. Rice is grown during the *Kharif* season (monsoon), and wheat is grown during the *Rabi* season (winter). **This system contributes to food security in India.**
- ✓ **Rice-based systems:** Prevalent in eastern and southern states such as West Bengal, Odisha, Tamil Nadu, and Andhra Pradesh. In these regions, rice is grown with other crops like pulses, oilseeds, and vegetables.
- ✓ **Millet-based systems:** Found in semi-arid regions like Rajasthan, Karnataka, and parts of Maharashtra, where millets like sorghum, pearl millet, and finger millet are the staple crops.
- ✓ **Sugarcane-based systems:** Common in states like Maharashtra, Uttar Pradesh, and Karnataka. Sugarcane is a major cash crop and contributes significantly to the income of farmers.

(2) Mixed farming systems:

- ✓ **Crop-livestock systems:** In many parts of India, small and marginal farmers rely on a combination of crop farming and livestock rearing. For instance, in states like **Gujarat and Rajasthan**, farmers grow crops and rear livestock (cows, buffaloes, goats) to diversify income sources and meet household needs for milk, meat, and manure.
- ✓ **Agroforestry systems:** These systems integrate trees with crops and livestock. Farmers in **southern and northeastern India** practice agroforestry. These systems are sustainable and increase farm resilience.

(3) Horticulture-based systems:

- ✓ **Fruit and Vegetable Farming:** India is a leading producer of fruits and vegetables such as mango, banana, papaya, citrus fruits, potato, tomato, and onion. Horticulture-based systems are prevalent in states like Kerala, Tamil Nadu, Maharashtra, and West Bengal. These systems provide high returns, although they are more labour-intensive and susceptible to price fluctuations.
- ✓ **Spice-based systems:** States like Kerala, Karnataka, and Tamil Nadu are known for cultivating spices such as **cardamom, pepper, ginger, and turmeric**. These high-value crops contribute to both domestic consumption and export.

(4) Livestock-based farming systems:

- ✓ **Dairy Farming:** India is the largest milk producer in the world, and dairy farming is an important livelihood for millions of rural households. Dairy-based systems are prominent in states like Uttar Pradesh, Punjab, Gujarat, and Maharashtra.
- ✓ **Poultry farming:** Poultry is a significant sector in states like Tamil Nadu, Andhra Pradesh, and West Bengal. The rising demand for eggs and poultry meat provides steady income to small farmers.

(5) Fishery-based systems:

- ✓ **Inland fisheries:** With its vast network of **rivers, lakes, and ponds**, India has a well-established inland fishery system. States like West Bengal, Assam, Andhra Pradesh, and Odisha are prominent in freshwater fish production.
- ✓ **Marine fisheries:** The coastal states of Kerala, Tamil Nadu, Maharashtra, and Gujarat have vibrant marine fishing communities. Fisheries contribute to both livelihoods and nutritional security in these regions.

(6) Integrated farming systems:

These systems combine various components of farming, such as crops, livestock, aquaculture, and agroforestry, to enhance farm productivity and sustainability. Integrated farming systems maximize resource use efficiency, improve soil fertility, and reduce input costs.

Contribution of farming systems to livelihoods in India

(1) Employment generation: Agriculture and allied activities provide employment to nearly 60% of India's rural population. Farming systems support both on-farm labour and off-farm rural employment.

(2) Food security: Farming systems, particularly rice-wheat and other cereal-based systems, are critical for ensuring food security in India. India is largely self-sufficient in food grains production.

(3) Income diversification: Farming systems help farmers diversify their sources of income. By incorporating livestock, fishery, or agroforestry, farmers reduce their dependence on a single crop or enterprise, thus minimizing risk.

(4) Sustainability and resource conservation: Integrated farming systems promote sustainable agricultural practices, such as crop rotation, organic farming, and soil conservation. This helps in preserving soil fertility and protecting natural resources.

(5) Economic growth: High-value farming systems, such as horticulture and dairy farming, contribute significantly to the rural economy. These systems provide higher returns and enable smallholder farmers to improve their standard of living.

(6) Women empowerment: Livestock-based farming systems and horticulture involve women significantly in day-to-day activities. These systems provide income-generation opportunities for rural women and contribute to their empowerment.

(7) Export earnings: Farming systems that produce high-value cash crops (sugarcane, spices, cotton, and horticulture) contribute to India's export earnings and enhance the livelihoods of farmers involved in these sectors.

Types of traditional and modern farming systems

Comparison between Traditional and Modern Farming Systems:

Technology: Traditional systems rely on minimal technology, while modern systems use advanced technology like machinery, GMOs, and precision tools.

Scale: Traditional farming is usually small-scale and subsistence-oriented, whereas modern farming is large-scale and profit-driven.

Inputs: Traditional systems use organic methods and low inputs, while modern systems depend heavily on synthetic inputs (fertilizers, pesticides).

Environmental Impact: Traditional methods often conserve biodiversity and maintain soil health, whereas modern systems may lead to environmental degradation if not managed sustainably.

Traditional Farming Systems

(1) Shifting Cultivation (Slash and Burn Agriculture): Farmers clear a patch of forest, burn vegetation, and grow crops on the nutrient-rich ash. After a few years of cultivation, the soil fertility declines, and the field is abandoned. The process is then repeated on a new patch of land.

Advantages: It allows soil recovery over time and requires fewer inputs like fertilizers or pesticides.

Disadvantages: Deforestation, loss of biodiversity, and unsustainable with increasing population pressure.

(2) Subsistence Farming: Farming system where crops are grown mainly for personal consumption rather than for sale. It is labour intensive, often reliant on family labour, and uses traditional tools like hoes and ploughs.

Advantages: Low input costs and minimal environmental degradation.

Disadvantages: Low yields, limited surplus for trade, and high vulnerability to climate variations.

(3) Pastoralism (Nomadic and Semi-Nomadic): A system where livestock (cattle, sheep, goats) are moved seasonally in search of grazing areas. Nomadic pastoralists are constantly on the move, while semi-nomadic ones have a home base but still move with their herds.

Advantages: Utilizes marginal lands that are unsuitable for crop production and allows flexible use of resources.

Disadvantages: Overgrazing, land degradation, and conflict over grazing rights.

(4) Mixed Farming: Mixed farming includes crop production with raising livestock, poultry, fisheries, bee keeping, *etc.*, to sustain and satisfy as many needs of the farmer as possible.

Advantages: Diversifies income, improves soil fertility through animal manure, and reduces risk through multiple income streams.

Disadvantages: Requires more labour, expertise in both animal husbandry and crop production, and may need more land.

(5) Terrace Farming: Farming on sloped land by constructing terraces (step-like structures) to prevent soil erosion and conserve water.

Advantages: Makes use of hilly terrain, conserves water, reduces erosion, and supports food production in mountainous areas.

Disadvantages: Labor-intensive to construct and maintain terraces.

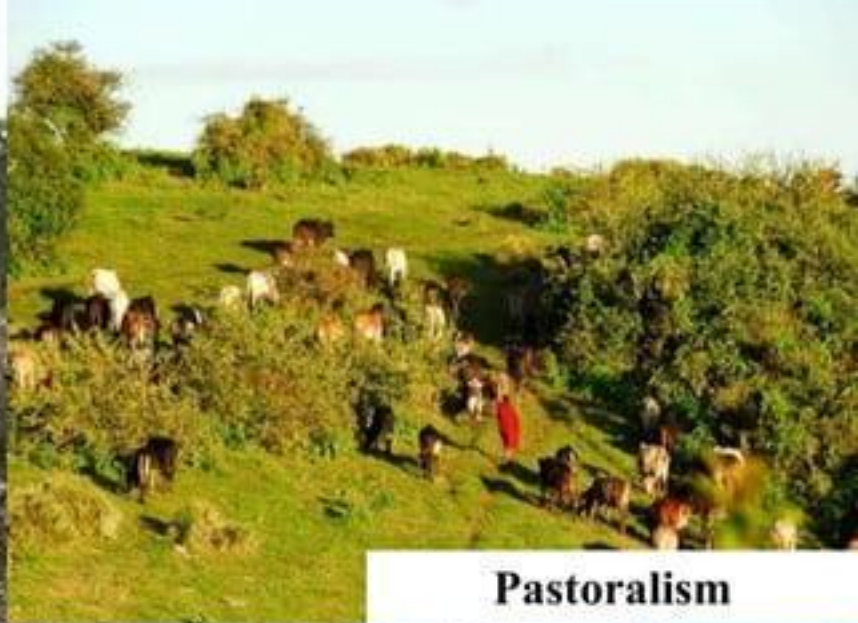
(6) Rainfed Farming: Farming that depends solely on rainfall for water, with little to no irrigation.

Advantages: Minimal cost for irrigation infrastructure, promotes local crop varieties suited to rainfall patterns.

Disadvantages: Highly vulnerable to weather changes, droughts, and inconsistent rainfall.



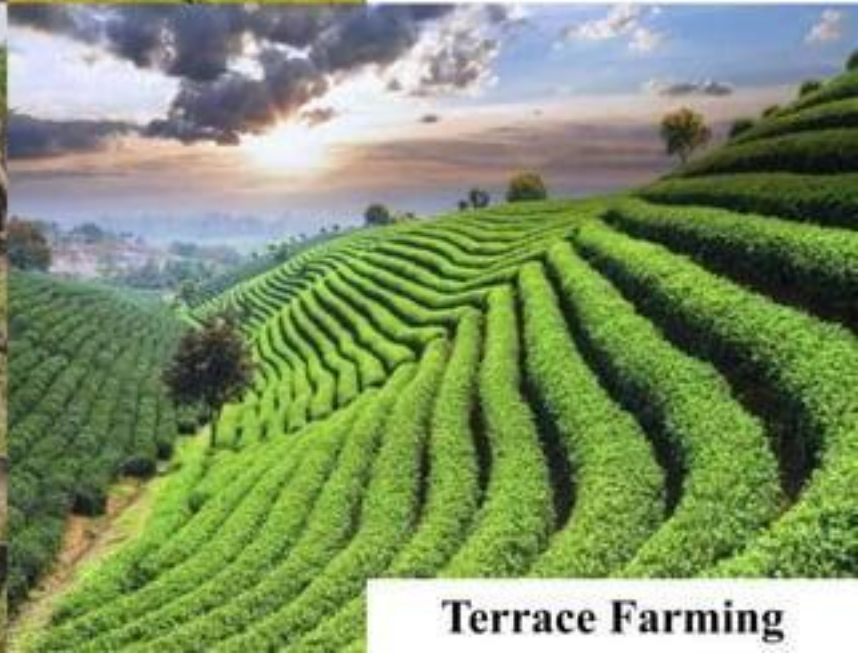
Shifting Cultivation



Pastoralism



Mixed Farming



Terrace Farming



Agroforestry



Rice-Fish Farming



Community Farming



Organic Farming

Modern Farming Systems

(1) Monoculture: The practice of growing a single crop on a large scale over a vast area.

Advantages: Simplifies management, efficient use of machinery, and maximizes output for high-demand crops.

Disadvantages: Depletes soil nutrients, increases vulnerability to pests and diseases, and leads to biodiversity loss.

(2) Commercial Farming: Large-scale production of crops or livestock for sale and profit, usually relying on advanced technologies, high inputs of fertilizers, and mechanization.

Advantages: High yields, increased efficiency through mechanization, and contribution to food security and export economies.

Disadvantages: High input costs, environmental damage from overuse of fertilizers and pesticides, and social inequalities in land ownership.

(3) Agroforestry: A system that integrates trees and shrubs into crop and livestock farming systems to improve land use and diversify production.

Advantages: Increases biodiversity, improves soil fertility, and provides multiple products (timber, fruits, fuelwood).

Disadvantages: Complex management system and longer time to see economic returns from tree crops.

(4) Hydroponics and Aquaponics: Soil-less farming systems where plants are grown in nutrient-rich water solutions (hydroponics) or integrated with fish farming (aquaponics).

Advantages: Uses less water, no soil degradation, high efficiency in small spaces, and reduced use of pesticides.

Disadvantages: High setup costs, need for technical expertise, and dependence on external inputs.

(5) Precision Farming: A technology-driven approach that uses GPS, sensors, and data analytics to optimize farm inputs (fertilizers, water, seeds) and monitor crop conditions in real-time.

Advantages: Increases efficiency, reduces waste, and enhances productivity by fine-tuning inputs to specific field conditions.

Disadvantages: High initial investment and dependence on technology.

(6) Vertical Farming: Growing crops in vertically stacked layers or vertically inclined surfaces, often in controlled environments (indoors or greenhouses).

Advantages: Efficient use of space, controlled environment allows year-round production, reduces need for pesticides.

Disadvantages: High energy costs for artificial lighting and climate control, expensive setup, and limited crop variety.

(7) Protected cultivation: Protected cultivation, also known as greenhouse or controlled environment agriculture (CEA), is a method of growing crops in a controlled environment to protect them from environmental stresses and produce healthier, higher-quality crops.

Advantages: Higher yield, better quality, reduced pesticide use, precise application of inputs.

Disadvantages: High energy costs for structure and climate control, expensive setup, requires technical knowledge, suitable for high value crops.

(8) Genetically Modified (GM) Crops: A system that utilizes genetically modified crops that are engineered for traits like pest resistance, herbicide tolerance, and improved nutritional content.

Advantages: Higher yields, reduced use of pesticides, and resistance to environmental stresses.

Disadvantages: Ethical concerns, potential environmental risks, and market resistance to GM products.

Industrial Agriculture



Three main principles of CA

1 minimum soil disturbance

2 permanent soil cover: crop residue or live mulch

3 crop rotation and or intercropping



Precision Agriculture/ Smart Farming

Auto Steer

VRT (Variable rate technology)

Remote Sensing

Yield Monitors



GPS & GIS



Wireless Telematics



Artificial Intelligence



Data Collection & Analysis





Hydroponics



Vertical Farming

Components of farming system/farming-based livelihood systems

Cropping:

- Cropping is the most important component of farming system.
- It is considered as the backbone of farming system, because it can be implemented in all type of situations like wetland, garden land and dry land.
- There are many types of crops and cropping systems raised by the farmers to fulfil their food, fiber and fuel requirements.
- Cereals, pulses, oilseed, fiber, fodder and cash crops are the important crops cultivated by majority of farmers.
- Cropping component also serves as base for many other components as it provides raw material and inputs to other components.

Horticulture:

- The demand and production of different horticultural crops viz., fruit, flower and vegetable crops are increasing day to day.
- A large number of farmers have included cultivation of horticultural crops as a component of farming system in garden land and dry land areas to fulfil the market demand and receiving higher economic returns.
- The horticulture-based food processing industries are also developing which support this component and create parallel economy and employment opportunities for the people.

Livestock/Dairy farming:

- For the centuries, farmers of India are growing crops and livestock together.
- Livestock has been integral part of the system. Apart from contributing to food basket and nutritional security, it provides constant income to the farmers throughout the year.
- This system plays a significant role in generating employment to landless, small and marginal farmers and farm women.
- Many farmers are shifting their activities to livestock and agroforestry when crop production becomes difficult due to failure of monsoon.
- Majority of the cattle owners in the country maintain only 1 or 2 milch animals as an integral part of the mixed farming system.
- They utilize family labour for various practices concerned with dairying.

- Successful dairy farming needs sound management practices.
- It is imperative to provide good managerial inputs (feed, fodder, housing, health care, breeding, general management and marketing) to exploit the full genetic potential of livestock and to make this economically viable.
- The success of dairy farming depends on the availability of inputs and better marketing facilities to milk.
- Besides producing milk, dairy animals are also good source of draft power and farmyard manure, which is good source of organic matter for improving soil fertility.
- The farm byproducts in turn are gainfully utilized for feeding the animals.

(a) Cattle:

Cattle rearing in India is carried out under a variety of adverse climatic and environmental conditions. The breeds are broadly classified into three groups.

- 1) **Draft breeds:** The bullocks of these breeds are good draft animals, but the cows are poor milkers, *e.g.*, Khillari, Nagore, Hallikar, Mali.
- 2) **Dairy breeds:** The cows are high milk yielders, but the bullocks are of poor draft quality, *e.g.*, Sahiwal, Red Sindhi, Gir.
- 3) **Dual purpose:** The cows are fairly good milkers and the bullocks are with good draft work capacity, *e.g.*, Tharparkar, Hariana, Ongole, Kankrej and Deoni.

❖ **Exotic breeds:** The exotic breeds are high milk yielder *e.g.*, Jersey, Holstein-Friesian, Aryshire, Brown Swiss and Guernsey.

(b) Buffalo:

- Buffaloes digest more of roughage than cows and thrive well on dry fodder. Buffaloes are able to utilize coarse feed even rejected also.
- Majority of the dairy products in the country are based on buffalo. The **higher fat percentage** in buffalo milk is more profitable in dairy enterprises, particularly for toned and double toned milk. The higher fat content around 7-8%, and sometimes up to 12-15% enables the farmers to get a higher income as the price of the milk is based on fat content.
- Buffalo milk is comparatively cheaper to produce, since a buffalo is able to utilize coarse feed even rejected also.
- Buffaloes are also utilized as a source of power for various field operations. They are **slow, but heavy and strong** and are well suited to work in muddy and submerged fields where they are able to pull heavier loads than cattle.
- ❖ **Breeds:** The important buffalo breeds are Murrah, Nili-Ravi, Kundi, Bhadawari, Tarai, Nagpuri, Pandharpuri, Mandya, Kalahandi, Sambalour (Central region), Toda, Surti, Jaffarbadi and Mehsani, Dharwari.

(c) Goat farming:

- India is blessed with the largest population of goats, i.e., about 23% of the world population.
- Employing goat rearing in integrated farming system is profitable and gives assured dividends.
- Goats are small animals and easy to manage.
- Goats are also a source of bones, hooves, glands, offal, fibre, urine and droppings.
- Goats are browsing rather than grazing. They obtain their intake from a wide variety of vegetation throughout the year.
- Goat farming can be more profitable if good pastures are available.
- The average milk production is 1 litre/day/animal.
- Goats produce a low-fat meat. The smallest viable unit of goats comprise 50 does (female) + 2 bucks (male).
- One can establish organized goat farms in multiples of 50 + 2.

❖ **Goat breeds:**

- **Milk & Meat:** Jamnapari, Osmanabadi, Barbari, Beetal
- **Meat and skin:** Black Bengal, Kanni adu
- **Meat, skin and milk:** Barvari, Malabari (Tellicherry), Sirohi, Surti
- **Meat, hair and skin:** Gaddi, Kutchi, Marwari
- **Fibre:** Angora, Gaddi, Pashmina, Chegu, Changthangi

Surti Goat is one of the best breeds in India for dairy. This breed is very small and is native of Surat in Gujarat. They are most economical to the rear. Surti female goats are bigger than male goats.



(d) Sheep farming:

- Sheep is also a small ruminant with a high adaptability to extreme climate. Sheep can thrive well in all agroclimatic conditions except in high rainfall areas.
- Sheep plays important role in the animal production in **arid and semi-arid regions** and largely in marginal and small holdings.
- Sheep with its multi-facet utility for wool, meat, milk, skins and manure, form an important component of rural economy.
- Sheep rearing can be recommended as an occupation to the rural people especially to the weaker sections in hilly, drought prone and desert area. In the event of failure of seasonal rains and crops, sheep rearing gives a helping hand to the farmers.
- Sheep can **subsist on low set and sparse vegetation** whereas other species of farm livestock may be struggling to thrive. This is possible because of their **inherent capacity to browse very close to the roots of herbage**.
- **Sheep penning** in harvested field enhances soil fertility due to addition of faecal materials, rich in nutrients.
- ❖ **Breeds:** Deccani, Nellore, Bellari, Mandya, Banur, Nilgiri, Gurez, Bhakarwal, Gaddi, Lohi, Bikaneri, Marwari, Kutchi, Coimbatore white, *etc.*

Poultry:

- Poultry is one of the fastest growing food industries in the world.
- Poultry meat accounts for about 27% of the total meat consumed worldwide and its consumption is growing at an average of 5% annually.
- Poultry industry in India is relatively a new agricultural industry.
- Poultry in IFS plays a pivotal role in fulfilling the ever-increasing demand for meat and eggs in the country.
- Rearing poultry in a backyard system is an age-old practice. Backyard poultry is a means of livelihood for large number of small and marginal farmers in India.
- Poultry farming is practiced under a wide range of conditions viz., i) Extensive system (Free-range extensive and Backyard extensive systems), ii) Semi-intensive system iii) Intensive system.

- Under **free-range extensive system**, the birds are not confined and can scavenge for food over a wide area.
- Under **backyard extensive systems**, poultry are housed at night but allowed free-range during the day.
- **Semi-intensive system** consists of a separate shelter for the birds during the night in which water and some feed is provided.
- In **intensive system**, more birds are reared commercially in a poultry house, where they are provided with food, water and all other requirements. The birds are not allowed to move outside the house.
- **Deep litter system** and **cage system** are two popular methods of housing the birds in India.
- In deep litter system, the birds are kept on the floor covered with litter material, while in battery cage system, the birds are kept in small compartments of galvanized irons built into cages. **Battery cage systems are designed to maximize space utilization** and provide a controlled environment for efficient egg production.

Intensive deep litter system



Intensive battery cages

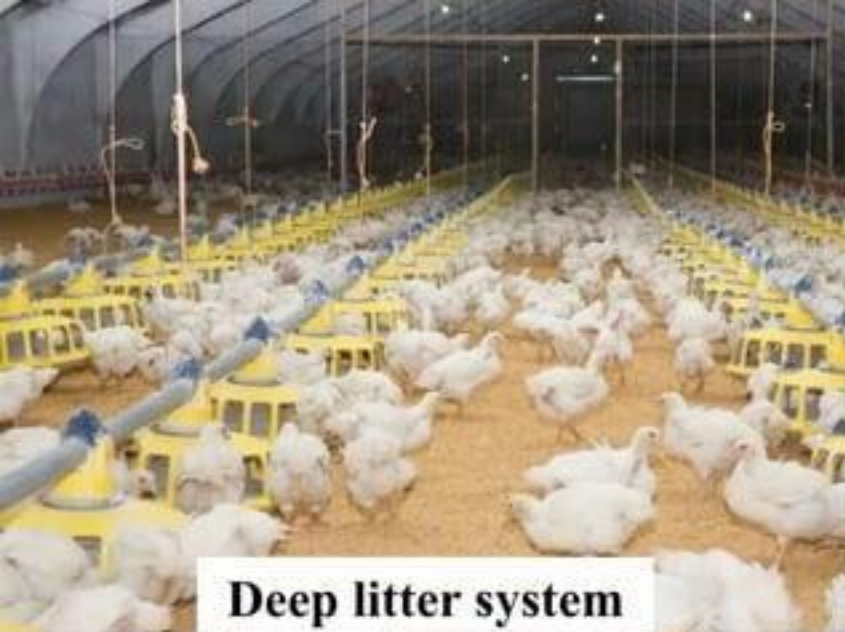


Semi-intensive system



Free-range (extensive) system





Deep litter system



Free-range extensive system



Battery cage systems



(a) Chicken farming:

- Chicken farming includes (1) Broiler farming for meat and (2) Layer farming for eggs.
- Besides the nutritive value, eggs have many **industrial uses** in preparation of adhesives, printer inks, shampoos, soap, varnishes, vaccines, *etc.*
- The eggshells are used as mineral-feed for animals and birds.
- The feathers are used for making cushions, mattresses, pillows, *etc.*
- ❖ **Breeds:** Specific poultry stocks are available for egg and broiler production. A majority of the stocks used for egg production are crosses involving the strains or inbred lines of white Leghorn. To a limited extent, other breeds like Rhode Island Red, California Grey and Australop are used.



Chicken farming



(b) Duck farming:

- The ducks occupy **second** place to chicken in population in the country. They are reared mainly for egg and meat purposes.
- **Marshy wetland areas are ideal** for duck rearing. Duck farming is suitable for mixed farming system such as duck-cum-fish farming, duck farming with rice culture, *etc.*
- In duck-cum-fish farming, the droppings of ducks serve as feed for the fishes and no other feed or manuring of the pond is necessary for fishes (200-300 ducks/ha of water area).
- Under integrated duck farming with rice culture, the ducks perform four essential functions *viz.*, **inter tillage, weeding, insect control and manuring.**
- Duck production is mostly concentrated in the eastern states like Assam, Manipur, Tripura and West Bengal followed by Andhra Pradesh, Bihar, Jammu and Kashmir, Karnataka, Kerala, Orissa, Tamil Nadu, and Uttar Pradesh.
- ❖ **Breeds:** The important Indian breeds are Sylhet Mete and Nageswari, which are mostly found in the Eastern region of the country. Khaki Campbell and Indian Runner are the most popular breeds for egg laying.



Duck farming

(c) Guinea fowl farming:

- India has a large population of guinea fowl and ranks **third** after chicken and duck.
- It is well adapted to diverse agro-climatic conditions prevailing in **arid and semi-arid regions**.
- It is also well accepted by the marginal farmers and small-scale poultry enterprises raised under free-range in the states of Madhya Pradesh, Punjab, Uttar Pradesh and some parts of India.
- Guinea fowls are **hardy, disease resistant, need low input** and have unique ability to survive and thrive under sub-optimal management and feeding conditions because of its foraging habit.
- They are highly resistant to viral diseases and therefore, they are generally raised without any vaccination.

❖ **Varieties:** Lavender, Pearl and White

Guinea Fowl



Most Popular Color Varieties



Pearl Grey



Pied



Royal Purple



Blue



Chocolate



White



Guinea fowl

(d) Quail farming:

- **Japanese quail** is mostly reared in India for meat and eggs.
- Quails are fast growing, hardy and can adapt to various environments. They are **more resistant to diseases than chickens**.
- They do not require specially designed houses. Quails require less floor space, feed and water in comparison to chickens and ducks and hence, less capital investment.



(e) Turkey Farming:

- Turkeys are mostly reared for meat purpose. Turkey meat contains very less fat as compared to meat of other avian species. In India, turkey production is still in its initial stage.
- Since the turkey poults and hens are bigger in size, their cutups can be marketed in various attractive packaging suited to the individual consumer. They are more resistant to disease than chicken and therefore, rarely suffer from diseases.
- Turkeys grow very fast and can be reared under semi-intensive system in the backyards.



(f) Emu farming:

- The emu is another latest addition to poultry species for commercial use.
- Emu meat contains low amounts of fat and cholesterol.
- Emu oil is also considered to be highly medicinal.
- Emu birds are practically immune to several diseases.



Piggery:

- Pigs are maintained for the production of **pork**.
- Pig farming is adapted to both diversified and intensive agriculture.
- Pigs convert inedible feeds, forages, certain grain byproducts into valuable nutritious meat.
- The faeces of pigs are useful in maintaining soil fertility. Pig raising fits very well with integrated farming system.
- The **reproduction interval of pig is short and pigs give birth to many off springs at a time**. Small sum invested in pig rearing can bring very good returns in a short time.

❖ **Breeds:** White Yorkshire, Barkshire, Poland china, Duroc Hampshire, Chester white

Yorkshire is the most extensively used exotic breed in India. It is a prolific breed having good growth rate and feed conversion ability.



Piggery

Fishery/Aquaculture:

- Farm ponds serve multiple benefits like domestic water requirements, supplementary irrigation and pisciculture.
- Clay soils have higher water retention capacity and hence are best suited for fish rearing.
- The depth of the pond should be **1.5-2.0 m**. Pond-water should have appropriate proportion of nutrients and slightly alkaline pH. Soil of the pond should be tested for N and P content. If the nutrient content is less, fertilisers can be added. Organic manures such as FYM and poultry droppings may also be applied to promote the growth of phyto and zooplanktons.

❖ Species of fish are:

(1) **Catla** (*Catla catla*) is the fast-growing fish. It consumes lot of vegetation and decomposing higher plants. It is mainly a **surface and column feeder**.

(2) **Rohu** (*Labeo rohita*) is a column feeder and feeds on growing fish. It consumes lot of vegetation and decomposing higher plants. It is mainly column and surface feeder.

(3) **Calbasu** (*Labeo calbasu*) is a bottom feeder on detritus. **Mrigal** (*Cirrhinus mrigala*) is also a bottom feeder, taking detritus to large extent, diatoms, filamentous and other algae and higher plants. **Common carp** (*Cyprinus carpio*) is a bottom feeder and omnivorous.

(4) **Silver carp** (*Hypophthalmichthys molitrix*) is mainly a surface and phytoplankton-feeder and also feeds on micro-plants.

(5) **Grass carp** (*Ctenopharyngodon idella*) is a specialised feeder on aquatic plants, cut grass and other vegetable matter. It is also a fast-growing exotic fish.

In composite fish culture, phytophagous fish (catla, rohu and mrigal) can be combined with omnivorous (common carp), plankton-feed (silver carp) and mud-eaters (mrigal and calbasu) in a composite fish culture system.

For higher productivity, fish are to be provided with supplementary feeding with rice bran and oilseed cakes. This will enable faster growth and better yield. Each variety of carps could be stocked to 500 fingerlings with the total 5000-8000 nos. per ha. This stocking density will enable to get a maximum yield of 2000 to 5000 kg/ha of fish annually under good management practices.



Inland Fish Farming – Common Fish Species

Carp

High stocking

High Value

Catla



Rohu



Mrigal



Silver carp



Grass carp



Common carp



Tilapia



Pangasius



Desi Magur



Roopchand



Koi



Murrel



Singhi



Pabda



SURFACE FEEDERS

have an UPTURNED MOUTH
for skimming the water surface
for food



MID-RANGE FEEDERS

have a mouth that appears
STRAIGHT from the face to
gather food as it falls through
the water



BOTTOM FEEDERS

have a DOWNTURNED MOUTH
for feeding from the
bottom surface





Aquaculture

Sericulture:

- Sericulture is defined as the practice of combining mulberry cultivation, silkworm rearing and silk reeling.
- India occupies second position among silk producing countries in the world, next to China.
- Sericulture is labour intensive in all its phases, including off-farm activities such as twisting, dyeing, weaving, and printing.
- It has considerable socio-economic importance in India largely due to its suitability for small and marginal farm-holdings by generating employment and requiring low investment.

There are three primary steps in production of mulberry silk:

(1) Moriculture:

- Moriculture refers to the cultivation of mulberry plants, whose leaves are used as silkworm feed.

(2) Silkworm rearing:

- Silkworm rearing process begins with the laying of eggs by the female silk moth. The hatched larvae are transferred to feeding beds prepared on a rearing tray by spreading chopped mulberry leaves onto it.
- The life cycle of mulberry silkworm completes in **45-55 days**, consists of stages egg (9-10 days), larva (24-28 days), pupa (8-10 days) and moth (3-4 days). The larvae undergo four times moulting during the larval period.
- The silkworm larvae initially have a good appetite. Late age worms are voracious feeder. Feeding, bed cleaning, maintenance of temperature and humidity, care during moulting and maintenance of hygiene are important aspects of silkworm rearing.
- After reaching maturity, the larvae begin searching for hospitable places to begin their pupation. These mature larvae now wrap themselves in a cocoon by secreting saliva from salivary glands. This saliva solidifies and becomes silk when it comes in contact with air.

(3) Silk reeling:

- Inside the cocoons, the larvae undergo metamorphosis and turn into pupae.
- First, the pupae inside the cocoon are killed by boiling the cocoon and exposing it to steam and dry heat. This process is called **stifling**.
- Now, the silk filaments are removed from the dead cocoon *via* a process called **reeling**.

❖ Types of silk worm:

- (i) Mulberry silk worm – *Bombyx mori*
- (ii) Eri silk worm – *Philosamia ricini*
- (iii) Tassar silk worm – *Antheraea mylitta*
- (iv) Muga silk worm



Types of silk worm (larva)



Mulberry silk worm



Tassar silk worm



Eri silk worm



Muga silk worm

Order: Lepidoptera

Mulberry silk moth



Tasar silk moth



Tropical Tassar



Oak Tassar



Muga silk moth



Eri silk moth



Muga



Eri

Sericulture

Apiculture:

- Apiculture is the science of raising and managing honeybees' colonies and their hives.
- It requires little investment and infrastructure so it can be taken up by small, marginal and landless farmers and the educated unemployed youth.
- It provides highly nutritious honey and cash income. It earns foreign exchange. It enhances the productivity and quality of agriculture, horticulture and fodder crops.
- It conserves the diversity of plant kingdom due to active role of honeybees in pollination.
- *Apis cerana indica* and *A. mellifera* are important honeybee species commonly used in India. The Indian bee (*Apis cerana*) colonies nest in the concealed dark places. Such colonies can be searched in the wild habitats and captured. The colonies can also be purchased by the bee keeping cooperative societies and other beekeepers. The apiary has to be established in the area where rich source of bee flora is available throughout the year. The area should be cool and calm.

- Honey is a sweet viscous fluid produced by honeybees mainly from the nectar of the flowers.
- Honey is an excellent energy food with an average of about 3500 calories per kg. It is directly absorbed into the human blood stream, requiring no digestion.
- Aroma, colour, consistency and floral sources are important quality parameters to meet the national and international standards.
- Proper honey straining and processing are needed to improve the quality of the produce.
- Honey varies in the proportion of its constituents owing to the differences in the nectar produced by different plants.
- The nectar collected by bees is processed and placed in comb cells for ripening. During the ripening, sucrose is converted into glucose and fructose by an enzyme called invertase, which is added to it by the bees.

Apiculture | Beekeeping



Honey Bee Products



HONEY



BEE POLLEN



ROYAL JELLY



BEESWAX



BEE VENOM

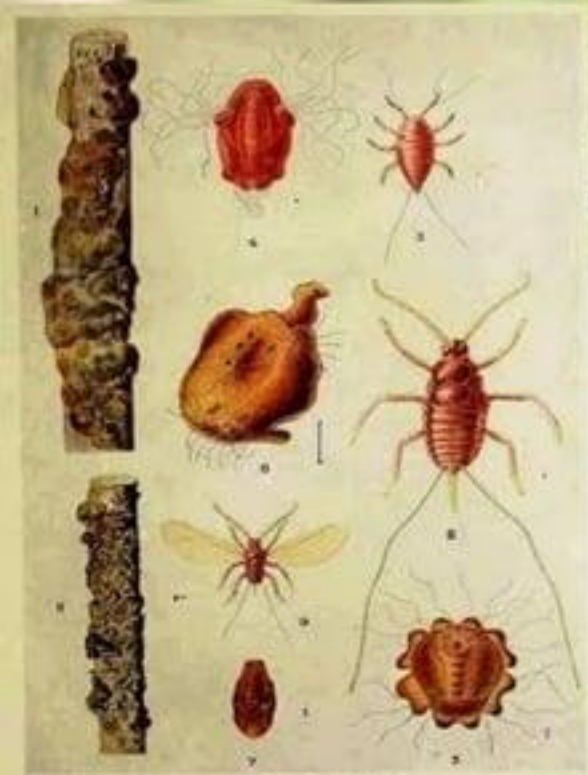


PROPOLIS

Lac farming:

- Lac is a resinous secretion of lac insect (*Laccifer lacca*), which is a scale insect.
- The insect feeds on certain trees, e.g. Ber, Palash, Kusum. The strain that thrives on Kusum tree is called **Kusum strain**. The one that comes up on all other hosts is known as **Rangeeni strain**. Both the strain has two generations a year. About 90% of lac produced in India comes from rangeeni strain.
- The life cycle of insect consists of three stages viz., egg, nymph and adult. The nymphs emerge in large numbers and crawl over the surface of twigs and branches of plants in search of suitable place for settlement, mostly shoots.
- Once settled, the nymph thrusts its proboscis into the bark and does not move from its place. After one or two days of settling, they start secreting resin from glands distributed under the cuticle all over the body, except few organs.
- Thus, the nymphs get covered in a cell of its secretion which increases in size with the growth of the insect. Nymphs moult three times before reaching maturity.

- Lac has multiple uses *viz.* ink, polishes, sealing wax, adhesive, filling material in ornaments, *etc.*
- It is cultivated mainly in India, Thailand and Burma which produce over 90% of the world supply of lac.
- India produces the maximum amount of lac (about 90%) from Bihar, Orissa, Madhya Pradesh, West Bengal, Assam and Uttar Pradesh and small quantities from other states.
- Lac cultivation and processing create substantial employment opportunities, especially during the off-season, and there is a high demand for lac products in domestic and international markets.
- It also plays a vital role in the local economy and the livelihoods of rural and tribal communities. In India, there are two strains of the lac insect.



Lac farming

Mushroom cultivation:

- Mushroom is the fungal fruiting body technically called **sporophore** that produces large number of spores which are the seeds of this plant.
- Mushroom lacks chlorophyll and hence cannot produce its own food and depends on other living or dead plants for its food.
- Mushrooms are well known for their delicacy and flavour. They are excellent source of vitamins and minerals. The protein of edible mushroom is superior and is rich in lysine.
- Mushroom cultivation is done indoor and hence very little land area is required.
- About 70 species of edible mushroom are suited for artificial cultivation. The most popular among these are European or White button mushroom (*Agaricus bisporus*), Oyster mushroom (*Pleurotus* spp.), Chinese or Paddy straw mushroom (*Volvariella volvacea*), and Japanese or Shiitake mushroom (*Lentinus edodes*).
- Among the cultivated types, **button and oyster mushrooms can be grown in the most part of India**. Paddy straw mushroom caters the demand of local consumers only.

- A variety of agricultural or **agro-industrial wates can be utilized for mushroom cultivation**. India with its varied agro-climatic conditions, availability of agro-wastes in abundance and manpower is most ideal to produce all the major mushroom varieties being produced in different regions.

❖ **Substrates used for mushroom cultivation:**

Oyster mushroom	: Paddy straw, Maize stalk/cob, Vegetable plant residues, <i>etc.</i>
Paddy straw mushroom	: Paddy straw, Water hyacinth, Oil palm waste, Banana leaves, Sugarcane waste, Cotton waste
White button mushroom	: Artificially prepared compost
Shiitake mushroom	: Sawdust of broad leave trees mainly tuni, mango, safeda, oak, maple and poplar

Composted process

Agro-industrial substrate

Wetting process

Composting Phase I

← Supply aeration system

Composting Phase II

- Pasteurization 50 – 60 °C

- Conditionings 45 – 50 °C

Inoculation of cultivation spawn

Compost colonization

Soil casing

Harvesting



Agaricus bisporus

Harvesting



Volvariella volvacea

Fermentation

Pasteurization /Sterilization

Mushroom cultivation

Non-composted process

Agro-industrial substrate

Sterilization
- Steam 100 °C/ 3 h
- Autoclave 121 °C/ 15 psi/ 1 – 2 h
- Retort 121 °C/ 15 psi/ 1 – 2 h

Inoculation of cultivation spawn

Spawn running

Harvesting



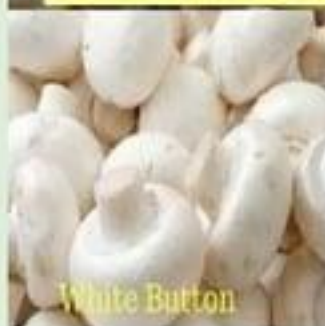
Hypsizygus marmoreus



Pleurotus ostreatus



Mushroom cultivation



White Button



Portobello



Dhimis (Oyster)



Paddy Straw

Agro-Industrial Materials for Mushroom Cultivation

Composted substrate

- Cotton seed waste
- Rice straw
- Wheat straw

- *Agaricus bisporus* (a)
- *Volvariella volvacea* (b)



Non-composted substrate

- Cotton seed waste
- Rice straw
- Wheat straw
- Sawdust
- Sugarcane bagasse
- Oil palm empty fruit bunch
- Plant stalk
- Corn residues
- Leaves

- *Pleurotus* spp. (c)
- *Lentinus* spp. (d)
- *Ganoderma* sp. (e)
- *Auricularia* sp. (f)
- *Lentinula edodes* (g)
- *Hypsizygus marmoreus* (h)
- *Pholiota* sp. (i)



Agroforestry

- Cultivation of forest trees combining with cultivation of agricultural crops and/or animals to fulfill the food, fodder, fiber, timber and fuel needs of farmer is known as agroforestry.
- It is the best component for dry land farming system to enhance the economic and social condition of farmers with maintaining the sustainability.
- Agroforestry is also important for conserving soil and water, maintenance of soil fertility, controlling salinity and water logging, positive environment impact and alternate land use for marginal and degraded lands.
- Selection of proper land use systems conserve biophysical resources of non-arable land besides providing day-to-day needs of farmer and livestock within the farming system.

(1) Agri-silviculture systems (Crops + Trees):

This system comprises growing multipurpose trees (fuel, fodder) in line and cultivation of field/fodder crops in the available space between the trees as alley farming.

(2) Agri-horti-silviculture (Crops + Fruit crops + Trees):

In this system fruit trees are grown along with crops and multipurpose trees (MPTs).

(3) Silvi-Pastoral system (Trees + Fodder crops + Animal):

This is most economic agroforestry system especially in arid and semi-arid regions having marginal, sub-marginal and degraded lands. In this system, grasses or grass legume mixture is grown along with the woody perennial trees simultaneously on the same unit of land.

(4) Horti-silvi-pasture system (Fruit crops + Trees + Fodder + Animal):

It involves integration of fruit and trees with pasture. *e.g.* Guava + Sissoo + Stylo.

(5) Agri-silvi-pasture (Crops + Trees + Fodder + Animal):

Crops are grown in strips along with grass strips to avoid shifting sand reaching cropped area. MPTs are introduced the pasture strips as well as in the crop strips, which protects the crops from desiccating hot and cold wind.

(6) Pastoral-silvicultural system (Fodder + Tree + Animal):

Grazing pasture is the main component with scattered trees grown in the area.

Apart from above, other popular agroforestry systems include Agri-horti-silvi-pasture (Crops + Fruit crops + Trees + Fodder + Animal), Silvi-apiculture (Trees + Honeybees), Agri-pisci-silviculture (Crops + Fish + Trees), Pisci-silviculture (Fish + Trees), *etc.*



Agroforestry system with tall trees and dense undergrowth



Agroforestry system with tall trees and dense undergrowth



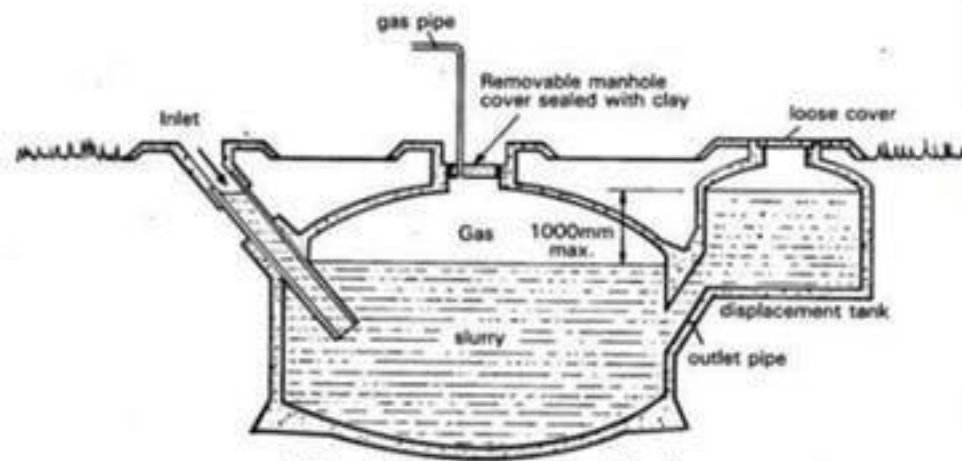
Agroforestry system with tall trees and dense undergrowth



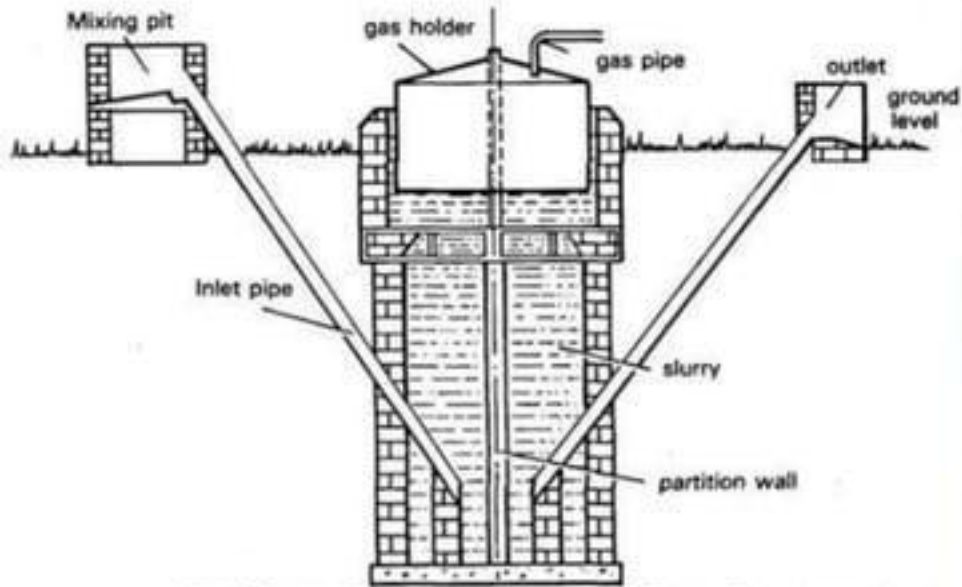
Agroforestry

Biogas plant:

- A biogas unit produces good manure and clean fuel and improves sanitation. Biogas is a **clean, unpolluted and cheap source of energy**, which can be obtained by a simple mechanism and little investment.
- The gas is generated from the cow dung during **anaerobic decomposition**. Biogas generation is a complex biochemical process. The cellulolytic material is broken down to methane and carbon dioxide by different groups of microorganisms. It can be used for cooking purpose, burning lamps, running pumps, *etc.*
- The two main designs of biogas plants are the **floating gas holder** and **fixed-dome types**. The merits and demerits of each design need to be considered while selecting a model. The size of the biogas plant is decided by the number of family members and the availability of dung.
- **Slurry** is obtained after the production of biogas. It is an enriched manure. Another positive aspect of this manure is that even after weeks of exposure to the atmosphere, the slurry does not attract fleas and worms.



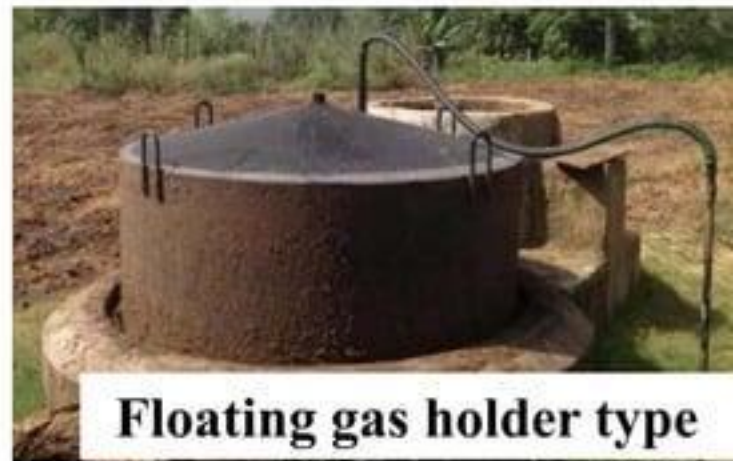
China - Fixed Dome Biogas Digester



India - Biogas digester with floating gas holder and no water seal



Fixed-dome type



Floating gas holder type

Biogas plant

Vermicomposting:

- Earth worms occur more than 80 per cent of soil invertebrate biomass. It acts as an aerator, crusher, mixer, grinder, chemical degrader and biological stimulator in soil, improving physical, chemical and biological properties of soil.
- The earthworm castings would improve the humus content of soil which has direct implications on long term soil fertility and sustainability.
- Earth worm causes increase in humus content would automatically influence higher uptake of major and micro-nutrients in plants.
- The process of composting organic wastes through domesticated earthworms under controlled conditions is known as vermicomposting. It is a mixture of worm casting (faecal excretions), organic materials including humus, live earthworms, their cocoons and other microorganisms.
- Earthworms have tremendous ability to compost biodegradable materials. Waste subjected to earthworm consumption decompose 2 to 5 times faster than in conventional composting.

- During composting, the wastes are deodorized, pathogenic microorganisms are destroyed, and volume of wastes is reduced by about 40 to 60%.
- It is estimated that the earthworms feed about **4 to 5 time** their own weight of material daily.
- There are more than 300 species of earthworms in the world and about 50 species in India.
- *Eudrilus eugeniae*, *Esenia fetida* and *Perionyx excavatus* are some of the species of earth worms used for vermicomposting. Vermicomposting is a low investment agribusiness model popular in rural area.



Vermicompost pits in the farmer's field



Healthy worms from the compost pits



Vermicompost

Earthworm Species used in Vermiculture



*Eisenia fetida** / *Eisenia andreii* (common name, Red Worm)



Eudrilus eugeniae (common name, African nightcrawler)



Amyntas gracilis (common name, Alabama or Georgia jumper)



Perionyx excavatus (common name, Indian Blue worm)



Vermicomposting

Cropping system:

- Cropping system is as important component of a farming system. It represents cropping patterns used on a farm and their interaction with farm resources, other farm enterprises and available technology which determine their makeup.

Cropping pattern:

- Cropping pattern means the **proportion of area under various crops at a point of time in a unit area**. It indicates the yearly sequence and spatial arrangement of crops and fallow in an area. It is for larger area like zone, taluka, district, *etc.*

Types of Cropping Systems:

Depending on the agro-climatic condition, resources and technology available, different types of cropping systems are adopted on farms. Broadly three types of cropping systems are followed by the farmers.

1. Sole cropping:

Only a single crop or variety grown alone in a pure stand at normal density during one farming year.

2. Mono cropping:

- Mono cropping refers to growing one and the same crop year after year or season after season on the same land is called mono cropping.
- It may be due to climatologically and socioeconomic conditions or due to specialization of a farmer in growing a particular crop.
- Under rainfed conditions, groundnut or cotton or sorghum are grown year after year due to limitation of rainfall. Flue cured tobacco is grown in Guntur district of Andhra Pradesh year after year due to specialization of the farmer in growing it. In canal irrigated areas under waterlogged condition, rice crop is grown as it is not possible to grow any other crop.

Disadvantages:

- 1) Inefficient utilization of resources like labour, fertilizers, water, farm machinery, *etc.*
- 2) The soil health not cared, and nutrients are depleted.
- 3) There are chances of occurrence of pest and diseases infestation.
- 4) Natural resources are not fully utilized.

3. Multiple cropping/Intensive cropping:

- Growing two or more crops on the same piece of land in one calendar year known as multiple cropping.
- It is the intensification of cropping in space and time, *i.e.*, more number of crops on the same piece of land and more number of crops in a year on the same piece of land at any given period.
- It includes inter-cropping, mixed cropping and sequence cropping.

(1) Mixed cropping:

- ✓ Mixed cropping is growing of two or more crop simultaneously on the same piece of land **without any row pattern**.
- ✓ It is a common practice in most of **dry land tracts** of India.
- ✓ Seeds of different crops are mixed in certain proportion and are sown. The object is subsistence, *i.e.*, to meet the family requirement of cereals, pulses and vegetables.

(2) Intercropping:

- ✓ Intercropping is growing two more crops simultaneously on the same piece of land with a definite row pattern.
- ✓ For example, growing sorghum + red gram in 3:1 ratio, i.e., after every 3 rows of sorghum, one row of red gram is sown. Thus, cropping intensity is achieved in space dimension.

Based on the per cent of plant population of each crop in intercropping system, it is dividing into two types.

(a) Additive series:

- One crop is sown with 100% population in pure stand which is known as **base crop**
- Another crop known as **intercrop** is introduced into the base crop adjusting or changing the geometry of base crop (Paired row system)
- Crop husbandry is according to the base crop
- The intercrop population is less than its recommended population in pure stand
- Objective is to get additional income and to cover risk
- Additive series intercropping is mostly adopted in India

(b) Replacement series:

- In replacement series, both the crops are called **component crops**
- Second component crop is introduced by sacrificing certain proportion of first component crop, i.e., replacing row/s
- Plant population of both component crops are lower than the plant population in sole crop
- This type of intercropping is popular in western countries

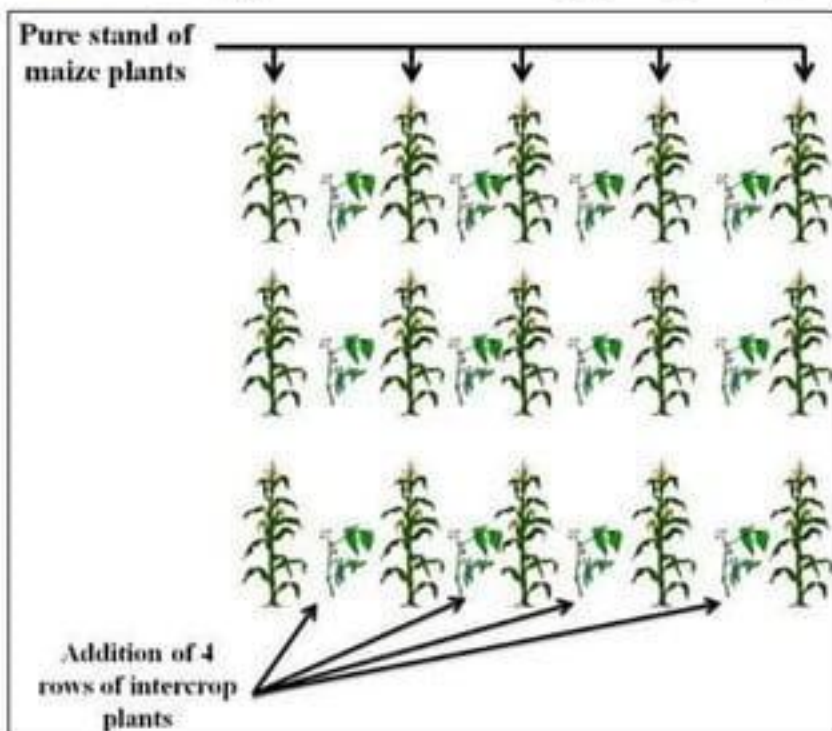


Fig.: Additive series

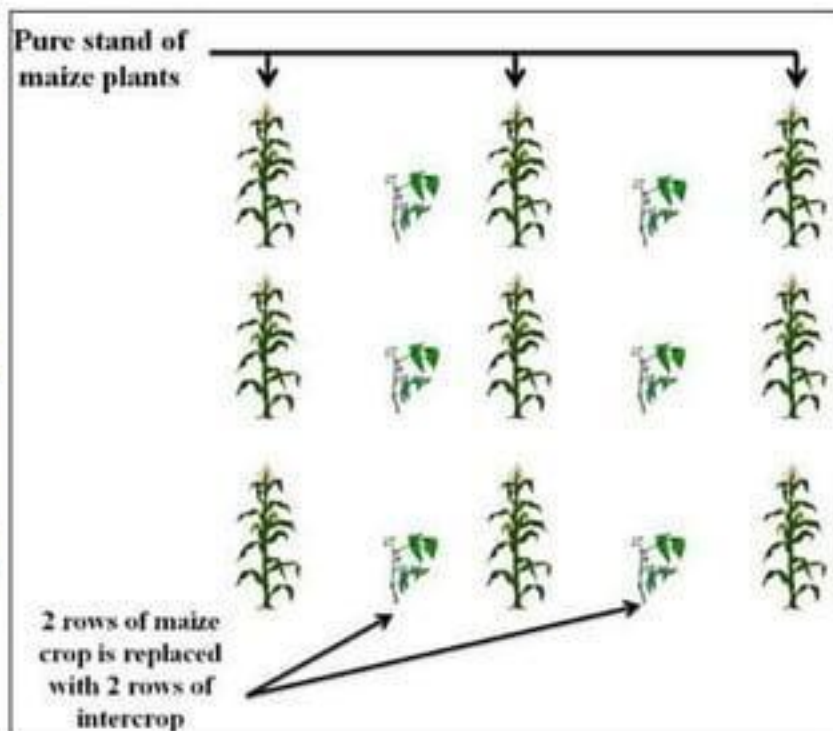


Fig.: Replacement series



Mixed intercropping



Row intercropping



Strip intercropping



Relay intercropping

Requirements for successful intercropping:

- 1) Objective is higher productivity in unit area in unit time with yield stability.
- 2) The time of peak nutrient demand of component crops should not overlap, *e.g.* In Maize + Blackgram intercropping, the peak nutrient demand for blackgram is at 30 to 35 DAS, whereas peak nutrient demand of maize is at 50 to 55 DAS.
- 3) The selected component crops should be complementary to each other.
- 4) The intercrop fitted should be of shorter duration than main crop at least 30 days.
- 5) There should be minimum competition between component crops for CO₂, water, light and space.
- 6) The component crops should have different rooting depth so as to have nutrient extraction from different depths, *e.g.* Main crop deep rooted and intercrop shallow rooted.

❖ **Advantage of intercropping:**

- 1) Intercropping gives **additional yield/income** per unit area than sole cropping.
- 2) It acts as an **insurance against failure of crops** in abnormal year.
- 3) Inter-crops maintain the soil fertility as the nutrient uptake is made from both layers of soil.
- 4) Reduction in soil runoff and controls weeds.
- 5) Intercrops provide shade and support to the other crop.
- 6) Inter cropping system utilizes resources efficiently and their productivity is increased.
- 7) Serves the purpose of **crop diversification**.

❖ **Disadvantages of intercropping:**

- 1) Yield decreases as the crops differ in their competitive abilities.
- 2) Management of crops having different cultural practices seems to be difficult task.
- 3) Improved implements cannot be used efficiently.
- 4) Component crops may differ in their response to inputs like fertilizer, irrigation, *etc.*
- 5) Harvesting is difficult.

(3) Multi-storied or multi-tier cropping:

- ✓ Growing plants of **different height**, rooting pattern and duration in the same field at the same time is termed as multi-storied cropping.
- ✓ It is mostly practiced in orchards and plantation crops for maximum use of solar energy even under high planting density.
- ✓ The objective of this system of cropping is to utilize the vertical space more effectively.
- ✓ In this system, the tallest components have foliage tolerant of strong light and high evaporative demand and the shorter components with foliage requiring shade and or relatively high humidity. *e.g.* Coconut + black pepper + cocoa + pineapple.



Fig.: Multi-storied or multi-tier cropping

(4) Sequence cropping:

- ✓ It is a practice of growing two or more crops in a sequence on the same piece of land during a farming year.
- ✓ **Crop intensification is only in time dimension** and there is no intercrop competition.
- ✓ Depending on the number of crops grown in a year, it is called as double, triple and quadruple cropping involving two, three, and four crops, respectively. e.g.
 - Double cropping: rice-potato/mustard, sorghum-gram, soybean-wheat
 - Triple cropping: Rice- potato-groundnut, cowpea-mustard-jute
 - Quadruple cropping: groundnut-leafy vegetables-wheat-summer green gram

(5) Ratoon cropping:

- ✓ Ratoon cropping or ratooning refers to raising a crop from regrowth coming out of roots or stalks after harvest of the crop. *e.g.* raising a crop from regrowth of sugarcane, pearl millet, rice, sorghum, banana, pineapple, *etc.*

Advantages of ratooning:

- 1) Ratooning can **reduce the cost** of cultivation, especially for multiple ratoons. This is because it requires less preparatory cultivation, seed material, and labor.
- 2) Ratoon crops usually mature at least one month earlier than plant crops.
- 3) Ratooning can lead to better quality in some crops, *e.g.* sugarcane.
- 4) Ratooning can help **conserve soil** quality and structure because it requires minimal tillage.
- 5) Ratooning can reduce water requirements because the crop duration is shorter.
- 6) Fallen leaves and other trash left in the field are converted into organic matter over time.

However, ratooning has also limitations or disadvantages like, poor crop quality in some crops, lower yield, depletion in soil fertility, reduced and thinner crop stand, risk of pests and diseases, *etc.*



Fig.: Ratoon cropping

(6) Relay cropping:

- ✓ Relay cropping refers to **planting of the succeeding crop before harvesting the preceding crop**. e.g. sowing of pigeon pea in-between two rows of *kharif* groundnut just one month before groundnut harvest.

Advantages of relay cropping:

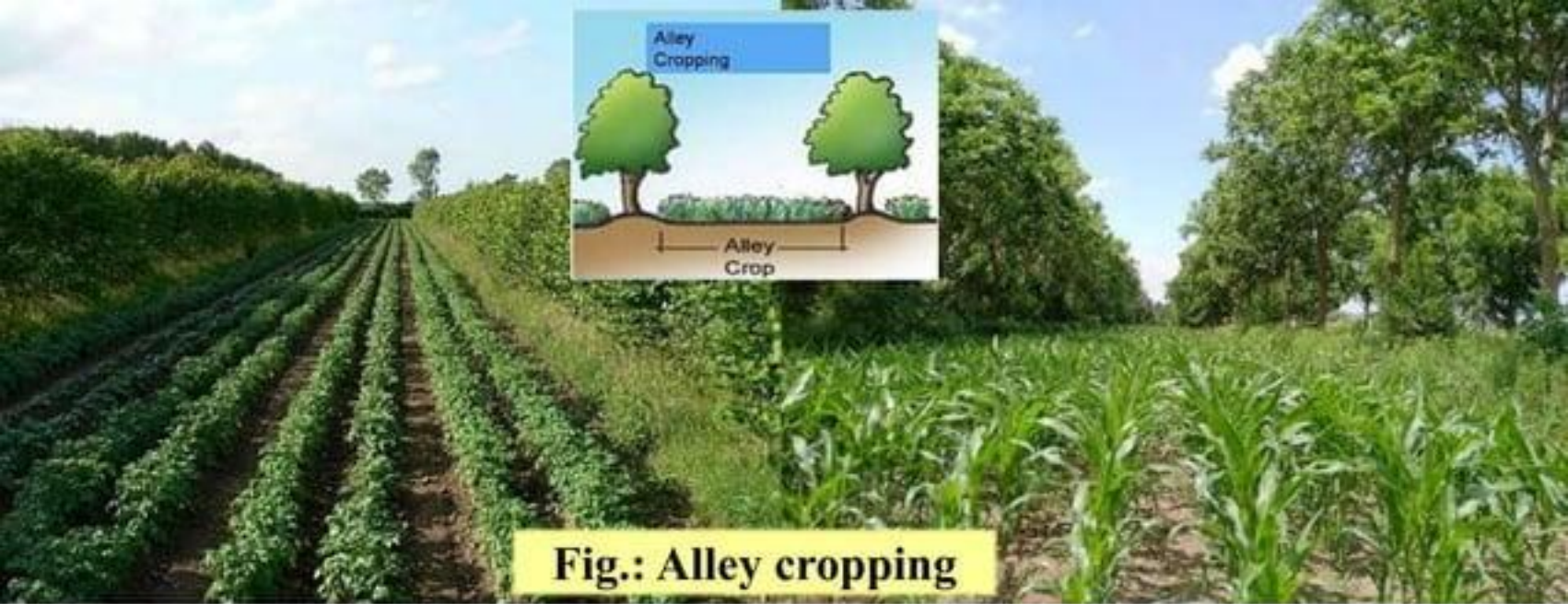
- 1) Minimum tillage is needed for relay cropping and primary cost of cultivation is less.
- 2) Weed infestation is less, as land remains covered with crops for longer period.
- 3) Crop residues are added in the soil and thus, more organic matter.
- 4) Residual fertilizer of previous crops benefits succeeding crops.

(7) Alley cropping:

- ✓ Alley cropping is an **agroforestry practice** that involves planting trees or shrubs in rows to create alleys within which agricultural or horticultural or forage crops are grown. The essential feature of this system is that hedge rows are cut back at about one meter height at planting to prevent shading and reduce competition with field crops.

Advantages of alley cropping:

- 1) Provision of green fodder during lean period of the year.
- 2) Higher biomass production per unit area than arable crops.
- 3) Efficient use off season rainfall in the absences of the crop.
- 4) Additional employment during off-season.
- 5) It serves as a barrier to surface runoff leading to soil and water conservation.
- 6) It improves soil fertility and is more remunerative under rainfed conditions.



Crop rotation:

- ✓ Crop rotation refers to recurrent succession of crop on the same piece of land either in a year or over a longer period of time. Component crops are chosen in such a way that soil health is not impaired.

Advantages of crop rotation:

- 1) Addition of considerable amount of organic matter in the soil form of crop residues
- 2) The system helps in building up of physical properties of soil
- 3) It increases the input use efficiency
- 4) It results in efficient utilisation of available resources
- 5) Less incidence of pests, diseases and also weeds

Principles of crop rotation:

- 1) Leguminous crops should be grown before non-leguminous crops because legumes fix atmospheric N into the soil and add organic matter to the soil.
- 2) Crops with tap roots (deep rooted like cotton) should be followed by those which have fibrous (shallow rooted crops like sorghum or maize) root system. This facilitates uniform nutrients extractions from different depths of soil.

- 3) More exhaustive crops should be followed by less exhaustive crops because crops like potato, sugarcane, maize, *etc.* need more inputs such as better tillage, fertilizers, number of irrigations, *etc.*
- 4) Selection of crop should be based on need or demand.
- 5) Crops of same family should not be grown in succession because they act as alternate hosts for insect pests and diseases.
- 6) The selection of crops should suit farmers financial conditions.
- 7) The crop selected should also suit to the soil and climatic condition.
- 8) Selection of crops should be based on the situations such as:
 - **On sloppy lands**, alternate cropping of erosion permitting and erosion resisting crops should be adopted.
 - **Under rainfed situations**, crops which can tolerate drought should be selected.
 - **In low-lying and flood prone areas**, crops which can tolerate water stagnation should be selected.
 - **In areas where salt affected soils** are there, salt tolerant varieties should be grown.

An ideal crop rotation must provide maximum employment to the farm families and labours and permits farm mechanization to ensure timely operations besides maintaining soil health.

Efficient cropping systems:

- 1) It depends on farm resources, farm enterprise and farm technology.
- 2) Farm resources are land, labour, water, capital and infrastructure.
- 3) When land is limited, intensive cropping is adopted to fully utilise available water and labour.
- 4) When sufficient and cheap labours are available, vegetable crops are also included in the cropping system.
- 5) When capital is not a constraint, commercial crops like sugarcane, banana, turmeric, etc. can be fitted in cropping system.
- 6) In low rainfall (< 750 mm/annum) mono cropping is followed.
- 7) When rainfall is > 750 mm, intercropping is practiced.
- 8) When water is plenty, triple and quadruple cropping is adopted while other climatic factors are not limiting.
- 9) Farm enterprises like dairying, poultry, *etc.* also influence the type of cropping system
- 10) When farm enterprises include dairy, the cropping system should contain fodder crops as component crops.
- 11) The day-to-day changes in available technology in agriculture /horticulture also determines the cropping systems.
- 12) Four crop sequences are followed in Gangetic alluvial plains which pave way for multiple cropping.

Interactions in cropping systems

Interactions in intercropping:

When crops are grown in association as in intercropping, there is interaction between different component crops. This interaction may be competitive or non-competitive or complementary.

(1) Competition for growth factors:

Plant requires growth factors such as solar radiation, water, nutrients and carbon dioxide for their growth. In inter or mixed cropping different kinds of plants compete with one another for the limited growth factors.

(2) Allelopathy:

Allelopathy is any direct or indirect harmful effect that one plant on another plant through the release of chemical substances or toxins into the root environment. Some crops may be unsuitable to be grown as intercrops because they may produce and excrete toxins into the soil which are harmful to other components.

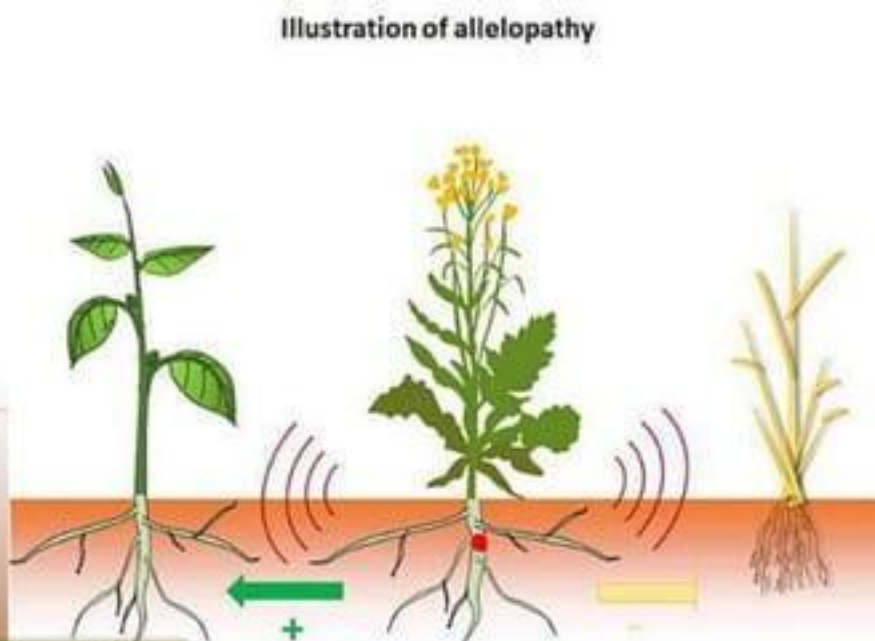
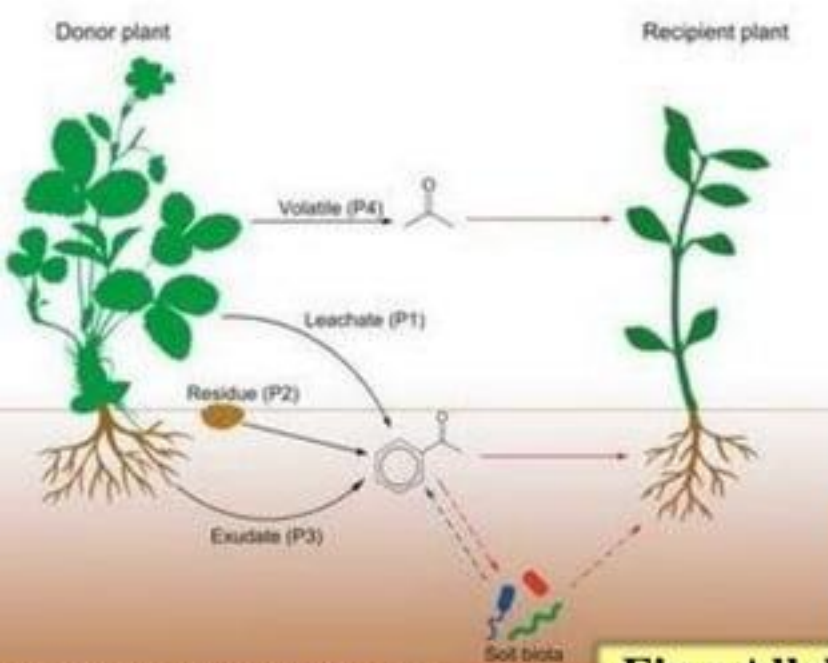


Fig.: Allelopathy



Allelopathy gradient

Allelopathy ring



Low allelopathy

High allelopathy

(3) Annidation

Annidation refers to **complementary interaction** which occurs both in space and time.

(a) Annidation in space:

The canopies of component crops may occupy different vertical layers with taller component tolerant to strong light and high evaporative demand and shorter component favouring shade and high relative humidity. Thus, one component crop helps the other. Multistoried cropping in coconut gardens, planting of shade trees in coffee, tea and cocoa plantations use this principle. Similarly, root systems of component crops exploit nutrients from different layers thus utilising the resources efficiently.

(b) Annidation in time:

When two crops of widely varying duration are planted, their peak demands for light and nutrients are likely to occur at different periods, thus reducing competition. When the early maturing crop is harvested, conditions become favourable for the late maturing crop. This has been observed to occur in sorghum + redgram, groundnut + redgram and maize + greengram intercropping systems.

(4) Other complementary effects

In an intercropping system, involving a legume and a non-legume, part of the nitrogen fixed in the root nodule of the legume may become available to the non-legume component. Another example is the provision of physical support by one species to the other in intercropping system. Erect crop plants may improve the yield of a climber as in the case of coconut + pepper. The taller component acts as wind barrier protecting the short crop.

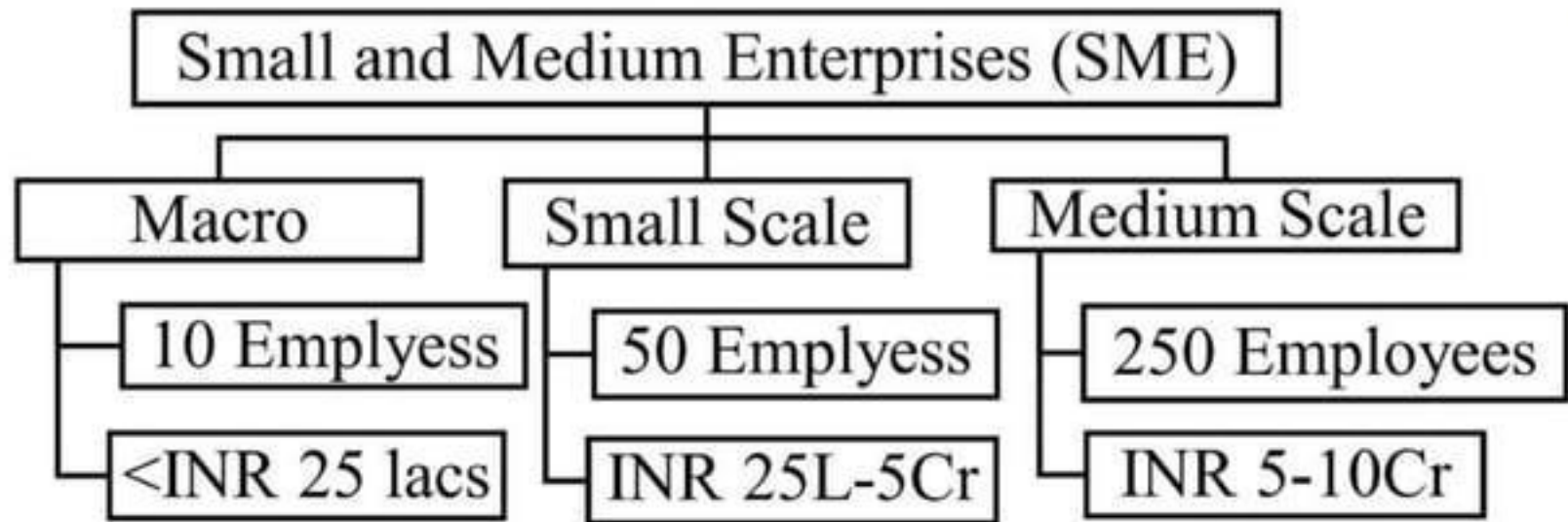
Interactions in sequence cropping:

- Competition for light, water and nutrients as in mixed crop communities does not occur when sole crops are grown in sequence. It occurs only in relay cropping for short overlapping span.
- In sequential cropping, the preceding crop has considerable influence on the succeeding crop mainly due to changes in soil conditions, presence of allelopathic chemicals, shift in weeds, and carry over effects of fertilizers, pests and diseases.

- Field preparation is difficult after rice crop since soil structure is destroyed due to puddling.
- Crops like sorghum and sunflower leave toxic chemicals in the soil which do not allow germination of subsequent crops.
- The previous leguminous crop leaves considerable amount of nitrogen for the succeeding crop.
- Phosphorous applied to the previous crop is available for the succeeding crop.
- Weed number and species differ in the succeeding crop due to the effect of the previous crop.
- Wheat crop that follows rice suffers from high density of weed *Phalaris minor*. The pests and diseases in crop stubbles and other residues of the previous crop may infect the subsequent crop.

Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers

- **Agricultural enterprise** means a business primarily engaged in the production of food and fibre, ranching and raising of livestock, aquaculture and all other farming and agriculture-related industries. They play crucial roles in supporting agricultural production and the livelihoods of farmers. These are classified as **micro, small, medium and large enterprises** based on their **nature, scale, investment limit and turnover**. The size enterprises are defined differently in every country.
- **Micro, small and medium enterprises (MSMEs)** are enterprises with limited manpower and financial turnover. MSMEs are covered under the MSME Development Act, 2006. Business owners can get registered and get MSME certificates to avail of the benefits made available by the government for the growth and support of such enterprises. The Government extends support in the form of easy credit facilities, marketing support, and other steps to facilitate their growth.



Small enterprises

Small enterprises are generally businesses that have fewer than 50 employees and modest revenue. For the farmers, these are often on-farm or near-farm activities that require minimal investment but provide additional income. *e.g. livestock, poultry, sericulture, apiculture, nursery raising, vermicomposting, etc.* Small enterprises operate in localized markets. Small enterprises reduce dependency on crop yield alone, provide year-round employment and lower risks by diversifying income sources.

Medium enterprises

Medium enterprises generally have between 50 and 250 employees and generate moderate revenues. For farmers, medium enterprises typically involve more formalized business activities that are larger in scale and may involve external investment or partnerships. *e.g. processing units, larger dairy farms, etc.* Medium enterprises involve regional and national market integration. Medium enterprises increase employment opportunities, provide stable income and create opportunities for market expansion.

Large enterprises

Large enterprises are enterprises which have an investment of more than ten crore rupees. These enterprises are important for the country and employ a substantial number of people, these enterprises require no support from the government and are self-sustaining. Large enterprises provide access to global markets, advanced agricultural technologies and bulk-buying opportunities. *e.g. large agro-processing units.*

Secondary agriculture enterprises

- ✓ Under the situation of multiple challenges faced by Indian agriculture, primary agriculture by itself would not be able to sustain the agriculture based Indian economy.
- ✓ **Primary agriculture is to be complemented by secondary agriculture.** Secondary agriculture activities do not compete with the time required for primary agriculture production activities.
- ✓ Despite the fact that India is doing remarkably well in terms of output, extent of value addition to raw food material is very small.
- ✓ Besides main products, agriculture also produces lots of residues and by products which need proper handling.
- ✓ In addition, huge quantities of produce are lost annually in India due to non-availability of appropriate processing and preservation technologies and improper or insufficient facilities for their handling, transportation and storage. These main products and byproducts can be utilized for secondary agriculture to generate extra income and employment.

- ✓ **Secondary agriculture is defined as a productive activity at enterprise level that utilizes raw material and byproducts of the primary agriculture and locally other biological resources available locally, deploying locally available skills and manpower to operate/manage/maintain the production of goods and services.**
- ✓ Secondary agriculture enterprises are covered under the Micro, Small or Medium Enterprises Development (MSMED) Act 2006. *e.g.* cotton ginning unit to separate lint and seed from locally grown cotton (within norms of MSME) is an example of secondary agriculture enterprise but cotton textile factory may not be qualified as secondary agriculture.

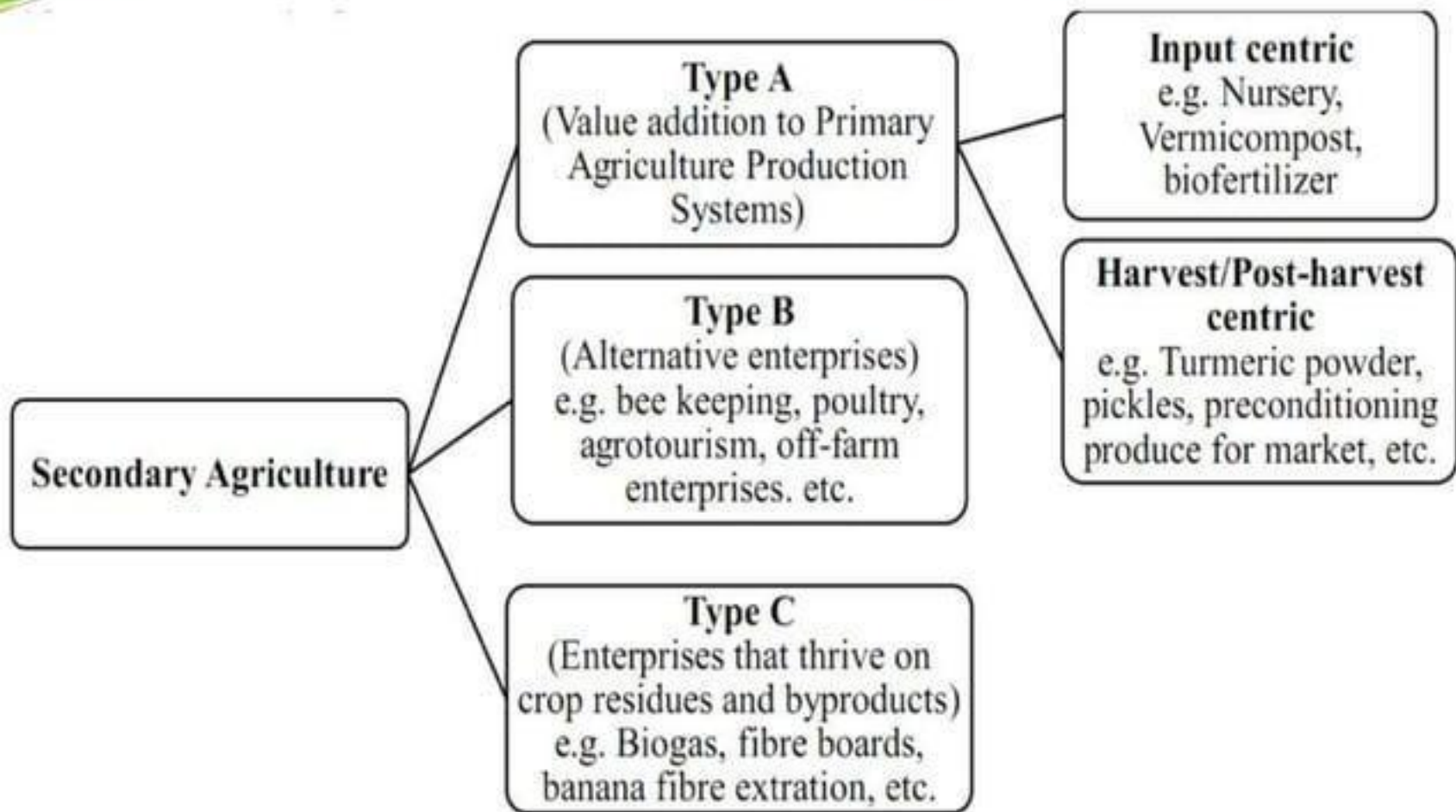


Fig: Types of secondary agriculture

Value chain

- ✓ A 'value chain' in agriculture defined as the set of actors and activities that bring a basic agricultural product from production in the field to final consumption, where at each stage value is added to the product.
- ✓ At the one end of agricultural value chain, there are producers, *i.e.*, farmers who grow crops and raise animals and at the other end, there are the consumers who eat, drink, wear and use the final products. In the middle, many persons and businesses perform steps in the chain, and each adds value by growing, buying, selling, processing, transporting, storing, checking, and packaging.

Actors and stakeholders of value chain:

- The value chain includes: (1) Input suppliers, (2) Technology delivering agencies, (3) Scientists engaged in developing appropriate technologies, (4) Extension officers who are involved in capacity building and providing various services to farmers, (5) Stakeholders involved in post-production activities like agencies collecting produce, grading, storage, transportation, processing, marketing of the produce, *etc.* (6) Financial institutions (7) Marketing agencies.

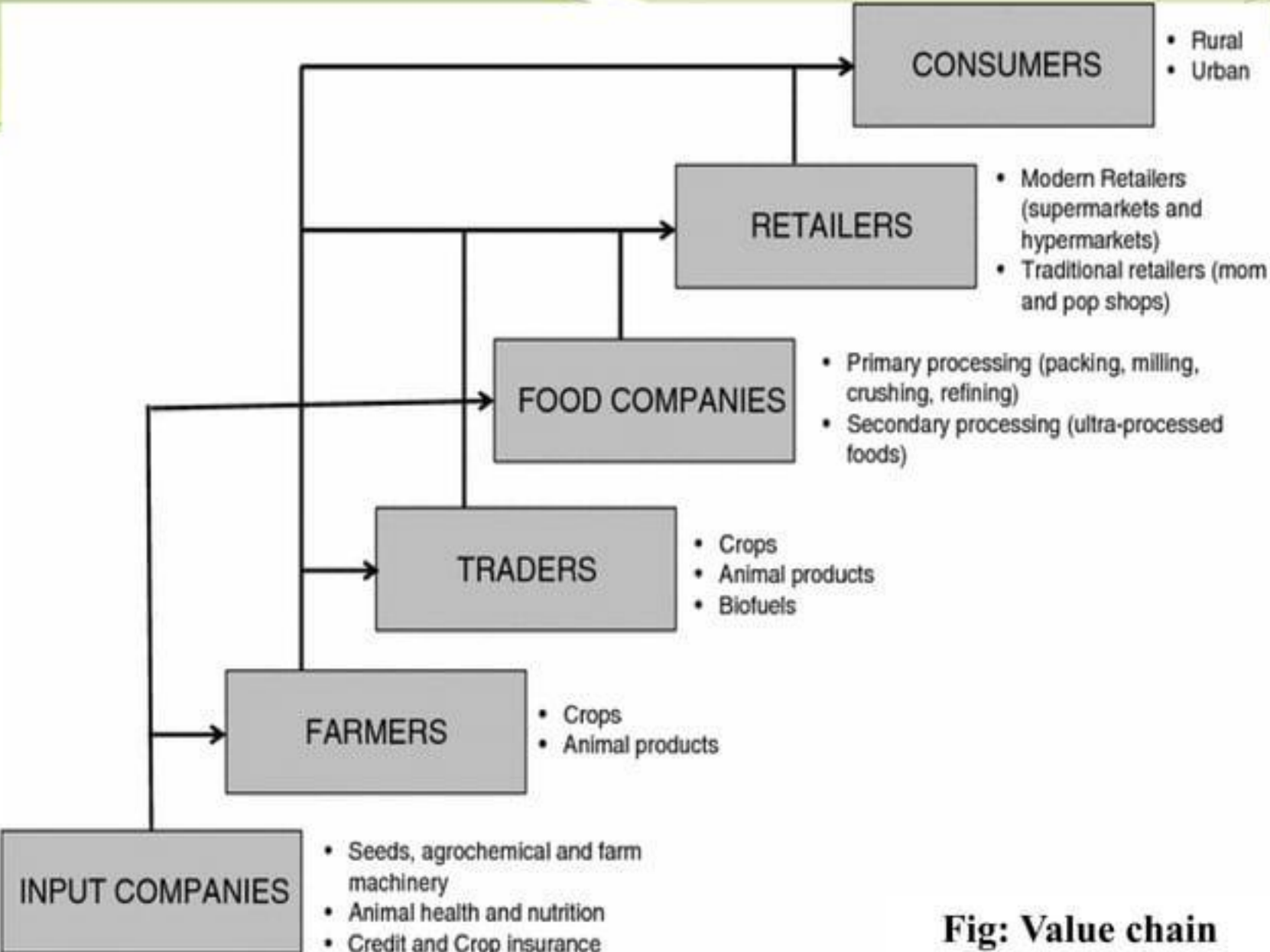


Fig: Value chain

- Efficient linkage of various stakeholders improves production, price realisation and profitability. Value chains perform well when actors in the value chain coordinate and cooperate to produce higher-quality products and generate higher income for all stakeholders along the chain.

Value chain development:

- 1) Identification of products and activities
- 2) Mapping of core processes
- 3) Mapping of actors
- 4) Mapping constraints and solutions
- 5) Developing relationships, linkage and trust
- 6) Deciding costs and margins

Factors Affecting the Integration of Various Enterprises of Farming for Livelihood

- The integration of different farming enterprises (such as crops, livestock, fisheries, agroforestry, and horticulture) is essential for creating a sustainable and diverse livelihood for farmers.
- The process of integrating these enterprises involves combining activities to optimize resource use, increase income, and reduce risks.
- Integrating various enterprises in farming is a multifaceted approach that depends on environmental, economic, technological, social, cultural, and policy related factors.
- A successful integration strategy focuses on maximizing resource use, improving income diversity, and ensuring ecological sustainability.
- With proper planning and support, integrated farming systems can improve farmers' livelihoods and make them more resilient to economic and environmental challenges.

(A) Natural resources and Climatic conditions

Sustainable integration of various enterprises requires careful management of soil, water, and biodiversity to avoid depletion.

(1) Type of soil:

- The type of soil available influences the crops that can be grown and the success of integrating livestock or agroforestry. For example, fertile soils may support multiple crops or trees that provide fodder for livestock, while poor soils may limit integration options.

(2) Climate and weather conditions:

- Climate affects which crops, livestock, or fish can thrive in a region. For instance, dairy farming and fish farming may thrive in temperate regions, while dry areas may be better suited to drought-tolerant crops and hardy livestock. Integrated farming systems that include a mix of crops, livestock, and trees can provide greater resilience to climate change by diversifying risks.

(3) Water availability:

- Access to sufficient and reliable water is crucial for integrating farming systems such as crop production, livestock, and fisheries. Irrigation infrastructure and rainfall patterns directly impact integration, especially in water-intensive activities like horticulture and aquaculture.

(4) Biodiversity and ecosystem health:

- A healthy ecosystem with diverse plant and animal species promotes natural pest control, soil fertility, and water conservation, creating better opportunities for integration of enterprises. Practices like crop rotation, agroforestry, and conservation agriculture can enhance ecological sustainability while integrating various enterprises. Degraded ecosystems, on the other hand, limit options for farmers.

(B) Economic Factors

(1) Market Access:

- The availability of local, regional, or international markets plays a significant role in the success of integrated farming systems. For instance, farmers may choose to focus on high-demand products (like dairy, fish, or organic vegetables) if they have access to markets that offer fair prices.

(2) Capital and investment:

- The initial cost of setting up integrated enterprises can be high, especially for infrastructure (e.g., irrigation systems, livestock pens, or fish ponds). Farmers with limited access to credit or financial resources may face challenges in adopting integrated systems.

(3) Price Volatility:

- Fluctuations in the prices of agricultural products can affect the stability of income from integrated farming systems. Farmers may hesitate to invest in high-risk enterprises if there is uncertainty in product prices or demand.

(C) Technological factors

(1) Access to modern farming technologies:

- Availability and adoption of modern technology (*e.g.*, precision agriculture, improved seeds, artificial insemination for livestock, aquaculture innovations) greatly influence the integration of different farming enterprises. Efficient use of these technologies improves productivity and sustainability.

(2) Mechanization:

- Mechanized farming tools and machinery can increase efficiency in integrating enterprises like crop-livestock farming. Lack of mechanization may limit integration potential, especially for smallholder farmers.

(3) Knowledge and skills:

- Farmers must have the technical know-how to manage multiple enterprises effectively. Training and extension services are critical to enable them to integrate crop, livestock, and fish production, as well as adopt modern farming practices.

(4) Information and communication technology:

- Information and communication technology can support integration by providing farmers with real-time data on market trends, weather forecasts, and farming techniques. This helps in making informed decisions regarding enterprise integration.

(D) Social and Cultural Factors

(1) Traditional farming practices:

- Some farming communities may rely on traditional, single-enterprise methods (*e.g.*, subsistence farming) that resist integration. Changing these practices requires education, incentives, and community involvement.

(2) Family labour and workforce:

- The availability of family labour or hired help affects the ability to manage multiple enterprises. Labor-intensive enterprises, such as livestock or horticulture, may require more workforce, and successful integration depends on the capacity to meet labour demands.

(3) Land tenure and ownership:

- Secure land ownership or long-term leasing arrangements encourage farmers to invest in diverse enterprises and adopt sustainable practices. In contrast, insecure land tenure limits long-term investment in integrated systems.

(4) Gender and social roles:

- In many farming communities, gender roles influence enterprise integration. Women may focus on specific enterprises (like small livestock or horticulture), while men may dominate larger-scale or more mechanized enterprises. Promoting gender equality in access to resources can improve integration.

(5) Cultural preferences:

- Local preferences for certain crops or livestock also play a role in what enterprises are integrated. Cultural significance attached to specific enterprises can affect the willingness to adopt others.

(E) Policy and Institutional Factors

(1) Government policies and subsidies:

- Supportive government policies, subsidies, and incentives can encourage farmers to adopt integrated farming systems. Policies that promote crop diversification, agroforestry, and livestock integration, as well as access to credit, can boost integration.

(2) Land use regulations:

- Zoning laws, environmental regulations, and land use policies can either promote or restrict the integration of enterprises. In some regions, laws may restrict activities like livestock farming or fish ponds, which limits integration opportunities.

(3) Cooperatives and farmer organizations:

- Cooperative groups and farmer associations can provide resources, training, and market access, making it easier for farmers to adopt integrated systems. Institutional support helps share knowledge and resources among farmers.

(4) Access to extension services:

- Availability of agricultural extension services that provide technical knowledge, support, and training on integrated farming practices is crucial. Without access to such services, farmers may not be able to effectively integrate enterprises.

(5) Rural infrastructure:

- Infrastructure such as roads, storage facilities, and energy access directly impact the ability of farmers to integrate enterprises and bring products to market.

Feasibility of different farming systems for different agro-climatic zones

- India is divided into **15 agro-climatic zones** based on soil, climate, rainfall, vegetation, cropping system, *etc.*
- Hence, **any single IFS model can not be applicable to all the zones/region.**
- Components should be selected judiciously and wisely to suit different situations.
- There are several factors, such as agroclimatic condition, available resources, demand, market, *etc.* which determine the selection of farming system components. IFS model should be most profitable and sustainable.

Table: Agro-climatic regions/zones in India

S.No.	Agro-climatic regions/zones	States represented
I	Western Himalayan region	Himachal Pradesh, Jammu & Kashmir, Uttarakhand
II	Eastern Himalayan region	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, West Bengal
III	Lower Gangetic plain region	West Bengal
IV	Middle Gangetic plain region	Uttar Pradesh, Bihar
V	Upper Gangetic plain region	Uttar Pradesh
VI	Trans Gangetic plain region	Chandigarh, Delhi, Haryana, Punjab, Rajasthan
VII	Eastern plateau and hills region	Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, West Bengal
VIII	Central plateau and hills region	Madhya Pradesh, Rajasthan, Uttar Pradesh
IX	Western plateau and hills region	Madhya Pradesh, Maharashtra
X	Southern plateau and hills region	Andhra Pradesh, Karnataka, Tamil Nadu
XI	East coast plains and hills region	Andhra Pradesh, Odisha, Puducherry, Tamil Nadu
XII	West coast plains and ghat region	Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu
XIII	Gujarat plains and hills region	Gujarat , Dadra & Nagar Haveli, Daman & Diu
XIV	Western dry region	Rajasthan
XV	Island region	Andaman & Nicobar Islands, Lakshadweep



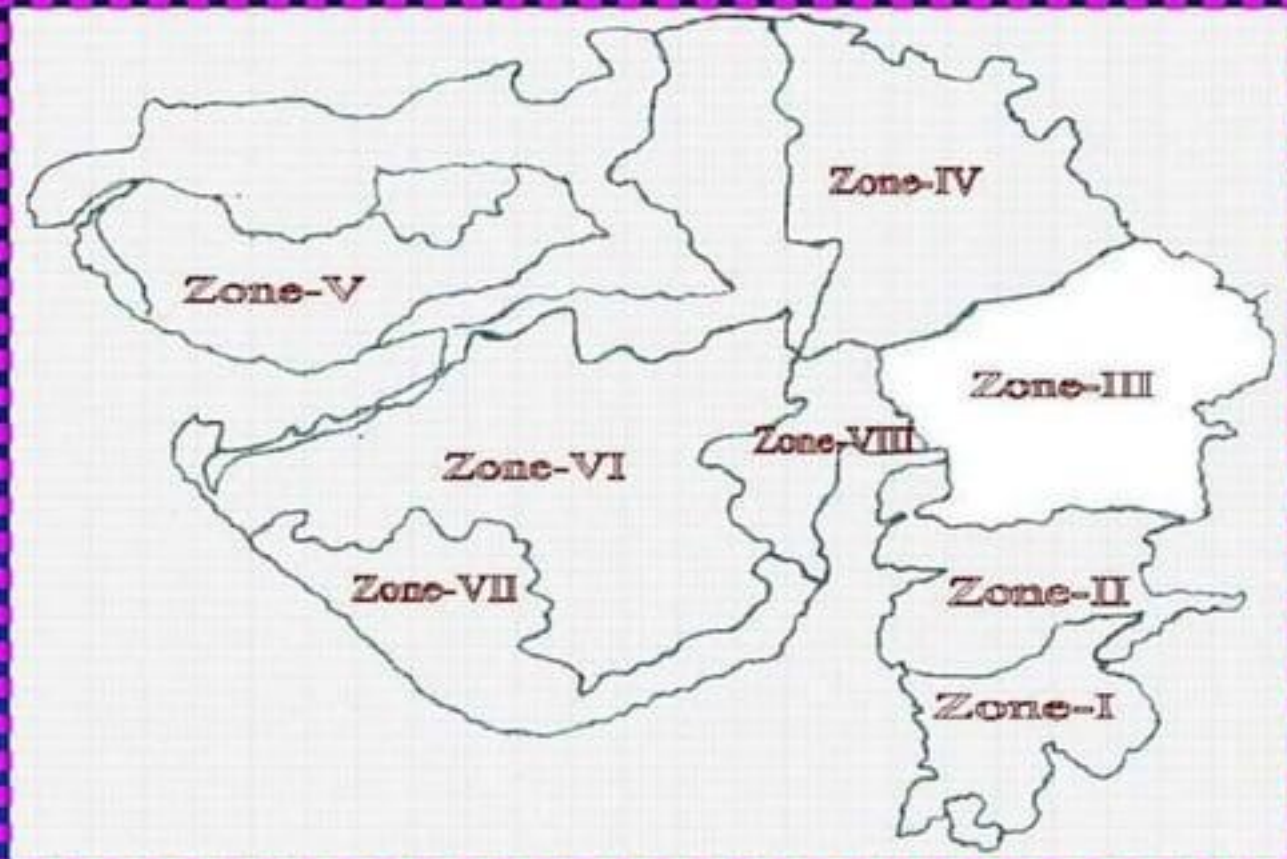
Agro Climatic Zones in India

1. North-Western Mountain Region
2. The North-Eastern Hill Region
3. The Satluj-Yamuna Plain Region
4. The Upper-Ganga Plain Region
5. The Middle-Ganga Plain Region
6. The Lower-Ganga Plain Region
7. The South-Eastern Plateau Region
8. The Aravali-Malwa Upland
9. The Maharashtra Plateau Region
10. The Deccan Interior Region
11. The Eastern Coastal Region
12. The Western Coastal Region
13. The Gujarat Region
14. The Western Rajasthan Region
15. Andaman & Nicobar Island Region

Fig: Agro-climatic zones in India

Table: Agro-climatic Zones of Gujarat

Zone	Name of the Agro-climatic Zone	Rainfall (mm)	Main Districts
I	South Gujarat (Heavy rainfall area)	>1500	Dang, Valsad, Navsari
II	South Gujarat	1000 - 1500	Surat , Bharuch, Narmada
III	Middle Gujarat	800 – 1000	Vadodara, Dahod, Panchmahal, Kheda, Anand
IV	North Gujarat	625-875	Gandhinagar, Sabarkantha, Banaskantha, Mehsana, Patan , Dantiwada
V	North West Gujarat	250-500	Kutch, Radhanpur
VI	North Saurashtra	400-700	Jamnagar, Rajkot, Surendranagar
VII	South Saurashtra	750-1000	Bhavnagar, Junagadh, Amreli
VIII	Bhal and Coastal areas	625-1000	Ahmedabad district, Arnej



Agro-climatic Zones of Gujarat State

Zone-I	South Gujarat (Heavy Rainfall Area)	Zone-V	North West Zone
Zone-II	South Gujarat	Zone-VI	North Saurashtra
Zone-III	Middle Gujarat	Zone-VII	South Saurashtra

Fig: Agro-climatic Zones of Gujarat

For the purpose of developing IFS models for different regions, these 15 Agro-climatic zones are clubbed into 8 regions.

Farming system models for different Agro-climatic zones of India

(1) High altitude cold deserts

Western Himalayan region, encompassing Ladakh and adjoining area is desert area and remains very cold and covered with ice. Hence, **cultivation of annual crops is very difficult** in this region.

Pastures with forestry; angora goats, angora rabbits and yak for fine quality wool purpose and limited settled agricultural crops like millets, wheat, barley and fodder. Wool of **angora goat** is famous as **mohair wool**.

(2) Western arid and desert region

This region comprises parts of **Gujarat and Rajasthan**, characterized by low rainfall, poor fertility and sandy soils.

Centring mainly in animal husbandry with the camels, sheep and goat with moderate cropping components involving sorghum, pearl millet, millets, wheat, pulses and fodders.

(3) Western and central Himalayas

Western and central Himalayan region is characterized by hills, snowfall during part of the year. It covers parts of Kashmir, Himachal Pradesh and Uttarakhand.

Emphasis is on horticultural crops like apple, peach and pear. Mostly terrace cultivation is followed for crop cultivation. Major crops include like maize, wheat, rice, pulses and fodders. Pastures with forestry, poultry, and livestock *viz.*, sheep, goats, rabbits, and yak (at altitudes above 2,500 m amsl) forms important components of farming system in this region.

(4) Eastern Himalayas

This region is characterized by high rainfall and high forest area covering parts of Manipur, Assam, Nagaland. Shifting cultivation is followed by the farmers of this area.

Important IFS components include (1) Horticultural crops with crops like maize, wheat, rice, pulses and pasture on terraces, pastures with forestry, sheep, goats, rabbits, yak and cold water fisheries at altitudes above 2000 m msl (2) Maize, rice, French bean, rice bean, piggery, poultry, fishery and cole crops above 1000 m msl (3) Rice, pulses, dairying, fish culture, vegetables in case of less than 1,000 m msl.

(5) Indo-Gangetic plains

This region covers parts of Punjab, Haryana, Uttar Pradesh, Bihar. It is characterized by fertile **alluvial soil** with **canal irrigation and good rainfall**. Hence, **intensive agriculture** is followed in this area and crop diversity is observed.

Major component is crop cultivation *viz.*, **rice-wheat** sequence, maize, sugarcane in some areas, pulses. Livestock, dairy and poultry are also significant components in this area.

(6) Central and southern highlands

Parts of peninsular India falls under semi-arid regions, characterized by less rainfall and low fertile lands. Hence, less water requiring hardy crops are grown in these areas.

Main crops of this region include cotton, sorghum, millets, pulses, *etc.* Major livestock comprises sheep, goat and poultry while dairy cattle to some extent.

(7) Western Ghats

This region includes parts of Kerala, Tamil Nadu, Karnataka, Maharashtra receiving good rainfall.

Cultivation of **plantation crops (coconut, rubber, coffee, tea)** is the major activity in this region whereas cultivation of rice and pulses are the secondary agricultural activities. Cattle, sheep and goats are the livestock components which in most parts are maintained as large herds and allowed to range.

(8) Delta and coastal plains

This region is characterized by high rainfall and coastal ecosystem.

IFS components include rice cultivation along with fish culture, goat, poultry and piggery enterprises. Capture fish (marine fishery) also important component in coastal areas.

Site-specific IFS models

The site-specific development of an IFS model for different agro-climatic zones is important for ensuring the productivity and sustainability of the system. By taking into account the local conditions and selecting appropriate components and practices, an IFS can provide a range of benefits such as improved soil fertility, diversified income, and enhanced food security.

ICAR-Indian Institute of Farming Systems Research, Modipuram is engaged in on station and on-farm research through AICRP on Integrated Farming Systems. Farming system models developed at various locations gives hope for realizing higher returns for farmers from a unit land. Region specific integrated farming systems models are synthesized under this network project using (1) On-station data (2) Benchmark information from characterization survey (3) Secondary information available.

Development of IFS model in Gujarat

The AICRP project is operating since 1972 in Gujarat. Integrated Farming System Research Centre, Sardarkrushinagar is working as the main centre in Gujarat whereas Junagadh and Navsari centres are working as sub-stations.

Brief highlights of the synthesized IFS model developed by SDAU under AICRP

District: Sabarkantha

NARP Zone: North Gujarat Plains

Agro-climatic zone: Gujarat Plains and Hills

Soil type: Medium black

Rainfall: 807 mm

Model area: 0.88 ha

- ❑ Synthesized IFS model (0.88 ha) for Sabarakantha district comprise cropping systems (0.70 ha), horticulture with vegetables (0.15 ha), dairy (1 Cross bred cow + 2 buffalos), fishery (0.07 ha), backyard poultry (15 birds), Goatary (4+1) along with supplementary enterprises like vermicomposting and boundary plantation.
- ❑ Total cost of Rs. 1,81,449 provides estimated net profit of Rs. 2,22,071.
- ❑ Improved IFS model results in significantly higher production (80%), profit (222%), employment (150%) as compared to existing farming system besides meeting the 100% family nutrition.
- ❑ Improved IFS model also results in 61% higher water productivity.

Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country

- Commercial farming-based livelihood models are designed to transform agriculture from subsistence farming into a profit-oriented business.
- The primary goal is to ensure a sustainable increase in income for farmers while maintaining environmental balance.
- These models emphasize market-driven crop production, value addition, and diversification of agricultural activities.

❖ **NABARD**

National Bank for Agriculture and Rural Development (NABARD) plays a crucial role in promoting farmer welfare and improving the livelihoods of rural communities in a variety of ways:

(1) Self-help group (SHG)

- ❑ A Self-Help Group (SHG) is a small, voluntary group of individuals who come together to support each other, share experiences, and work towards common personal or community goals.
- ❑ SHGs are a major part of that mission to promote sustainable rural development.
- ❑ The NABARD plays a key role in supporting SHGs in India.
- ❑ NABARD provides support to SHGs through a variety of programs and initiatives covering financial, operational, capacity building supports.
- ❑ NABARD links SHGs with mainstream banks through SHG-Bank Linkage Program (SBLP) and helps SHGs access microfinance loans for income-generating activities.

(2) Farmers Producer Organisation (FPO)

- ❑ A Producer Organisation is a **legal entity formed by primary producers**, viz. farmers, milk producers, fishermen, *etc.* FPO is a producer organisation whose members are farmers.
- ❑ The **FPO scheme** was launched by **NABARD** to promote sustainable agriculture and empower farmers in India.
- ❑ By working together in an FPO, farmers can get better deals for seeds, fertilizers, machinery, and sell their produce at higher prices due to collective bargaining power.
- ❑ Key support of NABARD to FPOs include financial support, capacity building, market linkages and governance support.

(3) Integrated Watershed Management Programme (IWMP)

- ❑ The Integrated Watershed Management Programme (IWMP) by NABARD is a scheme designed to improve the productivity of land and water resources in rural areas.
- ❑ Its main goal is to address issues like soil erosion, water scarcity, and land degradation by promoting sustainable land and water management practices.
- ❑ Under the program, NABARD provides financial and technical assistance to implement watershed management project activities like soil and water conservation, rainwater harvesting, afforestation and vegetation restoration.

(4) Dairy Entrepreneurship Development Scheme (DEDS)

- ❑ The Dairy Entrepreneurship Development Scheme (DEDS) is an initiative by NABARD aimed at promoting the establishment and growth of dairy farming in India.
- ❑ The key objectives of the DEDS are to promote dairy farming, increase milk production, enhance rural employment and modernization of dairy farming.
- ❑ The scheme provides financial assistance and technical support to encourage entrepreneurs to start or expand dairy farming activities.

(5) Contract farming

- ❑ Considering benefits of contract farming, NABARD developed a special refinance package for contract farming arrangements aimed at promoting increased production of commercial crops and creation of marketing avenues for the farmers.

❖ ICAR (Indian Council of Agricultural Research)

(1) Integrated farming systems

- ICAR-Indian Institute of Farming Systems Research (IIFSR), Modipuram (Uttar Pradesh) is engaged in on station and on-farm research through AICRP (All India Coordinated Research Project) on Integrated Farming Systems.
- Farming system models developed at various locations gives hope for realizing higher returns for farmers from a unit land.
- **Region specific integrated farming systems models** are synthesized under this network project.

Important features of IFS models:

- Representative district of the NARP (National Agricultural Research Project) zone was selected for developing an IFS model.
- Site specific IFS models have been developed for mean of the holding size of small and marginal farmers in the representative.

- The first priority of synthesized IFS model is to meet the demand of household for **6F's (food, feed, fodder, fibre, fertilizer and fuel)**.
- The remaining area can be utilized for commercial cropping systems/activities to enhance the profit for the family.
- Requirement of various commodities for the family was worked out using **ICMR (Indian Council of Medical Research) standards**.
- The gaps in production of required commodities in the existing systems were identified and cropping system and related components were selected to meet the gaps.
- The best available technologies in the domain area were employed for synthesized models.
- Standard values of different parameters were worked out for existing farming systems and synthesized models. *e.g.* input requirements, available residues/waste, water productivity, man days required, cost of farming system, saving of produce for sale, sustainability parameters, *etc.*

(2) Krishi Vigyan Kendras (KVKs)

- Krishi Vigyan Kendras (KVKs), established under the Indian Council of Agricultural Research (ICAR), play a crucial role in enhancing agricultural productivity and improving farmers' livelihoods across India through different types of extension activities.
- The Indian Council of Agricultural Research (ICAR) is the apex body responsible for overseeing the establishment and functioning of KVKs.
- **The main functions of KVKs are:**
 - 1) Technology dissemination
 - 2) Training and capacity building
 - 3) Demonstrations
 - 4) On-farm testing
 - 5) Advisory services
 - 6) Entrepreneurship Development
 - 7) Linkage with research institutes.

❖ OTHER ORGANISATIONS

(1) AMUL

- AMUL has not only revolutionized India's dairy industry but also created sustainable livelihood opportunities for millions of rural farmers. The cooperative model, centred around dairy production, has had a profound impact on both the agricultural economy and rural development.
- The Amul Model is a **three-tier cooperative structure**. This structure consists of a Dairy Cooperative Society at the village level affiliated to a Milk Union at the District level which in turn is further federated into a Milk Federation at the State level.
- The above three-tier structure was set-up in order to delegate the various functions, milk collection is done at the Village Dairy Society, Milk Procurement & Processing at the District Milk Union and Milk & Milk Products Marketing at the State Milk Federation.
- This helps in eliminating not only internal competition but also ensuring that economies of scale is achieved. This structure was first evolved at Amul in Gujarat and thereafter replicated all over the country under the **Operation Flood Programme**, it is known as the '**Amul Model**' or '**Anand Pattern**' of Dairy Cooperatives.

(2) NDDB

- The National Dairy Development Board (NDDB) plays a pivotal role in improving the livelihoods of rural farmers, particularly in the dairy sector, through the promotion of dairy-based livelihoods across India.
- The NDDB's work is deeply embedded in the **cooperative structure** that empowers farmers, particularly in rural regions, by providing access to resources, knowledge, and markets.

(3) National Horticulture Board (NHB)

- The main objectives of the NHB are to improve integrated development of Horticulture industry. NHB helps in coordinating, sustaining the production and processing of fruits and vegetables.
- NHB focuses on development of production clusters/hubs for integrated Hi-tech commercial horticulture, development of post-harvest and cold chain infrastructure, ensuring availability of quality planting material and to promote adoption of new technologies/tools/techniques for Hi-tech commercial horticulture, *etc.*

(4) National Fisheries Development Board (NFDB)

- NFDB enhances the livelihoods of those dependent on fisheries and aquaculture, especially in coastal and inland rural areas.
- NFDB provides focused attention to production, processing, storage, transport and marketing of fish and aquaculture products.
- It also aims at conservation of natural aquatic resources.
- It promotes application of modern tools of research and development for optimizing production and productivity from fisheries.
- It provides for training and empower women in the fisheries sector.

(5) APEDA (Agricultural and Processed Food Products Export Development Authority)

- APEDA plays an important role in livelihood development in India by promoting the export of agricultural products and developing consumer bases for Indian products in other countries.
- Primary Functions of APEDA are promotion of exports, quality control and standards, training, market development, financial assistance, registration of exporters, certification, *etc.*
- APEDA implements the **National Programme for Organic Production (NPOP)**, which includes promoting organic farming, setting standards for organic production, and accrediting Certification Bodies.

(5) Commodity Boards

- There are **five statutory Commodity Boards** under the Department of Commerce. These Boards are responsible for production, development and export of **tea, coffee, rubber, spices and tobacco**.
- The functions of these boards include increasing production and productivity, improving the quality, improvement of processing, market promotion, welfare measures for plantation workers, supporting research and development, collection & dissemination of statistical information to stakeholders, exporter registration, support infrastructure, *etc.* for respective commodities.

Schemes and programs by Central and State Government

Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)

- ✓ PM-KISAN is a central sector scheme launched in **2019** that aims to provide minimum income support to all small and marginal farmers per year.
- ✓ Under the scheme, financial benefit of **Rs. 6000/- per year** is transferred in **three equal four-monthly instalments** into the bank accounts of farmers' families across the country, through Direct Benefit Transfer (DBT) mode.

Pradhan Mantri Fasal Bima Yojana (PMFBY)

- ✓ PMFBY was launched in **2016** in order to provide a simple and affordable crop insurance product to ensure comprehensive risk cover for crops to farmers **against all non-preventable natural risks from pre-sowing to post-harvest** and to provide adequate claim amount. The scheme is demand driven and available for all farmers.

Pradhan Mantri Kisan Maandhan Yojana (PM-KMY)

- ✓ Pradhan Mantri Kisan Maandhan Yojna (PMKMY) is a central sector scheme launched in **2019**. PM-KMY is contributory scheme for small and marginal farmers (SMFs). Farmers can opt to become member of the scheme by paying monthly subscription to the Pension Fund.
- ✓ Similar, amount will be contributed by the Central Government. Small and marginal farmers between 18-40 years age are eligible for the benefits.

National Food Security Mission (NFSM)

- ✓ The Mission aims at increasing production of rice, wheat, pulses, coarse cereals (Maize and Barley) and Nutri-Cereals through area expansion and productivity enhancement in a sustainable manner.
- ✓ Other objectives include restoring soil fertility and productivity at the individual farm level, enhancing farm level economy and post-harvest value addition at farm gate.
- ✓ Government has taken many steps to achieve the aim of International Year of Millets (IYM) 2023. Millet missions have been launched across 13 states including. Start-ups and FPOs have been established and are operational in the millet ecosystem.

Rashtriya Krishi Vikas Yojana

- ✓ Rashtriya Krishi Vikas Yojana (RKVY), a centrally sponsored scheme was launched in **2007** as an umbrella scheme to promote the development of agriculture and allied sectors.
- ✓ The scheme aims to fill the resources gap of agriculture and allied sectors by providing financial support to states.
- ✓ The scheme focuses on creation of infrastructure in agriculture and allied sectors that help in supply of quality inputs, market facilities, *etc.* to farmers.
- ✓ It provides flexibility to states to implement projects as per the local farmers' needs and priorities.
- ✓ In **2017**, the scheme was renamed as **RKVY-RAFTAAR**, which stands for **Remunerative Approaches for Agriculture and Allied Sector Rejuvenation**.

Mission for Integrated Development of Horticulture (MIDH)

- ✓ MIDH, a Centrally Sponsored Scheme was launched during **2014-15** for holistic growth of the horticulture sector covering fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and Bamboo.
- ✓ Major components include plantation infrastructure development, establishment of new orchards and gardens for fruits, vegetables, spices and flowers, rejuvenation of unproductive, old, and senile orchards, protected cultivation, promotion of organic farming, pollination support through bee keeping, horticulture mechanization, post-harvest management and marketing infrastructure, *etc.*

National Agro-forestry Policy

- ✓ Agro-forestry was conceived on the recommendation of the National Agro-forestry Policy 2014 to promote plantation on farmlands. The restructured agro-forestry under RKVY is aimed to provide Quality Planting Materials (QPM) and the certification in order to promote planting of trees on farm land for improving the livelihood of farmers.

National Bamboo Mission (NBM)

- ✓ NBM mainly focus on the development of complete value chain of the bamboo sector. It is envisaged to link growers with consumers with a cluster approach mode. NBM is now merged with MIDH.

National Beekeeping & Honey Mission (NBHM)

- ✓ Keeping in view the importance of beekeeping, a Central Sector Scheme entitled National Beekeeping & Honey Mission (NBHM) was launched in **2020** under Atmanirbhar Bharat Abhiyan for its implementation in the field for overall promotion and development of scientific beekeeping and to achieve the goal of “Sweet Revolution”.

Soil Health Card (SHC)

- ✓ Soil Health Cards (SHCs) Scheme introduced in the year **2014-15**. Soil health card provides information to farmers on nutrient status of their soil along with recommendation on appropriate dosage of nutrients to be applied for improving soil health and its fertility. Now, Government of India has made some technological interventions in New Soil Health Card Scheme.

Modified Interest Subvention Scheme (MISS)

- ✓ The Interest Subvention Scheme (ISS) provides concessional **short term agri-loans** to the farmers practicing crop husbandry and other allied activities like animal husbandry, dairying and fisheries. ISS is available to farmers availing short term crop loans **up to Rs. 3.00 lakh** at an interest rate of **7% per annum** for one year. **Additional 3% subvention** is also given to the farmers for prompt and timely repayment of loans thus, reducing the effective rate of interest to **4% per annum**.

Agriculture Infrastructure Fund (AIF)

- ✓ In order to address the existing infrastructure gaps and mobilize investment in agriculture infrastructure, AIF was launched under Aatmanirbhar Bharat Package.
- ✓ AIF was introduced with a vision to transform the agriculture infrastructure landscape of the country. The AIF is a **medium-long term debt financing facility** for investment in viable projects for **post-harvest management infrastructure and community farming assets** through interest subvention and credit guarantee support.

Formation and Promotion of Farmer Producer Organizations (FPOs)

- ✓ The Government of India launched the Central Sector Scheme (CSS) for the formation and promotion of FPOs in 2020. The scheme aims to: Improve the economic strength and market linkages of farmers, create jobs for rural youth, improve the rural economy, increase farmers' income, and double exports by 2022.

Integrated Scheme for Agriculture Marketing (ISAM)

- ✓ ISAM supports state governments in governing the agricultural produce marketing through creation and improvement of market structures, capacity building and generating access to market information.
- ✓ During **2017-18**, **National Agriculture Market Scheme** popularly known as **e-NAM** scheme has also been made part of the same. National Agriculture Market (e-NAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities.

Market Intervention Scheme and Price Support Scheme (MIS-PSS)

- ✓ **PSS is implemented for procurement of pulses, oilseeds and copra.** MIS is implemented for procurement of agricultural and horticultural commodities which are perishable in nature and are not covered under PSS.
- ✓ The objective of intervention is to protect the growers of these commodities from making distress sale in the event of a bumper crop during the peak arrival period when the prices tend to fall below economic levels and cost of production.

Rainfed Area Development (RAD)

- ✓ RAD is being implemented since **2014-15**. RAD adopts an area-based approach in cluster mode for promoting Integrated Farming System (IFS) which focuses on multi-cropping, rotational cropping, inter-cropping, mixed cropping practices with allied activities like horticulture, livestock, fishery, apiculture, *etc.* to enable farmers not only in maximizing the farm returns for sustaining livelihood, but also to mitigate the impacts of drought, flood or other extremes weather events.

Paramparagat Krishi Vikas Yojana (PKVY)

- ✓ PKVY, launched in **2015** aims to increase soil fertility and produce agricultural products free from chemicals and pesticides residues by adopting eco-friendly, low-cost technologies.
- ✓ The scheme is implemented in a cluster mode with unit **cluster size of 20 hectares**.
- ✓ A group shall comprise **minimum 20 farmers** (may be more if individual holdings are less).
- ✓ Farmers in a group can avail benefit of maximum of 2 ha as per provision of PKVY.

Per drop more crop (PDMC)

- ✓ In order to increase water use efficiency at the farm level through **Micro Irrigation technologies, i.e., drip and sprinkler irrigation systems**, PDMC scheme was launched during **2015-16**.
- ✓ The micro irrigation helps in water saving as well as reduced fertilizer usage through fertigation, labour expenses, other input costs and overall income enhancement of farmers.
- ✓ It also supports micro level water harvesting, storage, management, *etc.* activities to supplement source creation for micro irrigation.

National Mission on Edible Oils-Oil Palm (NMEO-OP)

- ✓ A new Centrally Sponsored Scheme namely, NMEO-OP has been launched **2021** in order **to promote oil palm cultivation** for making the country Aatamnirbhar in edible oils.

Namo Drone Didi

- ✓ The Government has recently approved a Central Sector Scheme for providing drones to the Women Self Help Group (SHGs) for the period from 2024-25 to 2025-26.
- ✓ The scheme aims to provide drones to 15000 selected Women Self Help Group (SHGs) for providing rental services to farmers for agriculture purpose (application of fertilizers and pesticides).

Sub-Mission on Agriculture Mechanization (SMAM)

- ✓ SMAM is implemented from 2014 which aims to accelerate agricultural mechanization in India for small and marginal farmers and to the regions where availability of farm power is low.

Sub-Mission on Seed and Planting Material (SMSP)

- ✓ SMSP covers seed production chain, from production of nucleus seed to supply of certified seeds to the farmers, creation of infrastructure for development of the seed sector, support to the public seed producing organisations, creating seed banks. SMSP has launched the first phase of Seed Authentication, Traceability & Holistic Inventory (SATHI) portal for effective monitoring of seed chain. SMSP is now merged with NFSM.

Sub-Mission on Agriculture Extension (SMAE)

- ✓ SMAE is a part of the National Mission on Agricultural Extension and Technology (NMAET). The SMAE's objectives include Technology dissemination, Farmer-driven extension system, Multi-agency extension strategies, Group approach, Gender concerns, Awareness creation, Market-led technologies.
- ✓ To accelerate technology dissemination, Agricultural Technology Management Agency (ATMA) at district level is a new institutional arrangement to operationalize extension reforms in a participatory mode.

Deendayal Antyodaya Yojana-National Rural Livelihoods Mission (DAY-NRLM)

- ✓ DAY-NRLM is a flagship programme of the Ministry of Rural Development, Government of India. Livelihood promotion activities of DAY-NRLM include interventions in both on-farm activities like Agro Ecological Practices (AEP), improved livestock management practices, sustainable Non-Timber Forest Produce (NTFP) collection practices, *etc.* and off-farm activities like traditional occupations.

Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)

- ✓ The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is now known as the **Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)**.
- ✓ It is a landmark social security initiative launched by the Government of India in **2005**.
- ✓ It aims to enhance the livelihood security of rural households by providing guaranteed **at least 100 days of wage employment** to every rural household whose adult members volunteer to do unskilled manual labour.
- ✓ The primary focus of MGNREGA is **to provide income security to rural families**, reduce poverty, and create sustainable livelihood opportunities in rural areas, thereby promoting rural development.
- ✓ It supports asset creation activities like new farm ponds, dug wells, other water harvesting structures, livestock shelters, fish drying yards, *etc.*

Khadi and Village Industries Commission (KVIC)

- ✓ KVIC promotes the development of Khadi, village industries, and handicrafts to create sustainable livelihoods, especially in rural areas.
- ✓ The Commission works toward fostering economic independence, self-reliance, and employment generation in rural India, primarily through artisan-based enterprises.
- ✓ It encourages niche farming activities like bee keeping, sericulture and organic farming.

❖ **State Government Agricultural schemes (Gujarat)**

- Mukhya Mantri Pashupalan Yojana
- Kisan Parivahan Yojana
- Kisan Suryoday Yojana
- Horticulture Development Mission
- Skill Development for Farmers (Krushi Mahotsav)
- Vanbandhu Kalyan Yojana
- Gujarat Agro-Industries Corporation (GAIC)
- Organic and Natural Farming Schemes
- Farm Mechanization scheme
- Distribution of Seeds scheme
- Programme for Women Farmers and Farmers
- Scheme for establishment of new garden (Fruits)
- Cultivation of Aromatic and Medicinal Crops
- Scheme for vegetable cultivation
- Spice Crops to Increase Productivity
- Mushroom and Bee Keeping

Public and Private organizations involved in promotion of farming-based livelihood opportunities

Both public and private organizations play crucial roles in promoting farming-based livelihood opportunities. These organizations often focus on areas such as sustainable agriculture, capacity building, financial assistance, market linkages, and technological advancements.

❖ PUBLIC ORGANISATIONS

Central Government Ministries and Departments

(1) Ministry of Agriculture & Farmers' Welfare

- **Department of Agriculture, Cooperation & Farmers Welfare:** Implements schemes like PM-Kisan, Soil Health Card Scheme, and Pradhan Mantri Fasal Bima Yojana (PMFBY).
- **Department of Agricultural Research and Education (DARE):** Manages agricultural education and research through institutions like the Indian Council of Agricultural Research (ICAR).

(2) Ministry of Fisheries, Animal Husbandry and Dairying

The Department is responsible for matters relating to livestock production, preservation, protection from diseases and improvement of stocks and dairy development, and also for matters relating to Delhi Milk Scheme (DMS) and National Dairy Development Board (NDDB).

(3) Ministry of Rural Development

Focuses on rural employment, women's empowerment in agriculture and supports agricultural activities through schemes like Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and National Rural Livelihood Mission (NRLM).

(4) Ministry of Food Processing Industries

Supports value addition and market linkages for agricultural produce through schemes like PM Formalisation of Micro Food Processing Enterprises (PMFME).

(5) Ministry of Environment, Forest, and Climate Change

Promotes sustainable farming practices and agroforestry.

(6) Ministry of Commerce and Industry

The Ministry of Commerce and Industry (MoCI) in India has an Agriculture Export Policy that aims to help farmers improve their income and empower the farming community.

State Agricultural Departments

Each state has its own Department of Agriculture that implements both central and state-specific schemes.

Research and Development Institutions

(1) Indian Council of Agricultural Research (ICAR)

ICAR is an **autonomous organization** under the Department of Agricultural Research and Education (**DARE**) in the Indian **Ministry of Agriculture and Farmers Welfare**. ICAR plays a key role in the development of agriculture in India by conducting research, coordinating education, and promoting the application of research in agriculture.

(2) State and Central Agricultural Universities

State and Central Agricultural Universities are part of the **ICAR-Agricultural Universities System**. They are given responsibilities for agricultural research, education and training or extension education. The SAUs are given autonomous status and direct funding from the state governments.

Financial Institutions

(1) National Bank for Agriculture and Rural Development (NABARD)

The National Bank for Agriculture and Rural Development (NABARD) is a development bank in India that **focuses on the agriculture and rural sectors**. It provides credit and support to institutions working in the rural sector, including agricultural finance, rural infrastructure, and various other rural development initiatives.

(2) Regional Rural Banks (RRBs)

RRBs bridge the credit gap in rural areas and provide financial services to the marginal farmers, agricultural labourers, artisans, and small entrepreneurs.

(3) Cooperative Banks and Societies

These financial cooperatives are organized by farmers and other agricultural professionals to provide credit and other services to farmers. Primary agricultural credit societies are often organized in rural areas where access to traditional banking services may be limited.

Specialized Boards and Authorities

(1) The National Dairy Development Board (NDDB)

Established in **1965**, the NDDB is a statutory body of the Government of India, tasked with the mission of supporting the development of the dairy industry, improving the welfare of dairy farmers, and promoting sustainable livelihoods in rural areas.

(2) National Horticulture Board (NHB)

NHB was set up by the Government of India in **1984** as an autonomous organization under the administrative control of **Ministry of Agriculture and Farmers Welfare** and registered as a society. The main objectives of the NHB are to improve integrated development of Horticulture industry.

(3) National Fisheries Development Board (NFDB)

The National Fisheries Development Board (NFDB) is a statutory body established by the Government of India under the **Ministry of Fisheries, Animal Husbandry and Dairying** in **2006** to promote sustainable fisheries development in India.

(4) Agricultural and Processed Food Products Export Development Authority (APEDA)

APEDA is an organization established by the Government of India under the **Ministry of Commerce and Industry** to promote the export of agricultural and processed food products.

(5) Commodity Boards

Currently there are **five commodity boards** created under the administrative control of the Department of Commerce in the **Ministry of Commerce and Industry**. These Boards are responsible for production, development and export of **tea, coffee, rubber, spices and tobacco**.

(6) Khadi and Village Industries Commission (KVIC)

KVIC is a statutory body established by the Government of India under the **Khadi and Village Industries Commission Act, 1956** that **promote livelihood, especially in rural area**.

Cooperatives

(1) AMUL

AMUL (Anand Milk Union Limited) is a brand owned by the Gujarat Co-operative Milk Marketing Federation (GCMMF). AMUL is one of India's most iconic dairy cooperatives and has significantly contributed to rural livelihoods, particularly through its innovative and inclusive approach to dairy farming.

(2) IFFCO

Indian Farmers Fertiliser Cooperative Limited, is a **multi-state cooperative society** in India. IFFCO plays a key role in agriculture development in India by promoting sustainable agriculture, providing agricultural inputs like produces and distributes fertilizers, seeds, pesticides, and micro-nutrients, research, rural development programmes, promoting entrepreneurship, *etc.*

❖ PRIVATE ORGANISATIONS

Non-Governmental Organizations (NGOs)

(1) Self-Employed Women's Association (SEWA)

The Self-Employed Women's Association (SEWA) is a membership-based organization created in 1972 from a combination of the labour, women, and cooperative movements, to organize self-employed women in the informal economy. It supports women farmers.

(2) ActionAid India

ActionAid Association is a nationally registered organisation working with the poor and marginalised people in India since 1972. The association works across 25 States and three Union Territories. ActionAid India advocates for sustainable agriculture practices and technologies that are eco-friendly and suitable to the local climate.

(3) Bharatiya Agro Industries Foundation (BAIF)

BAIF has adopted the Gandhian approach to rural prosperity with emphasis on Climate Change Mitigation and Resilient and Sustainable Community Livelihoods. BAIF is implementing major Nature-positive programmes such as Livestock Development, Natural Resources Management, Agri-Horti-Forestry (Wadi) and Agrobiodiversity Conservation for Sustainable Livelihoods and Enriched Environment.

Agri-tech Companies

Agri-tech companies provide seeds, crop protection solutions, agricultural tools and other input supplies and agricultural services.

❖ WORLD ORGANIZATIONS

(1) Food and Agriculture Organization (FAO)

Implements global initiatives for sustainable agriculture.

(2) World Bank

Funds rural development and agricultural projects.

(3) International Fund for Agricultural Development (IFAD)

Supports small-scale farmers in developing countries.

Risk and success factors in farming-based livelihood systems

Farming-based livelihoods in India are a vital component of the economy. However, these livelihoods are influenced by various risk factors and success determinants.

Risk factors

India's agricultural sector faces multiple risks. The uncertainties in weather, yields, prices, government policies, markets, and other factors cause wide swings in farm income. Key risk factors include:

(A) Environmental risks

(1) Unpredictable rainfall

Agriculture in India is dependent on the monsoon season, which is erratic leading to droughts and floods. **Erratic monsoon** rainfall patterns in India frequently disrupts agricultural production.

(2) Climate change and natural disasters

Rising temperatures, unpredictable weather patterns, and extreme climate events threaten crop yields, especially in the regions dependent on rain-fed agriculture. Floods, earthquakes, and cyclones can destroy infrastructure, crops, and livestock.

(3) Soil degradation

Loss of fertility due to overuse of chemical fertilizers and inadequate organic inputs, soil erosion due to over cultivation and poor land management practices and **soil salinization** due to excess irrigation have degraded the soil health impacting crop productivity.

(4) Outbreak of pests and diseases

Increasing incidence and severity of pest and disease outbreaks due to climate change and excessive use of agro-chemicals poses significant risks to primary productivity and increases input costs. Indian farmers face frequent infestations of pests like locusts and certain diseases. Many farmers lack access to effective and affordable pest management solutions.

(B) Economic risks

- 1) **Price volatility:** Fluctuations in prices for outputs impact income stability of farmers. Crop prices fluctuate due to seasonal supply, policy shifts, and global market influences, leading to uncertain incomes.
- 2) **Credit access:** Small and marginal farmers often struggle to obtain credit, making it hard to invest in quality inputs and technology.
- 3) **Market access:** Poor infrastructure, such as limited transportation and storage facilities hinders farmers' ability to access profitable markets.
- 4) **High input costs:** Rising costs for seeds, fertilizers, and machinery can strain farmers' profitability. Small holders may struggle to afford modern equipment and methods.

(C) Policy and institutional risks

- 1) **Inconsistent agricultural policies:** Frequently changing inconsistent government policies on subsidies, tariffs, or exports can lead to uncertainty and disrupt farming operations.
- 2) **Land ownership issues:** Fragmented landholdings and uncertain land rights in some regions restrict farmers' opportunities.

(D) Social risks

(1) Personal risks:

Personal risk refers to factors such as problems with human health or personal relationships that can affect the farm business. *e.g.* accidents, illness, death, *etc.*

(2) Labour shortage:

Indian agriculture faces labour shortage due to agricultural workers' preference for non-agricultural sector and migration of young people to urban areas for better job prospects. It poses a significant challenge in agriculture, impacting the timely execution of agricultural operations and crop management.

(3) Skill and education:

Farmers often **lack technical knowledge** of modern agricultural techniques and technologies due to poor literacy and insufficient extension services, which limit their ability to maximize productivity.

Success factors

Despite these challenges, there are several factors that contribute to the success of farming-based livelihoods in India. Risk management involves adopting strategies that can mitigate negative financial effects from such uncertainties:

(A) Environment management

(1) Sustainable practices

Adoption of sustainable practices like crop diversification, precision farming, organic methods, natural farming practices, conservation agriculture, low-input practices and agroforestry reduce input costs, maintain soil health and enhance long-term viability.

(2) Climate smart agriculture

Agricultural practices which respond effectively to climate change can help adapt climate change. Use of resilient crop varieties, efficient water management techniques including watershed programmes and ground water recharge, and sustainable practices together with use of weather apps and services offering short-term and long-term weather forecast, *etc.* reduce the impact of climate change.

(B) Economic resilience

(1) Diversification:

Engaging in multiple income-generating activities reduces dependency on a single source of income.

(2) Access to markets:

Connectivity to local and international markets through cooperatives ensures better pricing. Digital platforms like e-NAM facilitates fair prices by connecting farmers with buyers nationwide, bypassing intermediaries.

(3) Financial inclusion:

Loans and microfinance enable farmers' investment in inputs and technologies. Insurance reduce vulnerability to economic shocks.

(C) Policy and institutional support

(1) Effective policies:

Stable and farmer-friendly policies, incentives to encourage sustainable farming practices, subsidies on farm inputs and machineries, crop and livestock insurance, direct benefit transfer, promotion of research and development, *etc.* play an important role in helping farmers to manage their risks.

(2) Infrastructure development:

Investment in roads, transportation, storage, water systems, and electrification boosts efficiency.

(3) Credit access:

Loans and microfinance enable investment in inputs and technologies.

(D) Social support and human capital

(1) Community support:

Strong social networks and cooperative models such as FPOs help small farmers access larger markets, better inputs, and credit by aggregating their resources provide risk-sharing mechanisms and collective bargaining power.

(2) Education and training:

Education and training to impart knowledge in modern agricultural practices, entrepreneurship, use of modern digital tools for weather forecast, market trends, farm management, precision farming practices, *etc.* enhance efficiency and profitability.

(3) Youth engagement and women empowerment:

Inspiring youth to participate in farming could encourage innovative approaches. Women empowerment in agriculture can positively impact agricultural production, food security, and child nutrition.

Case studies on different livelihood enterprises associated with the farming

Here are some notable case studies on different livelihood enterprises associated with farming. These examples highlight various approaches that have successfully improved farmer incomes and livelihoods:

1. Amul Dairy Cooperative (Gujarat):

- ✓ **Overview:** Amul is one of India's largest dairy cooperatives, established in 1946. It empowers farmers by providing them with a stable income through milk production.
- ✓ **Key Features:**
 - **Cooperative Model:** Farmers are members of the cooperative, sharing profits.
 - **Value Addition:** Amul processes milk into a variety of products (cheese, butter, ice cream) that cater to diverse markets.
 - **Training and Support:** The cooperative provides training in dairy farming, hygiene, and animal husbandry.
- ✓ **Impact:** Amul has transformed the livelihoods of millions of farmers, significantly increasing their income and promoting rural development.

2. Self-Help Groups (SHGs) in Tamil Nadu:

✚ **Overview:** The SHG movement in Tamil Nadu focuses on empowering women through collective savings and income-generating activities.

✚ **Key Features:**

- **Microfinance:** SHGs provide access to small loans for agricultural and non-agricultural enterprises.
- **Skill Development:** Training in various skills (*e.g.*, tailoring, handicrafts, and organic farming) enhances income opportunities.
- **Market Access:** SHGs facilitate collective marketing of products, improving bargaining power.

✚ **Impact:** Many women have started successful enterprises, leading to improved family incomes and enhanced social status.

3. Integrated Farming System (IFS) in Punjab:

✚ **Overview:** This model combines crop production, livestock, and aquaculture to optimize resource use and increase income.

✚ **Key Features:**

- **Diversification:** Farmers grow crops, raise poultry and livestock, and practice fish farming.
- **Waste Utilization:** Organic waste from livestock is used as fertilizer, while crop residues serve as animal feed.
- **Economic Resilience:** By diversifying income sources, farmers reduce risks associated with single-crop farming.

✚ **Impact:** Increased overall productivity and income stability for participating farmers.

4. Organic Farming Initiative in Sikkim:

✚ **Overview:** Sikkim has become India's first fully organic state, promoting organic farming practices among its farmers.

✚ **Key Features:**

- **Government Support:** Policies and training programs encourage the transition to organic farming.
- **Market Development:** Establishment of markets for organic produce, both locally and nationally.
- **Sustainable Practices:** Emphasis on sustainable farming techniques that improve soil health and biodiversity.

✚ **Impact:** Farmers have seen increased demand and premium prices for organic products, significantly enhancing their livelihoods.

5. Horticulture Development in Maharashtra:

✚ **Overview:** The government of Maharashtra promotes horticulture as a key livelihood option for farmers.

✚ **Key Features:**

- **Crop Diversification:** Farmers are encouraged to grow high-value crops like fruits and vegetables.
- **Market Linkages:** Support in establishing connections with markets and processors.
- **Training Programs:** Capacity building for best practices in cultivation, post-harvest handling, and marketing.

✚ **Impact:** Many farmers have transitioned from traditional crops to horticulture, leading to higher incomes and reduced risk.

6. Fish Farming in West Bengal:

✚ **Overview:** Fish farming has become an important livelihood option in West Bengal, leveraging the state's abundant water resources.

✚ **Key Features:**

- **Pond-Based Aquaculture:** Farmers utilize ponds for raising fish, often integrating it with rice cultivation.
- **Cooperative Model:** Formation of cooperatives to market fish collectively, enhancing income.
- **Training and Resources:** Support from government and NGOs for best practices in aquaculture.

✚ **Impact:** Increased fish production has led to improved household incomes and food security for many families.

These case studies illustrate diverse livelihood enterprises associated with farming, showcasing how innovative approaches, cooperation, and government support can lead to significant improvements in farmer livelihoods. By leveraging local resources and fostering community engagement, these models provide valuable lessons for scaling similar initiatives across regions.

Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing lifestyle

Agricultural production together with food processing significantly contribute to greenhouse gas emission and carbon footprint. Agricultural production consumes large amounts of water, energy and harmful chemicals, and follow the practices that maximize crop yields but not sustainable. Many farm and food processes operating in a **linear model (take-make-consume-throw away pattern)**, contribute large amount of **agro-wastes** annually. All together adversely affect the climate, natural resource, biodiversity, and pollute the environment.

CIRCULAR ECONOMY

- Circular economy refers to a **model of production and consumption**, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products **as long as possible**.
- Goals of circularity are to minimise resource use, reduce waste, repurpose materials to turn into value products and protect the environment. It is a kind of **value-chain loop** and lessens waste from every stage of a product's lifecycle.

Benefits of circular economy:

- 1) It helps to meet customers' expectations
- 2) It **encourages waste utilization to diversify income** and thus, mitigate vulnerability and increase farm efficiencies.
- 3) It **takes care of future regulations** and help earn distinction of being pioneer.
- 4) It distinguishes one's business from competitors by highlighting their sustainable practices.



The circular economy model:
less raw material, less waste, fewer emissions

Role of farming-based enterprises in circular economy:

- IFS involves the **synergistic integration** of crops, livestock, aquaculture, forestry, and other components. **Reuse** of byproducts and wastes from one enterprise as input in the other enterprise of process **minimizes** waste generation, need for external inputs, energy consumption and emissions. *e.g.*, using crop residues for livestock feed.
- Cyclic processes in water use such as **water harvesting**, ground water recharge, wastewater utilization, aquaculture provide efficient utilization of water resources. *e.g.* By adopting aquaculture with farming, **fishpond supplies nutrient-rich water for irrigation.**
- Thus, **farming-based enterprises promote a circular economy through recycling, reducing waste and innovative practices.**

GREEN ECONOMY

➤ A green economy is an economic model that **aims to improve human well-being and social equity while reducing environmental risks**. Farming-based enterprises play a crucial role in advancing the green economy by **promoting sustainable practices** that integrate environmental responsibility with economic growth.

Role of farming-based enterprises in green economy:

(1) Production of green products

Farming enterprises supply raw materials for eco-friendly products such as organic foods, bioplastics, biofuels, natural fibers.

(2) Encouraging green energy

IFS integrates renewable energy sources into farming systems, reducing emissions.

- **Solar-powered irrigation:** Solar panels power irrigation systems for crops.
- **Biogas units:** Animal waste is converted into biogas for cooking and lighting, reducing deforestation and fossil fuel use.

(3) Ecosystem services

Agroecological practices like crop rotation, polycultures, agroforestry, *etc.* encourages diversity which supports ecological balance and reduces vulnerability to pests and diseases. Mixed farming and agroforestry provide habitats for various species, enhancing ecosystem services.

CLIMATE CHANGE

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts can be natural, but human activities, which produces heat-trapping gases have been the main driver of climate change. The agriculture sector significantly contributes to greenhouse gas (GHG) emissions and the global carbon footprint. The three primary GHGs of concern are carbon dioxide, methane and nitrous oxide. The source of carbon dioxide is combustion of fossil fuel for agricultural machinery, transportation, irrigation, *etc.* and deforestation for agriculture expansion. Methane gas is produced due to decomposition of wastes, enteric fermentation (process in the digestive systems of ruminants) and rice cultivation. The major source of nitrous oxide are soil and manure management and wastewater treatments.

Though agriculture is a major cause of greenhouse gas emission, agricultural producers can play a big role in mitigating climate change by reducing greenhouse gas emissions or removing carbon dioxide from the atmosphere and storing it above or below ground. Integrated Farming Systems (IFS) play a significant role in mitigating climate change by enhancing resource efficiency, reducing greenhouse gas (GHG) emissions, promoting carbon sequestration, and increasing resilience to climate variability.

Role of farming-based enterprises in climate change:

(1) Carbon sequestration: Carbon sequestration is the process of transferring carbon from the atmosphere to plants and soil through photosynthesis. Farming-based enterprises has the potential to act as a carbon sink and mitigate climate change effects.

- **Regenerative agriculture:** Regenerative agriculture practices like no-till farming, cover cropping, and composting increase carbon storage in the soil.
- **Reforestation and agroforestry:** These practices integrate trees with agricultural crops and livestock. These activities maintain green cover, reduce emissions of greenhouse gases and store carbon in the soil and above-ground biomass.

(2) Reducing emissions: Improved livestock management practices and fertilizer management strategies like slow-release fertilizers, use of amendments, biofertilizers, fertigation reduces greenhouse gas emissions.

(3) Resilience to climate shocks: By diversifying farm activities, IFS enhances resilience to climate shocks like droughts, floods, and erratic weather patterns. *e.g.* A mix of crops, livestock, and aquaculture reduces the risk of total loss due to extreme events.

DIGITALIZATION

Integrated approach creates opportunities for digitalization to enhance productivity, resource management, and profitability.

(1) Enterprise performance

IFS involves various components such as crops, livestock, aquaculture, and agroforestry. Digital tools help measure and compare productivity, profitability, and resource use efficiency across all components of IFS.

(2) Precision farming

IFS, coupled with digital tools like **GPS, IoT, and sensors**, ensures precise application of inputs like water, fertilizers, and pesticides across different farming components.

(3) Digital audits

Systems like blockchain ensure transparency and traceability in the production chain, which is crucial for organic and sustainable certification.

(4) E-Marketing platforms

Digital tools enable farmers to access markets directly, reducing dependency on intermediaries and increasing profitability.

(5) Demand forecasting

IFS data integrated with digital market trends helps predict demand for diverse products like crops, milk, fish, or wood.

(6) Knowledge and capacity building

Digital platforms foster knowledge sharing among IFS practitioners, promoting best practices and innovation. Online modules, mobile apps, and videos help educate farmers about modern techniques in integrated farming.

(7) Climate resilience and risk management

Digitalization provides real-time weather updates, helping farmers plan activities for different IFS components.



CHANGING LIFESTYLE

Integration of different farming-based livelihood enterprises such as crops, livestock, poultry, fisheries, and agroforestry within a farm creates a sustainable, diversified, and efficient production system. It plays a crucial role in transforming lifestyles, especially in rural and agricultural communities. It impacts the lifestyle in the following ways:

(1) Income and economic stability

- **Diversified income sources:** Integration of different enterprises enhances income and reduces dependency on a single source of income by combining multiple agricultural activities. For example, if crop yields are poor, income from livestock or fishery can compensate. It also reduces the risk of market fluctuations and climatic adversities.
- **Year-round employment:** Integration of year-round productive components like dairy farming or poultry, *etc.* provides consistent employment and income.

(2) Food and nutritional security

- **Self-sufficiency:** Combination of different livelihood farming enterprises enables farmers to produce a variety of food items (grains, vegetables, milk, meat, fish, and fruits) on their farms, reducing dependency on external markets.
- **Improved nutrition:** Diverse farm produces provide a balanced diet, improving the health and well-being of families.

(3) Quality of life

- **Healthier living:** Reduced use of chemical inputs and reliance on natural cycles contribute to healthier food production and a cleaner environment.
- **Better livelihoods:** Increased and stable incomes enable farmers to afford better housing, education for children, healthcare, and access to modern conveniences.
- **Reduced urban migration:** With sustainable income opportunities in rural areas, families are less likely to migrate to cities in search of work, preserving community bonds and cultural heritage.

(4) Environmental sustainability

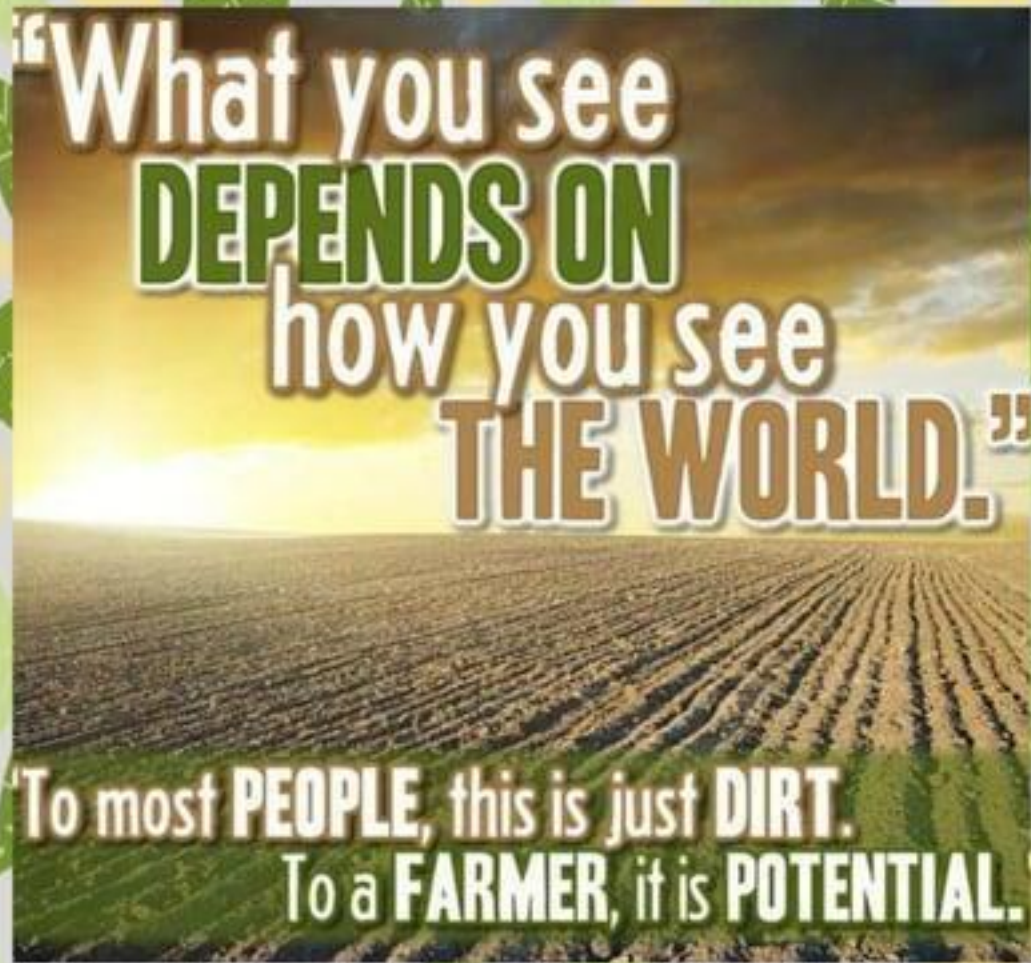
- **Reduced waste:** IFS emphasizes resource recycling. For instance, animal waste is used as manure for crops, and crop residues can feed livestock.
- **Conservation of natural resources:** By integrating systems like agroforestry or aquaculture, farmers make efficient use of water, land, and other natural resources.
- **Climate resilience:** Diverse systems are more resilient to climatic changes, ensuring long-term sustainability and reducing the stress of climate-related uncertainties.

(5) Knowledge and technology adoption

Farmers practicing IFS learn and adopt sustainable practices, advanced tools, and modern techniques, improving their efficiency and confidence.

(6) Cultural and social transformation

- **Empowering women and youth:** Integrated systems involving different enterprises like poultry, horticulture, or beekeeping, providing opportunities for women and youth to contribute to family income.
- **Community development:** Collaborative efforts to implement IFS often lead to shared knowledge, collective problem-solving, and stronger community networks.



**“What you see
DEPENDS ON
how you see
THE WORLD.”**

**To most PEOPLE, this is just DIRT.
To a FARMER, it is POTENTIAL.**

Thank You !