FARMING SYSTEM & SUSTAINABLE AGRICULTURE

AGR-223

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introduction

- **Farm**- farm is an area of land and its building which is used for growing crops and rearing animals. It is devoted primarily to agriculture processes with the primary objective of producing food and other crops. It is the basic facility in food production.
- **System**- a system is a set of inter related, interacting and inter dependent elements acting together for a common purpose and capable of reacting as a whole to external stimuli. It is unaffected by its own output and it has external boundaries based on all significant feedbacks.

DEFINITION OF FARMING SYSTEM

- Farming system is a decision making unit comprising the farm household ,cropping and livestock system that transform land , capital labour into useful products that can be consumed or sold (fresco and westphal, 1988)
- Farming system is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of farm livelihood while preserving resource base and maintaining a high level of enviorment quality (lal and miller 1990).

DEFINITION OF FARMING SYSTEM

- Farming system is a set of agro economic activities that are inter related and interact with themselves in a particular agrarian setting. It is a mix of farm enterprises to which farm families allocate its resources in order to efficiently utilise the existing enterprises for increasing the productivity and profitability of the farm. These farm enterprises are crop,livestock, aquaculture,agro forestry and agri- horticulture (Sharma et al 1991)
- Farming system is a mix of farm enterprises such as crop,livestock, aquaculture,agro forestry and fruit crops to which farm family allocates its resources in order to efficiently manage the existing environment for the attainment of the family goal.(pandey et al 1992.)

DEFINITION OF FARMING SYSTEM

- Farming system represents an appropriate combination of farm enterprises (Cropping system horticulture, livestock, fishery, forestry, poultry)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 on one hand and attempts to meet the national goals on the other. (Jayanthi et al 2002)
- Farming system is a unique and reasonably stable arrangement of farming enterprises that are household manages according to well defined practices in response to the physical, biological and socio economic environment and in accordance with the household goals preferences and resources.

- Scope of Farming System
- Farming enterprises include crop, livestock, poultry, fish,
- sericulture etc. A combination of one or more enterprises
- with cropping when carefully chosen, planned and executed
- gives greater dividends than a single enterprise, especially for
- small and marginal farmers. Farm as a unit is to be
- considered and planned for effective integration of the
- enterprises to be combined with crop production activity.

Scope of farming system

- Indian economy is predominantly rural and agriculture oriented where the declining in the land for farm site poses a serious.
- In problem agriculture majority of the farm holdings are dry lands and even irrigated areas depend on the monsoon .
- In this context,if farmers are only concentrated on crop production they will be subjected to a high degree of uncertainty in income and employment.

- Hence, it is imperative to manage certain strategies for the rural landless/marginal farmers by combining the different farming systems to ensure the profitability while preserving the environment and increase the productivity and supplement the income.

- In an agricultural country like India, the average land holding is very small. The population is steadily increasing and the farm holding spaces are reducing day by day. This is major issue for the farmers to manage production of their crops and livestock at the same time.

- The income from cropping for an average farmer is hardly sufficient to sustain his family. So, the farmer has to be assured of a regular income for a reasonable standard of living by including other enterprises like a combination of farming systems i.e. fish cum duck, Cattle cum paddy farming etc.

- By analyzing the fact above there is a strong need of development of integrated farming to ensure an all round development of farming families.

Role of Farming System

- Food security
- Provide balanced food
- Quality food basket
- High productivity and enhanced farm income
- Effective recycling of resources
- Minimizing environmental pollution
- Employment generation

Role of Farming System

Food security:

- Food security is defined as the balanced food supply and effective demand for food.
- Ensuring food security to the individual wards off the gender-based intra-household discrimination.
- Thus food security needs to be redefined as “livelihood security for the household and all members within, which ensures both physical and economic asses to balanced diet, safe drinking water, environmental sanitation, primary education and basic health care.

Provides Balanced Food

- There is need of farming system which has several components like dairy, poultry, goatry, fisheries etc. along with crop production.
- In this way, farming system would not meet the food for but also cater the need of protein, fat, vitamins and minerals required for good health.
- Conjunction of horticulture and agroforestry with cropping would ensure the seasonal access to fruits, fuel, fodder and fibre.

Quality food basket

- ✓ As the living status is improved the requirement of cereals will be decreased and supplemented by other items viz. milk, egg, meat, fruit etc.
- ✓ Integration of allied enterprises with cropping increase the nutritive value of the products.
- ✓ Cropping with pigeon+fish+mushroom founds to have the highest protein of 1963 kg.
- ✓ Integration of cropping with fish + mushroom and pigeon/poultry could result in 31 to 52 % higher protein yield than cropping alone.

Effective recycling of resources

The effective recycling of farm resources is possible by adoption of farming system research.

Crop by-product is utilized as fodder for animals, and animal by-product i.e. milk, and dung may be utilized for increasing income and soil fertility, respectively.

Minimize environmental pollution

- In Punjab, Haryana and western Utter Pradesh, burning of rice residue is common practice, which increased the concentration of green house gases in atmosphere, in addition to huge amount of nutrient loss.
- Such situation could be avoided by introduction of some more enterprises like animal husbandry on the farm.
- Rice straw may be used as animal feed.

Employment generation

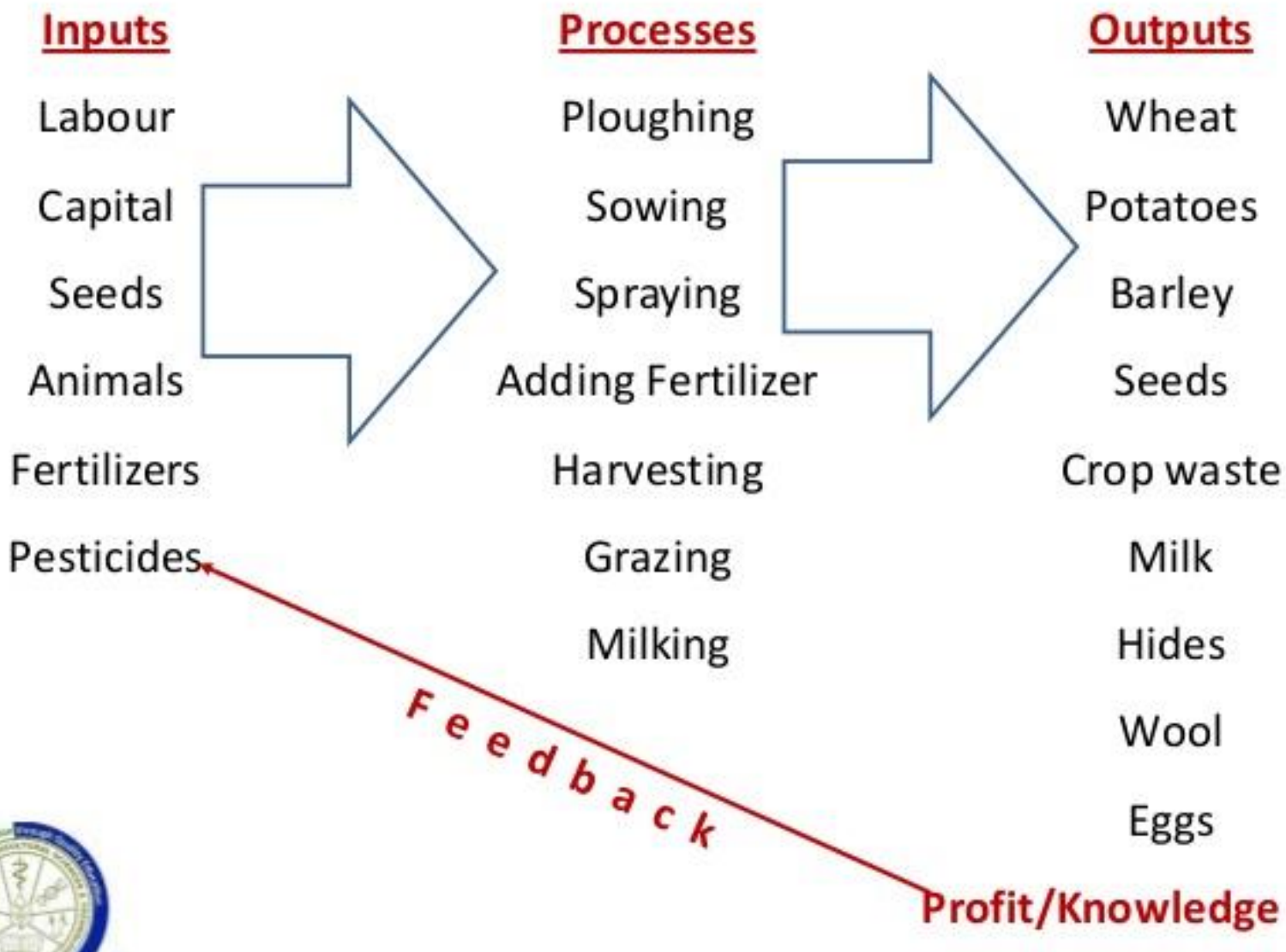
- Since crop based agriculture is highly season specific and time bond, the intensity of labour requirement increases during sowing and harvesting time of crops.

- For rest of the time farmers sitting idle if they do not have off-farm activities. This leisure time could be utilized effectively by adoption of farming system, which keeps the whole family busy throughout the year.

- Farming System Concept
- A farm is a system in that it has **INPUTS, PROCESSES and OUTPUTS**
- Depending on the type of farming e.g. arable/pastoral,
- commercial/subsistence, the type and amount of inputs,
- processes and outputs will vary.
- Income through arable farming alone is insufficient for bulk
- of the marginal farmers. The other activities such as dairying,
- poultry, sericulture, apiculture, fisheries etc. assume critical
- importance in supplementing their farm income.

- Time and space concept
- Time concept relates to increasing crop intensification in
- situation where there is no constraint for inputs.
- In rainfed areas where there is no possibility of increasing the
- intensity of cropping, the other modern concept (space
- concept) can be applied. In space concept, crops are
- arranged in tier system combining two or more crops with
- varying field duration as intercrops by suitably modifying the
- planting method.

- Income through arable cropping alone is insufficient for bulk
- of the marginal farmers. Activities such as dairy, poultry, fish
- culture, sericulture, bio-gas production, edible mushroom
- cultivation, agro-forestry and agri-horticulture, etc., assumes
- critical importance in supplementing farm income. It
- should fit well with farm level infrastructure and ensures full
- utilization of bye-products. Integrated farming system is
- only the answer to the problem of increasing food production
- for increasing income and for improving the nutrition of
- small scale farmers with limited resources.


Inputs
Labour
Capital
Seeds
Animals
Fertilizers
Pesticides
Processes
Ploughing
Sowing
Spraying
Adding Fertilizer
Harvesting
Grazing
Milking
Outputs
Wheat
Potatoes
Barley
Seeds
Crop waste
Milk
Hides
Wool
Eggs
Feedback
Profit/Knowledge

Types of farming system

- Subsistence Farming System
- Conventional Farming System
- Alternative Farming System
  - Organic Farming System
  - Agro ecological Farming System
  - Bio intensive Farming System
  - Bio dynamic Agriculture
  - Permaculture
  - Natural Farming
- Specialized Farming System
- Integrated Farming System

Types of farming systems

Commercial Farming

- Farmers that are operated with the goal of producing more than the owners need for personal use. This excess in output is sold for profit.
- Commercial farmers are often involved in large tracts of land. An example would be the large wheat farms of the prairies.
- Commercial farms are **capital intensive**, meaning they use more money and machinery than humans.

Subsistence Farming

- Farms that are operated to meet the needs of the owners with little or no extra produced.
- Subsistence farms usually involve small tracts of land. An example would be a backyard garden.
- Subsistence farms are **labour intensive**. They use people more than money or machinery (capital).

TYPES OF FARMING PRACTICES

Extensive Farming-

- Farming with low inputs of capital and labour, generally with low yields per hectare. It is associated with regions of cheap available land where high revenues are not important.

Intensive Farming-

- Farming with a high level of input (capital and labour) and high yields. Outputs are valuable and often perishable. Intensive farming is usually found in regions of dense population and high land values.

AGRIBUSINESS FARMING

- It is a unique, self sufficient farming system, much larger than a single farm.
- Agri businesses produce all of their own inputs, maintain their own processing facilities and market their outputs.
- They are large enough to form partnership[s with international corporations and have vast capital resources to be able to afford to consistently update to newer technologies.

SHIFTING CULTIVATION

- Also known as **Slash and Burn Farming**. This is a farming method used in tropical and warm temperate areas where there is thick vegetation and a good growing season. The vegetation is cut down and burned by the farmer and the burned out area is used for a few years until crops don't grow well and weeds begin to take over. farmers then move to a new site and repeat the process.

Terrace cultivation

- The hill and mountain slopes are cut to form terraces and the land is used in the same way as in permanent agriculture.
- Since the availability of flat land is limited terraces are made to provide small patch of level land.
- Soil erosion is also checked due to terrace formation on hill slopes.

SEDENTARY AND NOMADIC FARMING

- Sedentary farming is when a farm is based on the same location all the time.
- Nomadic is a farming practice of raising livestock where the farmer has no home base but rather moves around with the herd to different grazing areas as suits the farmer.
- This practice is found most often in underdeveloped countries where land ownership is not defined, or is defined on a cultural rather than personal level.

TYPES OF INTEGRATED FARMING SYSTEM

- Crop- Livestock Farming System
- Crop- Livestock- Fishery Farming System
- Crop- Poultry- Fishery-Mushroom Farming System
- Crop- Fishery-Duckery Farming System
- Crop- Livestock- Fishery- Vermicomposting Farming System
- Crop- Livestock- Forestry Farming System
- Agri-Silvi-Apiary Farming System
- Agri- Horti- Silvi- Pastoral Farming System

Crop-fishery-livestock farming system

Crop
- Upland paddy
- Maize

Horticulture
- Leechi
- Guava
- Papaya

Livestock
- Dairy cattle
- Pig
- Chicken
- Duck
- Rabbit

Fish
- Rohu
- Catla
- mrigal

Model developed at ICAR Research Complex for NEH Region,Mizoram Centre

Source : icarmizoram.nic.in

Dairy-agri-horti-silvi-pastoral Farming System

Livestock

- Dairy cattle

Agri

- Maize, soyabean
- Horti
- Banana

Silvi

- Teak

Pastoral

- Congo signal
- Setaria guinea grass

Model developed at ICAR Research Complex for NEH Region, Mizoram Centre

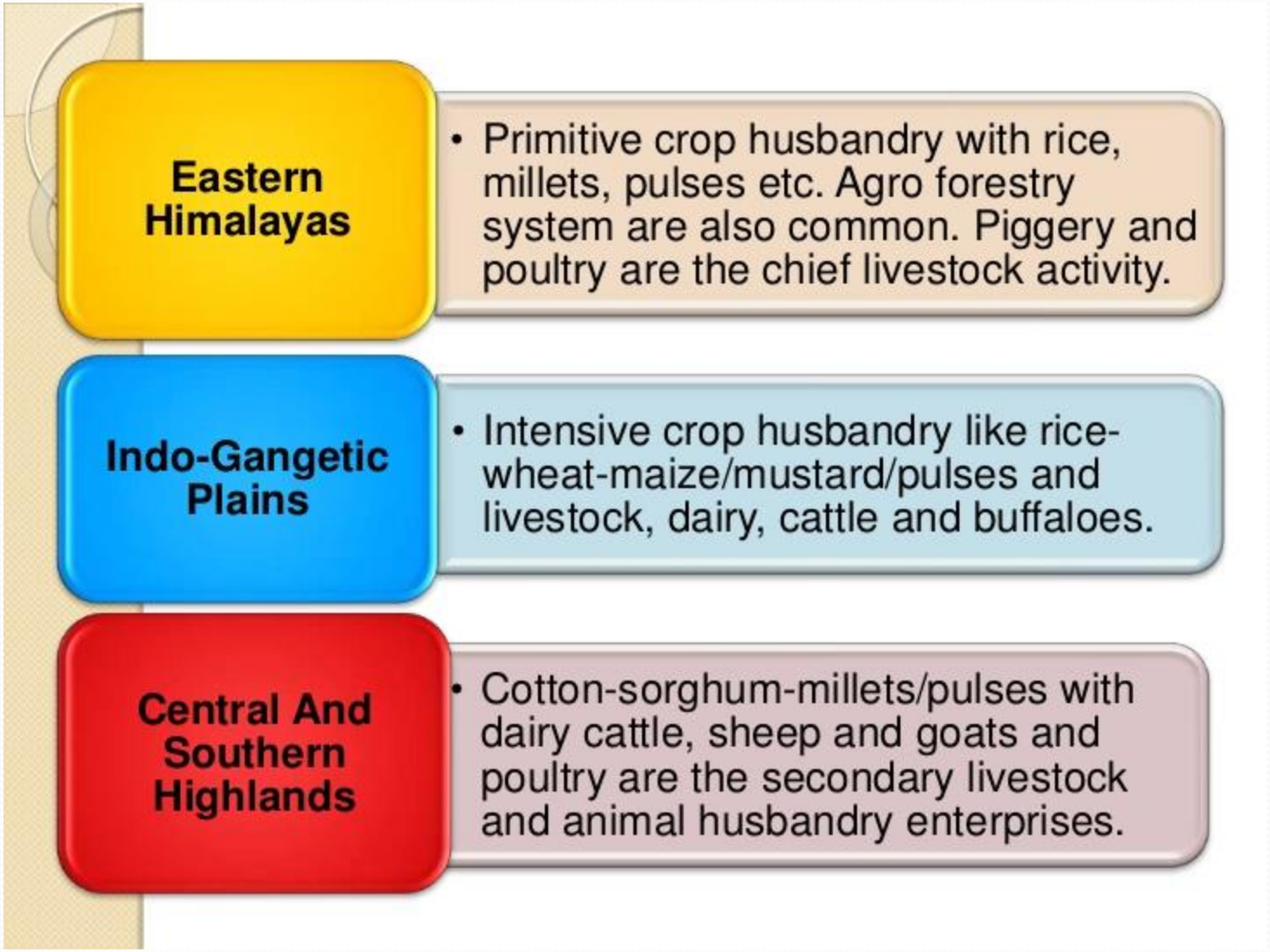
Source : http:// icarmizoram.nic.in

Integrated approach in wetland situation

- Rice based cropping with poultry-cum-fish culture
- Crop-poultry-fishery
- Cropping with dairy
- Cropping with goat rearing
- Cropping with aquaculture

Farming System Research For Different Agro Climatic Zones In India

High altitude cold deserts	• Pastures with forestry, goats, rabbits, and settled agricultural crops like millets, wheat, barley, and fodders.
Arid and desert region	• Animal husbandry with the camels, sheep and goats, and growing with fodder and field crops.
Western and central Himalayas	• Horticultural crops as a major component and agriculture mainly on the hill terraces and slopes with maize, rice, wheat, pulses and fodder crops.


Eastern Himalayas
• Primitive crop husbandry with rice, millets, pulses etc. Agro forestry system are also common. Piggery and poultry are the chief livestock activity.
Indo-Gangetic Plains
• Intensive crop husbandry like rice-wheat-maize/mustard/pulses and livestock, dairy, cattle and buffaloes.
Central And Southern Highlands
• Cotton-sorghum-millets/pulses with dairy cattle, sheep and goats and poultry are the secondary livestock and animal husbandry enterprises.

Western Ghats	• Major activity on plantation crops, cultivating rice and pulses are the secondary agricultural activity. Cattle, sheep and goats are the livestock components which in most parts, are maintained as large herds.
Delta And Coastal Plains	• Rice cultivation with other enterprises like fishery, poultry and piggery, etc., capture fisheries of marine ecosystem is a specialized enterprise.

FACTORS AFFECTING FARMING SYSTEMS

- Natural Resources and Climate
- Science and Technology
- Trade Liberalization and Market Development
- Policies, Institutions and public goods
- Information and human capital
- Indegenous Technological Knowledge

FACTORS AFFECTING FARMING SYSTEMS

- Soil and climatic features of the affected area.
- Availability of the resources, land ,labour and capital.
- Present utilization of resources.
- Economies of proposed integrated farming system.
- Managerial skill of farmer.

CATTLE

- **Breeds and Housing**
- Dairy breeds: Sahiwal, Sindhi, Gir.
- Dual purpose: Hariana, Ongole and Kankrej.
- Exotic breeds: Jersey, Holstein Friesian, Aryshire,
- Brown Swiss and Guernsey.
- Buffaloes: Murrah, Nili Ravi, Mehsana, Suti,
- Zafrabadi, Godavari and Bhadawari.
- **Housing: Each cow requires 12-18 sq m space and**
- the buffaloes need 12-15 sq m. The floor should be
- rough and have gradient of 2.5 cm for every 25 cm

- **Breeding and maintenance**
- Cow: The cows remain in milk for 9-10 months, the average calving
- interval being 16-18 months. Require 6-8 weeks of dry period.
- Should ordinarily be bred during the second and third months after
- calving. Come to heat in more or less regular cycles of about 21 days
- which lasts for about a day. The best time to serve a cow is during
- the last stage of heat. If artificially inseminated, a second
- insemination may be given within 6-8 hours after the first
- insemination. The gestation period is about 280 days.
- Buffalo: the lactation period last for 7-9 months. She buffaloes come
- to heat every 21-23 days. The gestation period is 310 days. Calf
- rearing is very important in the case of buffalo maintenance. Since
- they require abundant water, wallowing is required. Regular deworming
- is needed for buffalo maintenance.
- Under Indian conditions, cattle commonly mature at the age of about
- three years. This period can, however, be reduced by six months under
- well managed herd

- Feeding
- Feeding: Cattle feed generally contains fibrous, coarse, low
- nutrient straw material called roughage and concentrates.
- Roughages: Roughages are basic for cattle ration and include
- legumes, non-legume hays, straw and silage of legume and
- grasses.
- Concentrates: grains and byproducts of grains and oilseeds
- constitute the concentrates. These include cereals (maize,
- sorghum, oats, barley), cotton seeds, industrial wastes (bran
- of wheat, rice, gram husk) and cakes of oilseeds (groundnut,
- sesame, rapeseed, soybean, linseed).
- Vitamins (A and D) and mineral mixtures (salt, Ca and P).
- The ration per animal per day: concentrates at 1 kg for 2 litres
- of milk, green fodder at 20-30 kg, straw 5-7 kg and water 32 l.

Goat rearing

- Breeds
- There are nearly 102 breeds of goats in the world, of
- which 20 breeds are in India.
- Milk and Meat (dual purpose) – Osmanabadi,
- Barberi, Jamnapari, Sangamneri, Mehasa &
- Zalwadi, Beetal , Ajmeri & Kachhi .
- Meat – Assam, Kali Bengali, Brown Bengali and
- Marwari.
- Wool – Angora, Gaddhi and Pashmina

- Housing
- Dry, comfortable, safe and secure place, free from
- worms and affording protection from excessive heat
- and inclement weather. The kitts are kept under
- large inverted baskets until they are old enough to
- run along with their mothers. Males and females are
- generally kept together. The space requirement for a
- goat is 4.5 to 5.4 sq m.

- Breeding and maintenance:
- Goat matures in about 6-7 months. Breeding is
- allowed for buck at one year and doe after 10 months
- of age. Gestation period is 145-155 days. It gives birth
- to 1-3 kitts per time. Number of evings are three per
- 2 year. The kitts cane be weaned after 30-45 days.
- Mother can be allowed for mating 45-60 days after
- eving. Once in five years, change the buck. When the
- young ones attain a body weight of about 25-30 kg in
- about nine months, they can be sold.

- Feeding
- They are essentially browsers and eat which any
- other animals won't touch. Goats eat 4-5 times that
- of their body weight. Since the profit depends on
- weight addition, adequate protein and calorie should
- be given to goats. They eat more of tree fodder and
- the rest with other grass species. Goats should be fed
- with concentrates of maize, wheat, horse gram,
- groundnut cake, fish meal and wheat bran. Common
- salt and vitamin mixtures should also be added.
- Abundant clean fresh water should be made
- available to the goats

Sheep rearing

- Breeds of Indian Sheep
- 1. The dry temperate Himalayan region: Gurez,
- Karanah, Bhakarwal, Gaddi, Rampur-Bushiar.
- 2. Dry western region: Lohi, Bikaneri, Marwahi,
- Kutchi, Kathiawari.
- Southern region: Decani, Nellore, 3. Bellary, Mandya,
- Bandur.

- Breeding and maintenance
- One ram for 40-50 ewes.
- Ewes in general do not come in heat at regular intervals
- but are seasonal in this respect.
- The duration of heat period is 1-3 days and 75% of ewes
- remain in heat for 21-39 hours.
- The optimum time of service is towards the end of heat
- period. Average heat interval is 18 days during the
- breeding season.
- The gestation period 142-152 days.
- A normal ram is in full vigour for breeding from the age
- of 2½-5 years.
- Sheep grow fully at two years of age and may be expected
- to produce about five crops of lambs

- Feeding
- 1-2 kg of leguminous hay per day depending on the
- age and body weight.
- Proteins may be supplied through concentrates (110-
- 225 g) such as groundnut cake, sesame cake or
- safflower cake when the pastures are poor in legumes
- or when scarcity conditions prevail.
- A mixture of common salt, ground limestone and
- sterilized bone meal in equal parts is required to
- alleviate deficiency of minerals in the feed

Poultry

- Breeds
- A majority of the stocks 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.
- Heavy breeds such as white Plymoth Rock, White
- Cornish and New Hampshire are used for cross-bred
- broiler chickens.
- It is best to start with the day old chicks

- Housing
- Adequate space should be provided for the birds.
- Floor area of about 0.2 m2 per adult bird is adequate
- for light breeds such as white Leghorn and about
- 0.3-0.4 m2 per bird for heavy breeds.
- The house should have good ventilation and
- reasonably cool in summer and warm during winter

- Maintenance
- Vaccination against Ranikhet diseases with F1 Strain
- vaccine within the first 6-7 days of age.
- One drop of vaccine may be administered in the eye and
- nostril.
- When chicks get the optimum body weight of 1.0-1.5
- around six weeks, they can be marketed for broiler.
- Hens may be retained upto the age of 1½ years.
- One hen is capable of laying 180-230 eggs in a year
- starting from the sixth month.
- In addition, a laying hen produces about 230 g of fresh
- droppings (75% moisture) daily

Piggery

Rabbit rearing

Bee keeping

Aqaculture

- Pond
- The depth of pond should be 1.5 to 2.0 m.
- Clay soils are best suited for fish rearing.
- Pond water should have appropriate proportion of nutrients,
- phosphate (0.2 -0.4 ppm), nitrate (0.06-0.1 ppm) and
- dissolved oxygen (5.0-7.0).
- Water should be slightly alkaline (pH 7.5-8.5).
- Application of fresh dung may also reduce high pH in the
- water.
- Soil of the pond should be tested for N and P content. If the
- nutrient content is less, fertilizers can be added.
- Organic manures such as FYM and poultry droppings may
- also be applied to promote the growth of phyto and
- zooplanktons.

- Management
- The fish are to be nourished with supplementary
- feeding with rice brands and oilseed cakes.
- Each variety of carps could be stocked to 500
- fingerlings with the total of 5000-8000 per ha.
- This stocking density will enable to get a maximum
- yield of 2000-5000 kg/ha of fish annually

- **Sericulture**
- **Mushroom cultivation**
- **Biogas plant**
- **Duck rearing**
- **Turkey rearing**
- **Pigeons for meat**
- **Japanese quail**
- Vemicomposting
- Agroforestry

CROPPING SYSTEM

The cropping patterns used on a farm and their interaction with farm resources, other farm enterprises, and available technology which determine their make up.

Cropping pattern

The yearly sequence and spatial arrangement of crops and fallow on a given area.

Cropping system comprises all components required for the production of a particular crop and the interrelationships between them and environment. In the cropping systems, sometimes a number of crops are grown together or they are grown separately at short intervals in the same field.

Multiple cropping

In agriculture, **multiple cropping** is the practice of growing two or more crops in the same piece of land during a single growing season. It is a form of polyculture.

- It is the practice of intensification of cropping system in time & space dimension that is more no. of crops within a year & more no. crops in a same piece of land.

Types of multiple cropping system

1) Sequential cropping
2) Inter cropping
3) Multi storied cropping

Sequential Cropping

- Growing two or more crops in sequence on the same field per year. The succeeding crop is planted after the preceding one has been harvested.
- Crop intensification is only in the time dimension.
- There is no intercrop competition.
- Farmers manage only one crop at a time.

Types of Sequential Cropping

1) **Double Cropping:** growing of 2 crops in a year.

   Eg: cowpea- bajra

   green gram- jowar

2) **Triple Cropping:** growing of 3 crops in a year.

Eg: Rice- potato-groundnut

Cowpea- mustard- jute

3) **Quadruple cropping**: growing of 4 crops in a year.

eg: maize – toria – potato - wheat

green gram - maize – toria – wheat

4) **Ratoon cropping/ stubble cultivation:** cultivation stubble re-growth after the harvest of the crop.

eg: sugar cane

mulberry

Inter cropping

- Growing two or more crops simultaneously on the same field per year.
- Crop intensification is in both time and space dimensions.
- There is intercrop competition during all or part of crop growth.
- Farmers manage more than one crop at a time in the same field.

Types of Inter cropping

1. ***Mixed intercropping:*** *Growing two or more crops simultaneously* with no distinct row arrangement.

   eg: wheat + mustard

   fodder maize + fodder cowpea

2. **Row *intercropping:*** *growing two or more crops* simultaneously with one or more crops planted in rows.

eg: cotton + chilly

ground nut + maize

- ***Strip intercropping:*** *Growing two or more crops simultaneously* in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact agronomically.

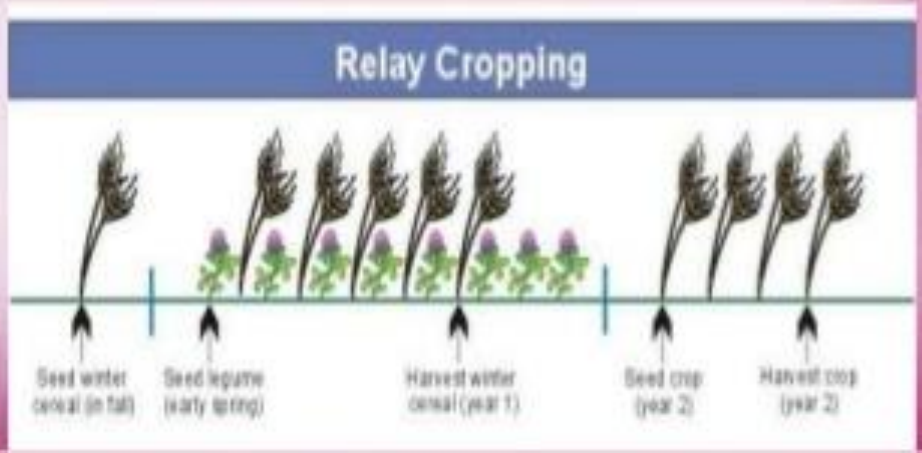
  eg:corn + alfalfa

  ragi+ groundnut

- ***Relay intercropping/over lapping cropping:*** *Growing two or more crops simultaneously* during part of each one's life cycle. A second crop is planted after the first crop has reached its reproductive stage of growth, but before it is ready for harvest.

  eg: rice + pulses

  potato + wheat



- **Alley Cropping:** is planting rows of trees at wide spacing with a companion crop grown in the alleyways between the rows. Alley cropping can diversify farm income, improve crop production and provide protection and conservation benefits to crops.

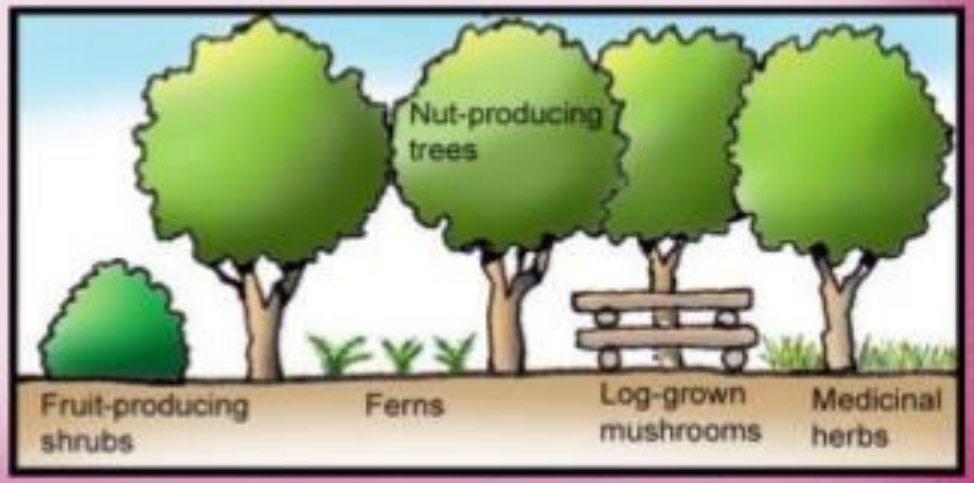
  eg: silver oak+ ragi

- **Ley farming** is a system of rotating crops with legume or grass pastures to improve soil structure and fertility and to disrupt pest and disease lifecycles. It has been practiced in many parts of the world for centuries.

  eg: grass + stylosanthu

Multi story cropping

- Growing plants of different height in the same field at the same time is termed as multistoried cropping.
- It is the practice of different crops of varying heights, rooting pattern and duration to cultivate together.
- It is mostly practiced in orchards and plantation crops.



Advantages multiple cropping

- With multiple cropping the risk of total loss from drought, pests and diseases is reduced. Some of the crops can survive and produce a yield.

- It gives maximum production from small plots. This can help farmers cope with land shortages.

- Including legumes in the cropping pattern helps maintain soil fertility by fixing nitrogen in the soil.

- Different types of crops can be produced, thereby providing a balanced diet for the family.
- Because of high planting density weeds are suppressed.
- Efficient uses of resources available.

CROPPING SYSTEM EFFICIENCY

- The objective of any **cropping system** is **efficient** utilization of all resources viz. land, water and solar radiation, maintaining stability in production and obtaining higher net returns. The **efficiency** is measured by the quantity of produce obtained per unit resource used in a given time.

Most efficient cropping systems of India

Mono cropping

Rice

Wheat

Maize

Sorghum

Groundnut

Mustard

Redgram

Gram

Cowpea

Soybean

Sugarcane

Cotton

Crop sequence

Rice – wheat

Maize - wheat

Groundnut – Barley/wheat

Pearl millet- Mustard

Gram – Mustard

Cotton –wheat

Cotton – Groundnut

Sorghum – Gram

Sesame –Chickpea

Soybean - Safflower

Sugarcane - Pulses

Inter cropping

Wheat + Raya

Maize + Peas

Pearl millet+ Gram

Toria + Gobhi Sarson

Mustard + Gram

Sugarcane + Potato

Sugarcane +

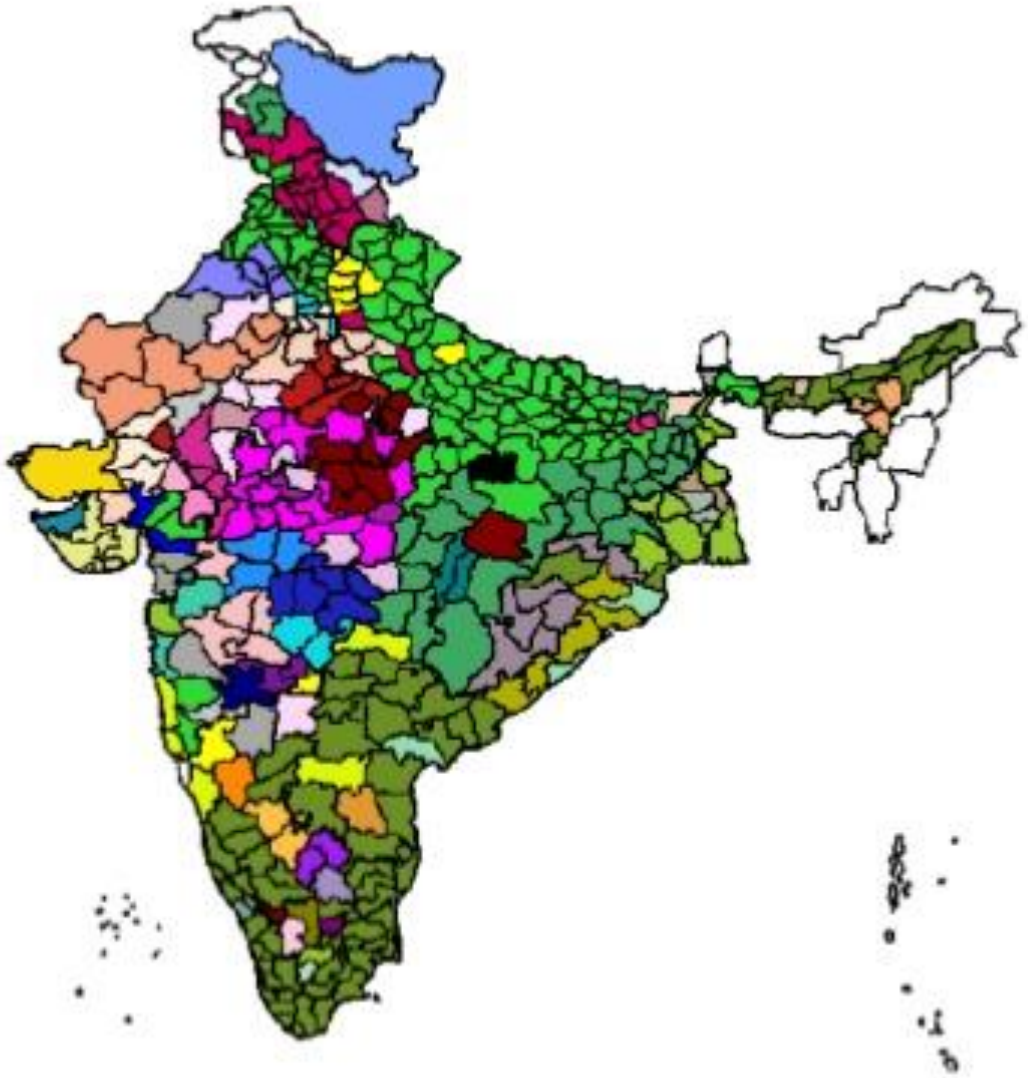
Frenchbean

Maize + Groundnut

Sorghum + Redgram

Sunflower + Cotton

Major Cropping Systems in India



- Rice – wheat (10.5 m ha)
- Rice – rice (5.89 m ha)
- Cotton – wheat (1.09 m ha)
- Soybean – wheat (2.23 m ha)
- Maize – wheat (1.86 m ha)
- P. millet - wheat (2.26 m ha)

Anon., 2014

Why the cropping systems evaluation is required..?

- To asses the system productivity maximization
- To evaluate the resource use efficiency
- To asses the ability to use inputs and their impact on environment



Conventional indices used in evaluation of Cropping systems

1. Land Equivalent Ratio (LER)
2. Crop Equivalent Yield (CEY)
3. Area Time Equivalent Ratio (ATER)
4. Relative Crowding Coefficient (RCC)
5. Aggressivity (A)
6. Competition Ratio (CR)
7. Cropping Intensity (CII)
8. Cropping Index (CI)
9. Multiple Cropping Index (MCI)
10. Relative Cropping intensity Index (RCI)

Present cropping system indices

Available Indices	Formula	Application	Drawback
Crop equivalent yield (CEY)	$CEY = \frac{Yba \times Pb}{Pa} + Yab$	Yield of one crop is converted into equivalent yield of other crop	Net income is not considered only grass in come is considered
Land Equivalent Ratio (LER)	$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$	Relative land area under sole crops	Its only yield advantage
Area Time Equivalent Ratio (ATER)	$ATER = \frac{LERa \times Da + LERb \times Db}{D}$	When the duration of inter crop is large	Not applicable for short duration difference in intercrops
Relative Crowding Coefficient (RCC)	$RCC = \frac{Yab}{Yaa - Yab}$	When intercrop has produced more or less than the expected yield than pure stand	• Not suitable in replacement series • 50:50 ratio is requiered

Aggressivity (A)	**A = LERa – LERb**	Measure how much the relative yield advantage increase in component 'a' than component 'b'.	It applicable only when crop mixture at 50:50 ratio.
Competition ratio (CR)	$CR = \frac{LER\ b}{LER\ a}$	It measures the competition between the intercrops	It applicable only when crop mixture at 50:50 ratio.
Cropping Intensity (CI)	$CI = \frac{\text{Total cropped area}}{\text{Net cropped area}} \times 100$	To calculated the cropping intensity	It suitable to calculated for large area
Cropping Index (CI)	$CI = \frac{\text{no. of Crops grown}}{} \times 100$	To know the crops index	It suitable to calculated for small area
MULTIPLE CROPPING INDEX(MCI)	$MCI = \frac{\sum_{i=1}}{A} \times 100$	Percentage utilization of land under multiple cropping systems.	
Relative Cropping Intensity index(RCII)	$RCII = \frac{\Sigma\ ak\ tk}{\Sigma\ aiti}$	To determine the amount of area and time allotted to one crop.	

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Recent approaches in evaluating cropping systems

Recent approaches are applied to agriculture for efficient utilization of all resources, maintaining stability in production and obtaining higher net returns.



1. System productivity
2. System profitability
3. Relative production efficiency (RPE)
4. Land use efficiency (LUE)
5. Energy efficiency (EE)
6. Specific energy (SE)
7. Energy productivity (EP)
8. Relative economic efficiency (REE)
9. Sustainability yield and value index (SYI)
10. Relative employment generation efficiency (REGE)
11. Radiation use efficiency (RUE)
12. Light interception

1. System productivity

System productivity:

- ✓ Yields of different crops are converted into single crop equivalent yield expressed as **kg/ha/day**

The equivalent yield should preferably be calculated

$$P = TP / R$$

Where,

P – Productivity (kg/ha/day)

TP – Total production (kg/ha)

R - Resource used (day)

2. System profitability

- Profit obtained by the crops & net returns is considered on hectare basis refers Rs/ha/ day.
- The time here is agricultural year (365 days)

$$\textbf{System profitability(Rs/ha/day)} = \frac{\textbf{Net return/ha}}{\textbf{365}}$$

Inference

- Higher the profitability shows better the system

3. Relative production efficiency

- Capacity of the system for production in relation to existing system and expressed in percentage.

$$RPE = \frac{(EYD - EYE)}{EYE} X\ 100$$

Where,

EYD- Equivalent yield under improved/diversified system

EYE- Existing system yield.

Inference

- ✓ **+ve** figures shows the superiority of the new system over the existing and desirable
- ✓ **-ve** figures shows inferiority over the existing system and not desirable
- ✓ Any positive figures of more than 20% are considered worth recommending for extension use.

4. Land use efficiency (LUE)

- It is the land use during the agricultural year

$$LUE(\%) = \frac{TND(i)}{365} \times 100$$

Where ,

TND (i)-Total number of days field remained occupied under different crops (i=1. ... n)

Inference

- Higher LUE denotes more use of the land in a year.
- Increased cropping intensity, the land use efficiency also improves.
- As higher the land use may not necessarily result in higher output from the system.

5. Energy efficiency (EE)

- Cultural energy utilized through inputs energy produced as products are calculated and expressed in Mega Joules (MJ)

$$\mathbf{EE} = \frac{\mathbf{Energy\ output}(\mathbf{MJ\ ha^{-1}})}{\mathbf{Energy\ input}\ (\mathbf{MJ\ ha^{-1}})}$$

Inference: Higher the ratio betters the system

6. Specific energy (SE)

- Specific energy of a treatment/system can be calculated in terms of energy required to produce a kg of main product and expressed in Mega Joules (MJ kg^{-1}).

$$\mathbf{SE} = \frac{\mathbf{Energy\ input\ (MJ\ ha^{-1})}}{\mathbf{Grain\ yield\ (kg\ ha^{-1})}}$$

Inference

- Lower the ratio better the treatment /system

8. Relative economic efficiency

- This is a comparative measure of economic gains over the existing system.

$$\text{REE}\ (\%) = \frac{\text{DNR} - \text{ENR}}{\text{ENR}} \text{ x } 100$$

Where,

DNR- Net return obtained under improved/diversified system

ENR- Net return in the existing system.

Inference

- Higher the economic efficiency better the system.

9. Sustainability Yield Index (SYI)

- The trend of yield over the year in systems reflects the sustainability yield of a cropping system.
- The sustainability yield index ranges from 0 to 1

$$SYI = \frac{Y - sd}{Y_{max}}$$

Where ,

SYI- Sustainability Yield Index,

Y- Average **yield** over years (n= 0, 1, 2, 3, 4....)

sd- Standard deviation

Y_{max} -Maximum yield obtained in any of the year.

Inference

- The value nearing unity shows higher stability reflecting that the system is higher sustainable.

10. SUSTAINABLE VALUE INDEX (SVI)

- ✓ In cropping system in which more than one crop is involved & the economic assessment is considered ideal than biological assessment.
- ✓ Minimum four year net profit data are required to calculate the Sustainable Value Index.

$$SVI = \frac{Y - sd}{Ymax}$$

Where

SVI - Sustainable Value index,

Y- Average **net profit** over years n,

sd -standard deviation

Ymax -maximum net profit obtained in any of the year

Inference

- The value nearing unity shows that the system is highly sustainable.

11. Relative employment generation efficiency (REGE)

$$REGE(\%) = \frac{MDD - MDE}{MDE} \times 100$$

Where

MDD: Total man days require in diversified system

MDE: Total man days require in existing system

Inference

Higher the percentage more employment generation through treatment/ system