

Tamil Nadu Agricultural University Coimbatore



AGR 204. Farming systems and Sustainable Agriculture (1+1) PRACTICAL MANUAL CUM RECORD II B.Sc. (Hons.) Agriculture



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Department of Agronomy
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THE INDIAN AGRICULTURE COLLEGE
(Affiliated to Tamil Nadu Agricultural University)



PRACTICAL MANUAL CUM RECORD
II B.Sc. (Agriculture)

AGR 204 Farming System & Sustainable Agriculture (1+1)

Compiled by

TAMIL NADU AGRICULTURAL UNIVERSITY

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AGR 204. Farming systems and Sustainable Agriculture (1+1)
PRACTICAL MANUAL CUM RECORD
II B.Sc. (Hons.) Agriculture
VI Semester

*Certified that this is the bonafide record of work done by
Mr/Mrs_____ ID. No. _____ in AGR 204.
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academic year.*

External examiner

Course Teacher

CONTENTS

NAME:

ID. No.

Ex. No.	Date	Name of the Exercise	Date of Submission	Signature
1.		Visit to cropping system experiments in wetland		
2.		Visit to cropping system experiments in irrigated upland and dryland.		
3.		Preparation of cropping scheme for wetland and working out input requirement.		
4.		Preparation of cropping scheme for irrigated upland and working out input requirement.		
5.		Calendar of operations for wet land and irrigated upland cropping system.		
6.		Working out indices for evaluating the cropping system - land use, yield advantage.		
7.		Working out indices for evaluating the cropping system - Economics, sustainability.		
8.		Visit to dairy, goat and poultry units.		
9.		Visit to mushroom unit.		
10.		Visit to sericulture and biogas units		
11.		Preparation of integrated farming system models: wetland ecosystem		
12.		Preparation of integrated farming system models: irrigated upland and dryland ecosystem		
13.		Resource recycling in integrated farming system models of different eco systems.		
14.		Evaluation of integrated farming system models : wetland eco-system.		
15.		Evaluation of integrated farming system models : irrigated upland and dryland eco systems.		
16.		On-farm visit to cropping fields and integrated farming system units.		

Visit to cropping system experiments in wetland

Agricultural ecosystem or agro-ecosystem:

It is composed of the total complex of the crops and animals in an area together with overall environment and as modified by management practices.

Crop ecology

The branch of 'plant ecology' which deals specifically with the study of the interrelation amongst crop plants and environment including management practices.

Crop ecosystems

Cropping systems ranging between monoculture and multi-species culture of field and garden crops, single or combination and their relation to environment conditions and management practices.

Cropping systems

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

Yearly sequential and spatial arrangement of crops, and crops and fallow on a given area is referred as cropping pattern (Usually representing larger landscape like district, delta region and state).

Cropping scheme

The annual farm plan according to which crops are raised on individual plots of a farm, with an objective of achieving the maximum returns from each crop without impairing fertility of the soil.

Farming

It is the process of cultivating crops, rearing livestock and fish etc.

Farming systems

Farming systems represent an appropriate combination of farm enterprises, viz. cropping systems, livestock, fisheries, forestry, poultry, and the means available to the farmer to raise them for profitability. It interacts adequately with the environment without dislocating the ecological and socio-economic balance on one hand, and attempts to meet the national goals on the other.

Wet land farming

It is the farming where crop production is successful when macro and micro pores of the soil are filled with moisture. E.g. Rice

Irrigated farming

Crop production depends on artificial application of water (at right time, at right quantity and at right place) to meet the crop water requirement.

Dry land farming

It is the farming or crop production where soil moisture availability is limited.

Rainfed farming

Growing of field crops entirely with rain water received during crop season (rainfall usually > 800 mm) under humid and sub-humid climates and the crops may face little or no moisture stress during their life-cycle

Diversified farm

A farm on which no single product or source of income equals as much as 50% of the total receipt and no such farm the farmer depends on several sources of income.

Subsistence farming

It is farming enterprise, which provides food and commodities just sufficient for the farming family, and there are no surplus to sell.

Sustainable agriculture

Sustainable agriculture should involve the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources.

Monoculture

The repetitive cultivation of a single crop on the same land in a year or over years.

Crop rotation

The cultivation of different crops on the same piece of land in a pre-planned succession.

Multiple cropping

The intensification of cropping in time and space dimensions. Growing two or more crops on the same field in a year.

Forms of multiple cropping**Intercropping**

Growing two or more crops simultaneously on the same field. Crop intensification is in both time and space dimensions. There is intercrop competition during all or part of crop growth.

(a) *Mixed intercropping*: Growing two or more crops simultaneously with no distinct row arrangement. It is referred to as mixed cropping. Ex: Sorghum, pearl millet and cowpea are mixed and broadcasted in rainfed conditions.

(b) *Row intercropping*: Growing two or more crops simultaneously where one or more crops are planted in rows. Often it is simply referred as intercropping. Maize + greengram (1:1), Maize + black gram (1:1), Groundnut + Redgram (6:1)

(c) *Strip intercropping*: Growing two or more crops simultaneously in strips wide enough to permit independent cultivation but narrow enough for the crops to interact agronomically. Ex. Groundnut + red gram (6:4) strip.

(d) *Relay intercropping*: Growing two or more crops simultaneously during the part of the life cycle of each. A second crop is planted after the first crop has reached its reproductive stage of growth, but, before it is ready for harvest. Often simply referred to as relay cropping. Rice- rice fallow pulse.

Advantages of intercropping

- Better use of growth resources including light, nutrients and water
- Suppression of weeds
- Yield stability; even if one crop fails due to unforeseen situations, another crop will yield and gives income
- Successful intercropping gives higher equivalent yields (yield of base crop + yield of intercrop), higher cropping intensity
- Reduced pest and disease incidences
- Improvement of soil health and agro-eco system

Sequential cropping

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

(a) *Double, triple and quadruple cropping*: Growing two, three and four crops, respectively, on the same land in a year in sequence.

Ex. Double cropping: Rice: cotton; Triple cropping: Rice: rice: pulses; Quadruple cropping: Tomato: ridge gourd: *Amaranthus* greens: baby corn

(b) *Ratoon cropping*: The cultivation of crop re-growth after harvest, although not necessarily for grain.

Ex. Sugarcane: ratoon; Sorghum: ratoon (for fodder).

Simple classification of Agricultural farms

a) Based on source of irrigation

- i) Rainfed
- ii) Irrigated

b) Based on water availability

- i) Wetland
- ii) Dryland

c) Based on elevation

- i) Upland
- ii) Lowland

Wetlands

Irrigated lowland is called as Wetlands.

Characteristics of Wetlands

- Plenty / copious availability of water
- Soils are normally clay based
- Fields are usually leveled
- Low erosion hazards
- Moderate to high inherent soil fertility
- Poor physical properties
- Have drainage problem

Rice based cropping systems

The cropping system adopted under lowland condition can be grouped into

1. All rice crop based cropping sequence
 1. Rice-Rice
 2. Rice-Rice-Rice
2. Rice-Irrigated dryland crop sequence
 1. Rice-Cotton
 2. Maize / Pulse-Rice-Groundnut
 3. Green manure-Rice-pulse

Possible farming systems in wetland ecosystem

- Crop + Fish + Poultry
- Crop + Fish + Duck
- Crop + Fish + Pigeon
- Crop + Fish + Poultry/pigeon + mushroom
- Crop + Fish + Mushroom
- Crop + Fish + Pig + Mushroom
- Crop + Fish + Goat

Exercises

1. Differentiate cropping pattern and cropping system
2. Classification of cropping systems with suitable examples
3. Promising rice based cropping systems in India
4. Write about observations made in the wet land farm regarding cropping systems experiment
5. List out the observations made on the characteristics of wet lands
6. Differentiate sequential cropping and crop rotation

Visit to cropping system experiments in Irrigated upland and Dryland ecosystem

Garden land (Irrigated upland)

Irrigated uplands are otherwise called as garden lands in Tamil Nadu.

Characteristics of garden lands

- Soils are mainly well drained
- Soils ranging from sandy loam to clay loam in texture
- Need based irrigation is practiced to crops
- Intensive cultivation is prevailed
- Choice of crops are wide
- Well developed soil physical properties
- Soil fertility is moderate
- Fields are levelled with desired slope
- Size of the field is small to medium
- Existence of well developed irrigation structures
- Moisture level in the micropores is controlled

Possible farming systems in garden land ecosystem

- Crop + Dairy + Biogas
- Crop + Dairy + Biogas + Sericulture
- Crop + Dairy + Biogas + Fishery
- Crop + Dairy + Biogas + Homestead garden + Sylvipasture
- Crop + Dairy + Biogas + Homestead garden + Silviculture + Apiculture.
- Crop + Dairy + Biogas + Spawn production + Mushroom
- Crop + Dairy + Biogas + Spawn production + Mushroom + Silviculture

Drylands

Rainfed dry uplands or lowlands are broadly classified as drylands.

Characteristics of drylands

- Soils ranged from sandy to clay loam in texture
- Drainage is not a problem
- Fully depend on rainfall and moisture from soil pool
- Partly leveled to undulating terrains
- Soil fertility is low to medium
- Fields are larger in size
- Moisture level in the micropores is uncontrolled.

Dry land based integrated farming system

- Crop + Goat
- Crop + Goat + Agroforestry
- Crop + Goat + Agroforestry + Horticulture
- Crop + Goat + Agroforestry + Horticulture + Farm pond
- Crop + Goat + Buffalo + Agroforestry + Farm pond
- Crop + Goat + Pigeon + Buffalo + Agroforestry + Farm pond
- Crop + Goat + Rabbit
-

Exercises

1. Write on the choice of crops for designing upland irrigated system
2. Observations on the visit of upland irrigated system for cropping system experiments
3. List out the choice of crops for dryland cropping system.
4. Define ley farming and sylvi-pasture system

Preparation of cropping scheme for wetland and working out input requirement

System

A system is defined as an arrangement of components that are interrelated, and interact among themselves according to some process and transform inputs into outputs.

Cropping pattern

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

Cropping system

The cropping patterns used on a farm and their interactions with farm resources, other farm enterprises and available technologies that determine their make-up.

Preparation of cropping scheme:

Cropping scheme is an annual plan of a farm indicating the crops and varieties to be grown, the season in which each crop and variety is to be raised and the area to be allocated for each crop and variety.

A well planned and well laid out cropping scheme will aim for,

- 1) Maximum returns from each crop
- 2) Efficient utilization of resources and
- 3) Maintenance of soil fertility over a long run.

Factors influencing the cropping scheme

1. Climate and seasonal conditions
2. Soil characters with reference to depth, texture, soil reactions, fertility, etc..
3. Monetary returns from various crops, price of produce and cost of cultivation.
4. Irrigation water-quality and duration of availability
5. Food grain requirements of the family
6. Fodder and feed requirements of cattle and other livestock
7. Labour availability, wages, skills, etc.
8. Credit availability
9. Storage, transport and marketing facilities
10. Input availability and price
11. Farm size
12. Soil fertility maintenance
13. Previous crops
14. Pest and disease incidence
15. Farmer's attitude, knowledge, skills and managerial ability
16. Influence of society, Government policies, taxes etc
17. Extent of hanization

Principles of cropping scheme

- **Area under building and layout**

A proportionate area is allocated for buildings and layout. If the farm area is 50 hectares or less, then the area under buildings and layout allocated is 8-10 per cent of the total area, if the farm area is more than 50 hectares then the area allocated is only 5 per cent.

- **Number of plots**

The number of plots should be either equal to the duration of rotation or a multiple of that e.g., if the total duration of rotations in a cropping scheme is 5 years, then the number of plots must be 5, 10, 15 or 20 etc.

- **Selection of the crops**

Selection of crops depends upon the situation of the farm as discussed below.

- **Near a city**

If the farm is near a city, the farmer should grow vegetables on at least 60% of his net cultivated area.

- **Near a sugar factory**

If the farm is situated near a sugar factory then the farmer should put at least 60% of his net cultivated area under sugarcane or sugar beet.

- **Near a canning factory**

- In such a locality, the farmer should grow vegetables, e.g., peas, tomato etc., on at least 60% of his net cultivated area.

- **Near a vanaspati factory**

- The farmer should grow oil seed crops, e.g., groundnut, sunflower, etc. in such a locality.

- **Near a dairy farm**

- If the farm is located near a dairy farm, the owner should go for fodder cultivation. Apart from fodder he can raise oil seeds and pulses on 10-15% of his net cultivated area.

- **Near a cold storage**

In such areas, the farmer should grow potatoes, onion etc.

- **Near a highway or railway station**

Then farmer can go for perishable crops like vegetables etc. In such cases, the farm is considered to be within the proximity of a city area.

- **Facilities available on the farm**

Selection of crops also depends upon the facilities for power, irrigation, inputs, labour, transport, etc.

- **Area of individual plots**

The area of individual plots should be equal unless topography, soil conditions or any other person compels the farmer to layout.

- **Area allotted to crops for calculation of cropping intensity**

If the farmer takes crop mixtures then the relative area under different crops has to be considered so that none of them are adversely affected due to their mutual competition.

A crop planning which can utilize inputs and other resources available on the farm without wastage should be adopted

Advantages of cropping scheme

1. Advance planning to meet the objectives
2. Assessment of input requirement in advance and arranging for purchase and stocking
3. Advance arrangements for labour and machinery
4. Proper scheduling of farm operations for smooth implementation.
5. Anticipation of problems and finding remedies.

Time of preparation

Cropping scheme can be prepared during the summer months of April, May before the commencement of regular cropping season in June.

Steps in preparing a cropping scheme

1. Describing the availability of all resources
2. Determine specific objectives/requirements of the farmer
3. Selection of crop and varieties
4. Deciding the season
5. Fixing area for each crop and variety during different season
6. Preparing the calendar of operations.
7. Estimation of input requirements

Cropping Intensity:

$$\text{Cropping Intensity} = \frac{\text{Gross cultivated area in a year}}{\text{Net cultivable area}} \times 100$$

Example:

Net cultivable area	:	1 ha
Crop rotation	:	Green manure (1 ha) - Rice(1 ha) - Pulses(1 ha)
Total cropped area	:	3 ha
		3
Cropping intensity	=	$\frac{3}{1} \times 100 = 300\%$

Rotational Intensity:

This is calculated by counting the number of crops grown in a rotation and is multiplied by 100 and then divided by the duration of the rotation.

$$\text{Rotational Intensity} = \frac{\text{Number of crops grown during the crop rotation}}{\text{Duration of the crop rotation}} \times 100$$

Example:

Crop rotation

Green manure - Rice - Pulses : 1 year

Rice - Rice - Pulses : 1 year

Green manure - Rice - Fallow : 1 year

8

$$\text{Rotational intensity} = \frac{8}{3} \times 100 = 267\%$$

Working out Input Requirements (Different Crops and Cropping System)

The various kinds of agricultural inputs on crop production are to be organized effectively to improve the productivity level of crops and to maintain soil health on long run. The different form of inputs includes farm ushers great dividends. The important inputs are seeds, manures and fertilizers, plant protection chemicals, products used for seed treatment and growth promoting substances, besides water and labour.

Factors influencing the extent of input usage

1. Crops and cropping systems adopted
2. Type of farming
3. Water availability - source quantity, quality and duration of availability
4. Size of land holding
5. Managerial ability of the farmer
6. Degree of mechanization
7. Extent of mechanization
8. Purchasing power of the farmer
9. Credit facilities available
10. Government policies

Exercise

1. Prepare a suitable cropping scheme for a wetland farm having the following resources

Farm Size	5 ha (Number of fields 5)
Soil Type	Heavy Clay
Irrigation	Canal irrigation (From last week of June to Middle of January)
Crops of the Region	Rice (Short, Medium duration and Samba long duration varieties); Pulses (Black gram, Green gram); Green manure (Daincha)

- a. Work out the cropping intensity for the cropping schemes prepared
- b. Justify for the crops and varieties chosen
- c. Suggest improvement measures for effective resource utilization and management

2. Work out the input requirement (seeds, manure, biofertilizers, biocontrol agents for seed treatments, herbicides and fertilizers) for the proposed cropping scheme

Preparation of cropping scheme for irrigated upland and working out input requirement

Irrigated upland

The land supplied with water from underground i.e., irrigated uplands. Crops grown in these lands are irrigated through lift irrigation and hence water is under control.

Irrigated upland cropping pattern

Cotton	-	Sorghum	-	Ragi
(Aug-Feb)		(Feb-May)		(June-Aug)

Sorghum	-	Fodder sorghum	-	Cotton
(Aug-Nov)		(Nov-Jan)		(Feb-July)

High intensive cropping system for garden land

Cotton +Onion/Black gram	-	Sorghum + Cowpea	-	Ragi + Onion
(Aug-Feb)		(Feb-May)		(June-Aug)

The various kinds of agricultural inputs on crop production are to be organized effectively to improve the productivity level of crops and to maintain soil health on long run. The different form of inputs includes farm ushers great dividends. The important inputs are seeds, manures and fertilizers, plant protection chemicals, products used for seed treatment and growth promoting substances, besides water and labour.

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4. Size of land holding
5. Managerial ability of the farmer
6. Degree of mechanization
7. Extent of mechanization
8. Purchasing power of the farmer
9. Credit facilities available
10. Government policies

Exercise

1. Prepare a suitable cropping scheme for irrigated upland farm having the following resources.

Location	10 km away from district headquarters
Farm size	5.0 ha (Gross cultivable area)
Soil type	Red loamy (1.5 ha) & Black cotton soil (1.0 ha)
Irrigation	Bore well fitted with 10 HP submersible motor. Water available through- out the year for the entire farm, however an area of 1.0 ha alone could be irrigated during summer.
Crops of the region	Sorghum, Maize, Cotton, Red gram, Groundnut, Black gram, Cowpea, Vegetables, Coconut, Sugarcane, Mulberry, Trees , Fodder crops
Livestock	2 pairs of work animal and 3 cross bred Jersey cows with two calves

- Work out the cropping intensity and rotational intensity for the cropping schemes prepared
- Justify for the crops and varieties chosen
- Suggest improvement measures for effective resource utilization and management
- Work out the input requirement for the proposed cropping scheme

2. Prepare a suitable cropping scheme for a dry land farm having the following resources.

Farm size	4.00 ha (net cultivable area)
Soil type	Red and black soil in equal distribution
Rainfall	Average annual rainfall - 450 mm (30% during SWM and 45% during NEM season)
Crops of the region	Sorghum, Groundnut, Castor, Horse gram, finger millet, Red gram, Black gram, Green gram, Cowpea, Lablab, Maize
Other activities	Goat rearing (10 nos.), Agro-forestry, Silvi-pasture, fruit trees.

- Work out the cropping intensity and rotational intensity for the cropping schemes prepared
- Justify for the crops and varieties chosen
- Suggest improvement measures for effective resource utilization and management
- Work out the input requirement for the proposed cropping scheme

3. Work out the inputs like seed, manure and fertilizer requirement for the proposed cropping scheme

Ex. No: 5

Date:

Calendar of operations for wet land and irrigated upland cropping system

Calendar of operation

Calendar of operation is the schedule of operations to be carried out during each month of a cropping year. It furnishes information on requirements of inputs and periodicity of operations. It is drawn based on the cropping scheme already prepared for the farm

Advantages

- It helps the farmers to carryout operations in time without any delay.
- It helps in assessing the input requirements like seeds, fertilizers, and pesticides, labour and arrange to purchase/plan in advance
- It helps to arrange for storage and marketing of produces and products.

The calendar of operations has to be prepared in the following format

Crop:

Variety:

Season:

Area:

Date	Operation	Manures and fertilizers					Plant Protection Measures	Power		Labor		Cost
		FYM	Urea	SSP	MOP	Bio		Mech.	Animal	Hired	Family	

1. Prepare a suitable calendar of operations for a wetland farm having the following resources

i.	Farm size	5 ha (Number of fields = 5)
ii.	Soil type	Heavy clay
iii.	Irrigation	Canal irrigation (Farm last week of June to middle of January)
iv.	Crops of the region	Rice (short, medium duration and samba varieties) Pulses Black gram, green gram); Green manure (Daincha)

2. Prepare a suitable calendar of operations for irrigated upland farm having the following resources

i.	Location	Near to city
ii.	Farm size	5 ac
iii.	Soil type	Red loamy soil
iv.	Irrigation	Bore well fitted with 7.5 HP submersible motor. Water available for the whole year.
v.	Crops of the Region	High value irrigated uplandcrops

Working out indices for evaluating the cropping system - land use and yield advantage.

Evaluation of cropping system

Various types of cropping systems are practiced in a farm/region. They are to be properly evaluated to find out their stability and relative advantage. Such a comparison may be made with reference to land use efficiency, biology potential, economic variability, etc. Differences indices are used in many forms of data summary to combine information. If we wish to compare systems of cropping involving two or more measurements, then we must either accept that the systems are not comparable because they differ in several aspects or convert yields into a single scale. Some of the important indices to evaluate the cropping systems are presented in this chapter.

Multiple Cropping Index (MCI)

Proposed by Dalrymple (1971).

It is calculated by dividing the total crop area by total cultivated land area and multiplying by 100

$$\text{MCI} = \frac{\sum_{i=1}^n a_i}{A} \times 100$$

Where

n = Total no of crops

a_i = area occupied by ith crop planted and harvested within a year

A = total land area

ii) Cropping intensity / Intensity of cropping (CI)

$$\begin{aligned} \text{CI} &= \frac{\text{Total cropping area} \times 100}{\text{Net cultivated area}} \\ &= \frac{\text{Area under Kharif} + \text{Rabi} + \text{Zaid crops} \times 100}{\text{Area under actual cultivation}} \end{aligned}$$

Cultivated Land Utilization Index (CLUI)

Proposed by Chuang (1973).

$$\text{Cultivated Land Utilization Index (CLUI)} = \frac{\sum_{i=1}^n a_i d_i}{A \times 365}$$

$$\text{Cultivated Land Utilization Index (CLUI)} = \frac{\sum_{i=1}^n a_i d_i}{A \times 365}$$

Diversity Index (DI)

Proposed by Strout (1975) and Wang and Yu (1975).

It measures the multiplicity of crops or farm products, which are planted in a year by computing the reciprocal of sum of squares of the share of gross revenue received from each individual farm enterprise in a single year.

In the following farms, which farm is mostly specialized?

CROP	A	B	C
Sugarcane	30000	-	-
Cotton	10000	20000	10000
Wheat	40000	20000	20000
Jowar	20000	10000	10000
Potato	-	50000	40000
TOTAL	100000	100000	80000

Diversity Index

$$\text{Farm A} = 1.00 \div 0.30 = 3.330$$

$$\text{Farm B} = 1.00 \div 0.34 = 2.940$$

$$\text{Farm C} = 1.00 \div 0.3437 = 2.909$$

Therefore, Farm 'A' is more diversified and Farm C is more specialized. Lower is the diversity Index, higher is the specialization.

Rotational Intensity (RI)

$$\text{RI} = (\text{No. of crops grown in a field} \div \text{Years of rotation}) \times 100$$

e.g., Maize – Potato - Onion: 1 year

$$\text{RI} = (3 \div 1) \times 100 = 300\%$$

*Crop taken as green manure is not considered as crop grown.

Land Equivalent Ratio (LER):

It denotes relative land area under sole crop required to give the same yield as obtained under a mixed or an intercropping system at the same level of management. It is the ratio of land required by pure crop to produce the same yields as that of intercrop,

$$\text{Land equivalent Ratio} = \frac{Y_a}{S_a} + \frac{Y_b}{S_b}$$

Y_a and Y_b = Yield of individual crops a & b respectively in mixture.

S_a and S_b = Yield of individual crops a & b respectively in pure stand.

Let, $L_a = 0.70$ and $L_b = 0.40$

$LER = 1.10$ means, to produce the combined mixture yield by growing in pure stands would require 10% more land and i.e. the mixture gives 10% yield advantage.

Thus it gives a better picture of the competitive abilities of the component crops. It also gives actual yield advantage of intercropping. In another words LER is the unit to measure the production efficiency of different intercropping system by converting the production in terms of land acreage. LER gives an accurate assessment of the biological efficiency of intercropping.

When $LER > 1$, intercropping is beneficial.

Example

Yield of groundnut and pigeon pea as sole crops were 1000 and 500 kg ha⁻¹. Corresponding yield in intercropping was 700 and 400 kg ha⁻¹. Price of pigeon pea is Rs. 12 kg⁻¹ and that of groundnut Rs. 10 kg⁻¹. Calculate LER and total monetary returns due to intercropping?

Solution

$$LER = 700/1000 + 400/500 = 1.5$$

Monetary Advantage

Financial value of sole groundnut = $1000 \times 10 = \text{Rs. } 10,000$.

Financial value of sole pigeon pea = $500 \times 12 = \text{Rs. } 6,000$.

Financial value of sole groundnut = $700 \times 10 = \text{Rs. } 7,000$.

Financial value of sole groundnut = $400 \times 12 = \text{Rs. } 4,800$.

There are two different objectives for which such indices have been proposed. The first is the assessment of the benefit or overall advantage of intercropping and the second is the assessment of the relative performance of the two crops, the concept of dominance or competitiveness. It is important not to confuse these two objectives, which should be quite separate conceptually. The RYT and LER is the main index of advantage currently used.

Relative Crowding Coefficient (RCC)

Proposed by Dewit (1960).

It is used in replacement series of intercropping. It indicates whether a species or crop, when grown in mixed population, has produced more or less yielded than expected in pure stand.

In 50:50 mixture

$$RCC = (\text{Mixture yield of a}) \div (\text{Pure stand yield of a} - \text{mixture yield of a})$$

$$K_{ab} = \frac{Y_{ab}}{(Y_{aa} - Y_{ab})}$$

For all mixture

$$Kab = \frac{Yab \times Zba}{(Yaa - Yab) \times Zab}$$

Yab = Mixture yield of a crop grown with b

Yba = Mixture yield of a crop grown with a

Yaa= Mixture yield of a crop grown with a

Ybb= Mixture yield of a crop grown with b

Zab= proportion of sown spp. a in mixture with b.

Zba= proportion of sown spp. b in mixture with a

RCC>1 Means yield advantage (more yield than expected)

RCC=1 No difference, RCC<1 Yield disadvantage

Crowding coefficient and LER give the yield advantage but only LER give the magnitude of advantage. Therefore, LER is preferred to assess the competition effects and yield advantage in intercropping situations.

Aggressvity

Proposed by McGihrist (1965).

It is the mixture of how much the relative yield increase in component a is greater than that for component b.

Aab = (Mixture yield of a ÷ Expected yield of a) - (Mixture yield of b ÷ Expected yield of b)

$$Aab = \frac{Yab}{Yaa \times Zab} - \frac{Yba}{Ybb \times Zba}$$

Aab = 0 means component crops are equally competitive

Aab= negative means dominated

Aab= bigger value either positive or negative means bigger difference in competitive abilities.

Aggresivity and crowding coefficient can be used only in replacement series whereas LER in both replacement and additive series.

Competition Index (CI):

Proposed by **Donald (1963)**.

It is a measure to find out the yield of various crops when grown together as well as separately.

In indicates the yield per plant of different crops in mixture and their respective pure stand on a unit area basis.

If the yield of any crop, grown together is less than its respective yield in pure stand then it is harmful association but on increased yield means positive benefits.

$$\text{Competition index} = \frac{(Y_{aa} - Y_{ab}) \times (Y_{bb} - Y_{ba})}{Y_{aa} \times Y_{bb}}$$

The CI values of <1 indicates a positive benefit and the crops can be grown in association, whereas the values of >1 shows a harmful association.

Indices for assessing yield advantage in the cropping system

1. Crop yields

Cropping systems are evaluated by quantifying the economic produce from component crops expressed as kg ha⁻¹ or tonnes ha⁻¹

2. Crop productivity

Crop productivity is calculated by dividing crop yields with its duration and expressed as kg ha⁻¹ day⁻¹

3. Crop equivalent yield

To assess the yield advantage of multiple cropping sequences, it is not possible to compare the economic produce of one crop to another. The yield of rice cannot be compared with the yield of maize or legumes from the same land. In such situations, comparisons are to be made based on economic returns (gross or net returns) or Crop equivalent yields (CEY) are used which, refers to the yields of different crops are converted into equivalent yield of any one crop based on price of the produces.

$$\text{Crop Equivalent Yield (CEY)} = \frac{\sum_{i=1}^n (y_i \times v_i)}{P(B)}$$

Where

n = Number of crop grown

y_i = yield of ith crop (kgs.)

v_i = value of ith crop produce (₹ kg⁻¹)

P(B) = Price of the produce ((₹ kg⁻¹)

4. System productivity

System productivity is calculated by dividing crop equivalent yield from a system of unit area in an year with 365 days and expressed as kg ha⁻¹ day⁻¹

5. Relative Production Efficiency

Relative productive efficiency is calculated by the following formula and expressed in percentage

$$= \frac{\text{Crop equivalent yield from improved system} - \text{Crop equivalent yield from traditional system from unit area}}{\text{Crop equivalent yield from traditional system from unit area}} \times 100$$

Exercise:

1. Calculate LER, RCC, Aggressivity, Competition index from the given particulars and interpret the results.

Sl. No.	Treatments	Yield (kg/ha)	
		Base crop	Intercrop
1.	Sorghum (CSH.9) + Pigeon pea (Co.5) in 2:1 additive series	2401	358
2.	Sorghum + Pigeon pea (3:3)	2167	420
3.	Sorghum + Sunflower (3:3)	1784	636
4.	Sorghum + Green gram (3:3)	2006	536
5.	Sorghum + Pigeon pea (4:2)	2340	327
6.	Sorghum + Sunflower (4:2)	2130	494
7.	Sorghum + Green gram (4:2)	2389	537
8.	Sole sorghum	2531	-
9.	Sole pigeon pea	-	654
10.	sunflower	-	1531
11.	Sole Green gram	-	1012

Marketable Price of Sorghum grain = Rs. 6/kg, Marketable price of Sunflower = Rs. 12/kg

Working out indices for evaluating the cropping system – Economics and sustainability

Gross Returns

The total monetary returns of the economic produce such as grain, tuber, bulb, fruit, etc. and byproducts viz. straw, fodder, fuel etc. obtained from the crops included in the system are calculated based on the local market prices. The total return is expressed in terms of unit area, usually one hectare. The main draw back in this calculation is that market price of the produce is higher than that actually obtained by the farmer. Generally gross return calculated is somewhat inflated compared to the actual receipt obtained by the farmer.

Net returns or net profit:

This is worked out by subtracting the total cost of cultivation from the returns. This value gives the actual profit obtained by the farmer. In this type of calculation only the variable costs are considered. Fixed costs such as rent for the land, land revenue, interest on capital etc. are not included. For a realistic estimate, however, fixed costs should also be included.

Return Per Rupee Invested:

This is also called benefit-cost-ratio or input- output ratio. This index provides an estimate of the benefit derived and expenditure incurred by the farmer in adopting a particular cropping system. Anything above the value of 2.0 (meaning that the farmer can get RS.2 as return for every rupee invested) can be considered profitable.

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (₹)}}{\text{Cost of cultivation (₹)}}$$

Per Day Return:

This is called as income per day and can be obtained by dividing the net return by number of cropping period (days). This gives the efficiency of the cropping system in terms of monetary value. If the system is stretched over one year, the denominator can be replaced by 365 days and per day for the whole year can be calculated.

$$\text{Per day returns} = \frac{\text{Net returns (₹)}}{\text{Cropping period (Days)}}$$

Sustainable yield index:

Sustainable yield index is calculated by the formula

$$\text{Sustainable yield Index} = \frac{\text{Mean of yields} - \text{Standard deviation for yields}}{\text{Maximum yield over years}}$$

Instead of yields, if net returns are used in the formula, it is referred as sustainable value index

1. Work out MCI, DI, CLUI, and Cropping intensity for the given particulars.

Sl.No.	Crop			Field No.	Area (Ha)
	I	II	III		
I	Rice (160 days)	Gingelly (90 days)	-	A1	0.75
				A2	0.60
				A3	0.75
				A4	0.40
II	Rice (110) days	Rice (135) days	Black gram (60 days)	B1	1.0
				B2	1.5
				C1	0.25
				C2	0.50
III	Rice (135 days)	Cotton (135) days	Green Manure (45 days)	C3	0.25

2. Workout the above indices for the proposed cropping scheme of wet land, irrigated upland and dry land

Visit to dairy, goat and poultry units

1. Dairy**Importance:**

- It could provide constant income throughout year
- Success depends on availability of feed, fodder and marketing facilities of milk

Dairy breeds**Jersey cross bred cows**

Suitable for all conditions

Takes less feed and fodder
Give more milk with high fat

Possess better disease resistance

Holstein-Friesian cross

Reared for higher milk
and yield

Require cool climate

Buffalo (Murrah)

Digests more of roughages

Thrive well on dry fodder
Buffalo contribute 60% milk
to national grid

High profit can be obtained

2. Goat rearing

Goat is a multi-functional animal and plays a significant role in the economy and nutrition of landless, small and marginal farmers in the country. Goat rearing is an enterprise which has been practiced by a large section of population in rural areas. Goats can efficiently survive on available shrubs and trees in adverse harsh environment in low fertility lands where no other crop can be grown.

The advantages of goat rearing are:

- The initial investment needed for Goat farming is low. Due to small body size and docile nature, housing requirements and management problems with goats are less.
- Goats are prolific breeders and achieve sexual maturity at the age of 10-12 months gestation period in goats is short and at the age of 16-17 months it starts giving milk. Twinning is very common and triplets and quadruplets are rare.
- In drought prone areas risk of goat farming is very much less as compared to other livestock species.
- Goats are ideal for mixed species grazing. The animal can thrive well on wide variety of thorny bushes, weeds, crop residues, agricultural by-products unsuitable for human consumption.

- The goat meat is more lean (low cholesterol) and relatively good for people who prefer low energy diet especially in summer and sometimes goat meat (chevon) is preferred over mutton because of its "chewability"
- Goat milk is easy to digest than cow milk because of small fat globules and is naturally homogenized. Goat milk is said to play a role in improving appetite and digestive efficiency. Goat milk is non-allergic as compared to cow milk and it has anti-fungal and anti-bacterial properties and can be used for treating urogenital diseases of fungal origin.
- Goats are 2.5 times more economical than sheep on free range grazing under semi-arid conditions.
- Goat creates employment to the rural poor besides effectively utilizing unpaid family labor. There is ample scope for establishing cottage industries based on goat meat and milk products and value addition to skin and fiber.

3. Poultry

Poultry is integrated in IFS condition for nutrition, employment and to meet out the meat and egg requirement of family. India ranks the world's 5th largest egg producing country but in terms of per capita availability, it would rank the lowest per capita of poultry products. Currently, it is estimated to be less than 30 eggs and 100g poultry meat per year.

A matured bird of good stock lays 14 kg of egg in a year numbering about 250 which is 8-9 times its body weight. Similarly, a good broiler in 6-7 weeks attains a weight of 1.4-1.7 kg with feed conversion ratio of 2.2 to 2.3. The capital investment/ bird in a layer farm averages Rs.80, in broiler Rs. 55. The net profit amounts to Rs.1.50/layer/month. The net profit amounts to Rs.2/ broiler/month.

Exercise:

1. Write in detail about the visits made by you to different components in the practical class.
2. Write about the input requirements for successful management of livestock, goat and poultry.

Visit to mushroom unit

Mushroom cultivation:

Mushroom cultivation is an important component in Integrated farming system. It can be profitable in areas where agricultural residues are abundantly available. Mushroom can be made as profitable agribusiness particularly for small and marginal farmers, landless laborers, unemployed youth and young entrepreneurs.

Mushroom is a fruiting body, technically called as **sporophore**, which produces and disseminates large number of spores, called needles of this plant. It lacks chlorophyll, so that it depends on other living or dead plant for its food.

Edible mushrooms occur during rainy season and used as delicious food. More than 10,000 species are used as food in the world and about 70 species are suited for artificial cultivation.

Types of cultivated mushrooms:

- | | | |
|-----------------------------|---|-----------------------------|
| 1. Paddy straw mushroom | - | <i>Volvariella volvacea</i> |
| 2. Oyster mushroom | - | <i>Pleurotus sp.</i> |
| 3. Button/European mushroom | - | <i>Agaricus bisporus</i> |

Exercise:

1. Make a critical review on your visit to mushroom unit
2. Write about the input requirements for successful mushroom cultivation.

Visit to sericulture and biogas units

I. Sericulture

Sericulture is defined as a practice of combining mulberry cultivation, silk worm rearing and silk reeling. Cultivation of mulberry plants is called as 'Moriculture'. There are about 20 species of mulberry, of which four are commonly cultivated. They are *Morus balba*, *M. indica* and *M. latifolia*. The crop can yield well for 12 years, after which they are pulled out and fresh planting is done. Yield of mulberry leaves is 30-40 t/ha/year.

Silkworm rearing

There are four types of silk worm

- a. Mulberry silk worm - *Bombyx mori*
- b. Eri silk worm - *Philosa miaricini*
- c. Tassar silk worm - *Antheraea mylitta*
- d. Muga silk worm - *Antheraea assami*

II. Biogas

Biogas means a gas produced by the anaerobic digestion or fermentation of organic matter. The organic matter can be manure, sewage sludge, municipal solid waste, biodegradable waste or any other biodegradable feedstock. Biogas is mainly methane and carbon dioxide. Biogas is practically produced as landfill gas (LFG) or digested gas.

Composition of biogas

Components	Composition (%)
Methane	50-75
Carbon di oxide	25-50
Nitrogen	0-10
Hydrogen	0-1
Hydrogen sulphide	0-3
Oxygen	0-1

A biogas plant is the name often given to an anaerobic digester that treats farm wastes or energy crops. It can be produced using anaerobic digesters. These plants can be fed with energy crops such as maize silage or any biodegradable wastes including sewage sludge and food waste. During the process, an airtight tank transforms biomass waste into methane producing renewable energy that can be used for heating, electricity, and many other operations that use an internal combustion engine, such as GE Jenbacher gas engines.

The methane in biogas is 20 times more potent a greenhouse gas than carbon dioxide. Therefore, uncontained landfill gas, which escapes into the atmosphere, may significantly contribute to the effects of global warming. In addition, volatile organic compounds (VOC's) in landfill gas contribute to the formation of photochemical smog. It is one of the alternatives to alleviate energy crisis in the farm sector. In addition it gives good quality manure devoid of weed seeds. About 208 million kg of dung is available per day and it is possible to produce 8.4 million m³ of biogas / day. But only 7% of dung is utilized for biogas production. About one lakh biogas plant of 4 m³ capacity each requiring about 100 kg of dung/day could be possible with the available manure in the state. Apart from cattle dung, wastes from birds, sericulture, goat, field wastes can be used for biogas production. From cow dung which comprises of 60 % methane and 40% of CO₂ was used as a fumigant in specially designed air tight bin of one quintal capacity for the control of storage insects of pulses in seeds and grains of pigeon pea. Three jersey cross bred milch cows with 2 calves can be included as component under Integrated farming system. For effective recycling of farm and animal waste a bio-gas unit of 2 m³ capacity can be installed for the production of fuel, light and enriched manure. Sixty kg of cow dung expected out of 5 animals is sufficient enough to produce 2 m³ of gas every day which is equivalent to 1.5 litres kerosene. By this recycling, some of the weed seeds present in the raw cow dung also get killed during digestion process, thus improving the quality of the slurry over its raw material used viz., cow dung. The quality improvement by way of recycling the cow dung through bio gas chamber was studied by analyzing the NPK content of slurry and FYM prepared utilizing the cow dung from the system. Recycling of 730 m³ of biogas with the possibility of enhancing the nutrient value of NPK to the tune of 44.5 kg, 65.9 kg and 28 kg respectively in a year. The calorific value of biogas is 3600 k Cal m³. Bio gas can be used for cooking, lighting and as a substitute for diesel. Digested slurry from the biogas plant is a superior organic manure as it has narrow C:N ratio, low per cent of weed seed and colourless. Biogas plant size is decided based on number of animals and quantity of dung.

Exercise:

1. Make a critical review on your sericulture and biogas unit
2. Write about the rearing and maintenance of silkworms.
3. Write about the types of biogas plants and their capacity& output.

Preparation and evaluation of integrated farming system models: Wetland eco-system

Farming with crop cultivation alone will encounter certain specific problems like unstable income, under employment of farm family members and improper utilization of resources available in the farm. Integrated farming with allied activities like dairying, poultry, fishery, sheep and goat rearing, piggery, rabbit rearing, duck farming, pigeon rearing, sericulture, apiary, mushroom production, biogas production, homestead garden and fruit tree cultivation and agro-forestry would result in stability of farm income with proper distribution of employment. Integration of two or more appropriate and feasible activities/ components/ enterprises ushers great dividends to the farmer.

Advantages of Integrated Farming System

- Higher food production to equate the demand of the exploding population.
- Increased farm income through proper residue recycling and allied components. □ Sustainable soil fertility and productivity through organic waste recycling.
- Integration of allied activities will result in the availability of nutritional food enriched with protein, carbohydrate, fat, minerals and vitamins.
- Integrated farming will help in environmental protection through effective recycling of waste from animal activities like piggery, poultry and pigeon rearing.
- Reduced production cost of components through the products like egg, mushroom, vegetables, honey and silkworm cocoons from the lined activities in integrated farming.
- Possibility of adopting improved package of technology for crop cultivation through the regular income realized from integrated farming system components.
- Inclusion of biogas and agro-forestry in integrated farming system will solve the energy crisis.
- Cultivation of fodder crops as intercropping and in border cropping will result in the availability of adequate nutritious fodder for animal components like milch cow, goat and sheep, pig and rabbit.
- Firewood and construction wood requirements could be met from the agro-forestry system without affecting the natural forest.
- Avoidance of soil loss through erosion by agro-forestry and proper cultivation of each part of land by integrated farming.
- Generation of regular employment for the farm family members of small and marginal farmers
- Development of revenue paying allied farm activities at village level through integrated farming.
- Integrated farming system models will vary widely in each agro-climatic zones with very high location specific natural resource availability like rainfall, and other climatic factors, soil types and market demand. Depending upon the agro-ecological condition and successful cropping systems adopted in each zone, specific farming system models were proposed based on the

research carried out and could be recommended with slight modification for each agro-climatic zones of Tamil Nadu.

Factors influencing the selection and size of components in Farming Systems

- Climatic conditions- Rainfall, temperature, solar radiation, wind, humidity etc.
- Soil type
- Farmers preferences
- Size of the Farm
- Knowledge, skill and technology
- Storage, transport and marketing
- Resource mobilizing power of the farmer
- Credit facilities available
- Socio-economic condition
- Customs, sentiments and believes

Steps involved in the preparation of a model Integrated Farming System to a specific situation

1. Assessment of available resources
2. Identifying the existing cropping system
3. Identifying component(s) to be integrated
4. Fixing the size of the individual components
5. Working out the requirement of the components
6. Modifying the existing cropping system to suit the requirements of the components integrated
7. Working out the economics of individual components and for the IF system as a whole
8. Identifying constraint and suggesting remedy measures/modifications for technical feasibility, economic viability and practical utility.

Cropping in low land (wetland) is considered to be less risky due to abundant availability of water. In addition, most of the low land soils are heavy type of soils, which are fairly fertile soil. Mostly rice is the principle crop in our low lands. Crops like Banana, Sugarcane and coconut are also grown in this ecosystem. Diversified farming (IFS) can be adopted in the low lands with the components like Fish, Poultry, Duck and Mushroom.

Wetland Farming System-Model

A model was developed for 0.4 ha (1.00acre) considering small and marginal farmers of Tamil Nadu State. While programming for the cropping system, due consideration has been given to the crops under cultivation in the locality, the crop rotation that is followed, and water requirement for the fish pond. The details of each system integrated are furnished below.

Components

1. Cropping
2. Fisheries
3. Poultry

Allocation of land

I. Cropping	: 0.36ha
II. Fish pond	: 0.04ha
III. Poultry shed is placed over the pond :	
Total	: 0.40 ha

I. Cropping programme

Rice (CO 51) - Rice (CO 50) - Maize (COHM 6)0.16ha

(May-Aug) (Aug-Dec) (Jan-April)

Rice (CO 51) – Rice (CO 50)-- Groundnut (TMV 6) 0.10 ha

Maize (HM 6) - Rice (IR 50) - Gingelly (TMV 3) 0.10 ha

II. Fisheries

The number of fingerlings used for the proposed has been arrived at based on the recommended stocking density of 7500 numbers per ha of ponded water. Accordingly 300 numbers at the ratio noted against each of the following varieties were released in the pond.

Silver carp /Catla	: 120 (4)
Rohu (Column feeder)	: 60 (2)
Mrigal/Common carp (Bottom feeder)	:90 (3)
Grass carp (Grass feeder)	:30 (1)

III. Poultry

Five hundred layer chicks are sufficient enough to void required quantum to extract to meet the feed requirement of 7500 polyculture fingerlings in a hectare of ponded water. Accordingly twenty bapkok chicks were used in the study.

Control: The normal crop rotation that is being followed in this tract under low land condition is also included in the programme to compare with income under integrated farming system. The details of which is furnished below:

Rice (CO 51) - (May-Aug)	Rice (CO 50) - (Aug-Dec)	Green gram (CO 7) : 0.20 ha (Jan-Mar)
Rice (CO 51) -	Rice (CO 50) - Sunnhemp	: 0.20 ha
Total : 0.40 ha		

In rice cultivation, even with best management practice we are getting about 5-7 percent ill filled or partly filled grains. This waste product of rice when it is hulled becomes a substitute of 35 percent of poultry feed cost can be reduced by about 57.5 percent by substituting the ill filled /partly filled rice grain, maize grain, oil cakes of crop component, the lucerne grown around the fish pond and fish waste anticipated through disposal of fish.

Effective recycling the products of crop component leads to reduction in the cost of production per egg. In commercial poultry farm, cost of production per egg is around 42 to 44 paise. By way of reducing the feed cost, the cost of production per egg is reduced to 19 paise, thus leading to fingerlings which solely depend on the poultry excreta grows at the rate of one kilogram per year yielding about 250 to 300kg/year, which on marketing will be a bonus.

The growth of fingerlings was solely due to the dropping of the birds kept over the fish pond. The poultry droppings contain protein 30 percent and fat 2.5 percent. The poultry droppings were found to enhance the nutritive value when compared to periodical fertilization and supplemental feedings of fish with groundnut cake and rice bran. Mortality of birds was almost nil till the end of the program. This may be due to the cool environment created by the fish pond. In rice cultivation even with best management practice about 5-7 per cent ill filled or partly filled grains are obtained.

This waste product of rice when it is pooled becomes 35 per cent of poultry feed can be reduced to certain extent. By converting the groundnut and sesame seed into it's by product viz., oil and cakes, can be made free of cost to the poultry feed component and thus can reduce the cost of poultry feed.

The poultry feed cost can be reduced by about 57.5 percent by substituting the ill filled or partly filled grain, maize grain of the farm, oil cakes of the crop component and the alfalfa grown around the fish pond. The reduction in feed cost by way of effective recycling the products of crops components, leads to reduction in cost of production in the egg. It works of Rs.0.19 as against Rs.0.40 in the conventional poultry farm.

Evaluation criteria of Farming system:

Technological analysis is performed by the agronomist or animal scientist from the farming system design team and determines if the new technology is practical in a technical sense. For example, can the farmer receive a greater yield or more animal product with the inputs and practices he/she can reasonably be expected to use with respect to the new technology?

Economic analysis is used to determine if the farmer will receive a greater economic and more stable return from adopting the technology, Part of the economic evaluation is an assessment as to whether the farmer has enough resources available to adopt the technology or can acquire them by borrowing or receiving a government subsidy to facilitate adoption,

Social analysis is used to determine if the technology is acceptable within the household (i.e., intra-household) and overall village (i.e., inter-household) situation. Socio/cultural analysis looks at the technology in a whole farm, analyzes acceptability for the various members of the household who are involved with the technology, determines if there are cultural factors that influence acceptability, examines consumption/nutrition implications, etc.

Exercise

A farmer in Tanjore district own 2.0 ha wetland. He wants to integrate components like fish and poultry with cropping. Canal water is available from June-Jan (7 months). Rice (short, medium and long duration varieties), green manure (daincha and pillipesara), and pulses like black gram are grown in the region.

1. Formulate a model IFS for the above situation
2. Evaluate the IFS proposed by you economically comparing the conventional practice.
3. What is the advantage of having polyculture of fish system in the farm ponds? Give the different species suitable for polyculture.
4. Give the ingredients of poultry feed and daily ration for the layers.
5. Present the resource utilization and waste recycling through flow charts.

Preparation and evaluation of integrated farming system models: Irrigated upland and dry land eco-systems

The possibility of having a viable integrated farming system in irrigated uplands is possible. The control and management of available resources in more effective manner paves way to integrate two or more components with cropping.

The choice of components is many in irrigated upland compared to lowlands and rainfed lands. Components like dairy, poultry, goat, sheep, piggery, sericulture, mushroom, apiary, pigeon, rabbit, quill etc., can be easily integrated in an irrigated upland farm. In addition, perennial trees like coconut and other fodder, multipurpose farm forestry trees can be grown along the borders of the fields and boundary of the farm.

Special features of upland

1. Wide range of crops and varieties can be grown
2. Effective resource utilization and management is possible due to controlled irrigation system

The following are some of the examples of integrated farming system for irrigated uplands

1. Crop+ Dairy+ Biogas unit
2. Crop+ Poultry+ Biogas unit
3. Crop+ Sheep/Goat rearing+ Biogas unit
4. Crop+ Sericulture
5. Crop+ Piggery
6. Crop+ Sericulture+ Biogas unit
7. Crop+ Dairy+ Biogas unit+ Homestead garden
8. Crop+ Dairy+ Biogas unit+ Vermicompost

Garden Land Farming System-Model

A model on integrated farming system to suit the small farmers under upland condition was developed. The following are the components of the model.

I. Cropping: 1.00 ha

Ragi +Sunflower - Cotton+ Maize+ Green gram/Cowpea = 0.56 ha

Summer cotton- Maize+ Green gram/Cowpea/

Sun flower/Radish/Beetroot/Bengal gram/ Bellary Onion = 0.19 ha

Perennial grass fodder (CO1) = 0.15 ha

Perennial legume fodder (Lucerne) = 0.05 ha

Farm shed = 0.05 ha

II. Dairy

3 number of graded jersey cross breed milch animals with two calves

III. Biogas plant

For effective recycling of farm and animal waste for fuel, light and enriched manure.

IV. Farm silviculture

200 Subabul trees along the boundary of field for fodder and timber

A model on integrated input management to suit the small farmers under garden land conditions was studied during 1988 to 1993 at the garden lands of TNAU, Coimbatore were contemplated in this study. The receipt, expenditures and net income of 1988 to 1993 in Integrated Farming System (IFS) and conventional cropping system (CCS) was Rs.34584 and 13496/ha, respectively. IFS thus provides an additional mean net income of Rs. 20638/ha over a period of five years by way of effective recycling. The employment opportunity in the new integrated model with proposed components was enhanced to the tune 770 man days per year over CCS. The results of five years study revealed that by way of integrating agricultural allied enterprises with crop activity, the standard of living of the farmer, income per unit area, employment opportunity for the family etc. enhanced over the CCS

Dry Land Farming System-Model

The dry land ecosystem is characterized by

1. Inadequate and uneven distribution of rainfall
2. Poor and marginal soils
3. Low cropping intensity
4. Limited crop diversification
5. Low value crops
6. Poor resource mobilizing power of farmers

The agriculture in dry lands is seasonal. The cropping season is restricted to 4-5 months and people remain without employment for rest of the year. Diversification of cropping by integrating with components like livestock (Sheep/Goat rearing), silviculture, horticulture tree crops and pasture would improve the standard of living and employment opportunities of the dry land farmers.

Possible combinations are

- Crop + Silviculture + Goat / Sheep rearing
- Crop + Silviculture + Hort. Fruits trees
- Crop + Agro-forestry + Goat + Farm pond
- Crop + Silviculture + Goat + Pigeon + Farm pond
- Crop + Silviculture + Buffalo + Farm pond

Advantages of IFS under dry land

1. Risk is minimized.
2. Optimum use of resources
3. Soil and moisture conservation will be improved
4. Improved is stabilized during period of drought

Dry land farming system Model

One hectare of dry land was selected in Tamil Nadu Agricultural University, Coimbatore. The mean annual rainfall of the tract is 648 mm. The mean maximum temperature range of 17°C to 23°C. The soil type is clay loam. Six goats (5 female and one male) were taken up for the study with the following cropping programme.

Cropping System

IFS	1. Sorghum + Cowpea (grain)	:	0.20 ha
	2. Sorghum + Cowpea (fodder)	:	0.20 ha
	3. Subabul + Cenchrus ciliaris	:	0.20 ha
	4. <i>Acacia Senegal</i> (tree fodder)	:	0.20 ha
	5. <i>Prosopis cineraria</i> (tree fodder)	:	0.20 ha

Control

Sorghum + Cowpea (grain)	:	0.20 ha
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Feed for the goat

The goats were allowed in the developed pasture viz., *Cenchrus ciliaris* grass + *Clitoria ternata* (leguminous plant) grown in the pasture land. Dry fodder was fed to the animal as stall feeding at 2 kg / day.

Crop Yield

The straw and green fodder yield from the experimental area was recorded and income calculated. The animal yield was recorded in terms of meat, the weight gained by the six animals for one year. The results of the one year experiment reveals that the net income under Integrated Farming System may be increasing the herd size/ha that can be fed with the biomass produced from one hectare of land, besides increasing the employment opportunity round the year.

Exercise

I. A farmer is having 2.5 ha irrigated upland located 29 kilometers away from Coimbatore city. The soil is sandy clay loam with pH 7.5. The farm has two deep bore wells fitted with 7.5 HP motors. Water is available from June-Jan to irrigate the entire area and in summer only 1.25 ha can be irrigated. Crops like cotton, vegetables, sugarcane, soybean, sunflower, maize, sorghum and coconut are grown in the area. A tractor with farm implements and trailer is available for agricultural purpose. The farmer is interested to have a dairy unit and a vermicomposting. Formulate a suitable IFS model for the farmer.

- b. Work out productivity and economics of the proposed model
- c. Prepare flow charts for resource utilization and waste recycling

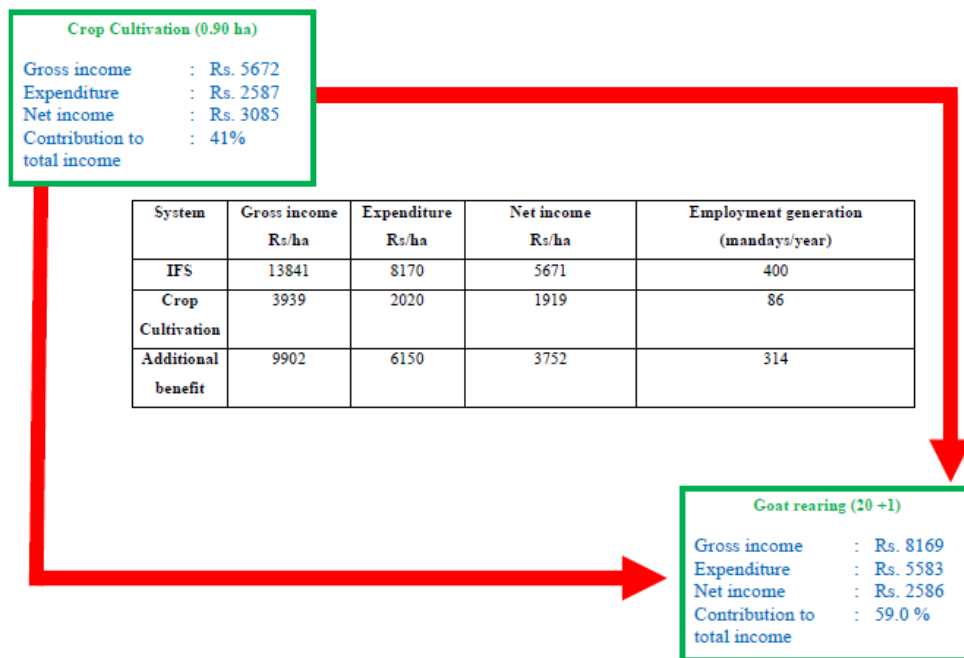
II. A farmer with 3.0 ha of dry land (black soil) in Palladam Taluk of Coimbatore district is interested to adopt the IFS approach instead of his conventional farming of cropping alone. More than 50 % of annual rainfall is received during NEM. Farm family size is 2+3.

- a. Formulate a suitable Crop + Goat + Silviculture + Horticulture tree crops based integrated farming system for dryland.
- b. Give a detailed account of feed compositions, ration and breed characters for Tellicherry goat.
- c. Identify the extent of support one component offers on the other.
- d. Identify the possible areas where recycling of residues of crop and animal components can be done in the system.

Resource recycling in integrated farming system models of different eco systems

The emergence of Integrated Farming Systems (IFS) has enabled us to develop a framework for an alternative development model to improve the feasibility of small sized farming operations in relation to larger ones. Integrated farming system (or integrated agriculture) is a commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches. It refers to agricultural systems that integrate livestock and crop production or integrate fish and livestock and may sometimes be known as Integrated Biosystems. In this system an inter-related set of enterprises used so that the “waste” from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. IFS works as a system of systems. IFS ensure that wastes from one form of agriculture become a resource for another form. Since it utilizes wastes as resources, we not only eliminate wastes but we also ensure overall increase in productivity for the whole agricultural systems

RESOURCE RECYCLING IN CROP + GOAT INTEGRATED FARMING SYSTEM



Exercise:

1. Illustrate resource-recycling linkage among the components of wet land ecosystem
2. Elaborate the potential of bio gas plant for resource recycling in upland irrigated ecosystem
3. Role of vermicomposting and biogas components in resource recycling

Evaluation of integrated farming system models : Wetland eco-system

Indices for Production efficiency

1. Crop equivalent yield

To assess the yield advantage of multiple cropping sequences, it is not possible to compare the economic produce of one crop to another. The yield of rice cannot be compared with the yield of maize or legumes from the same land. In such situations, comparisons are to be made based on economic returns (gross or net returns) or Crop equivalent yields (CEY) are used which, refers to the yields of different crops are converted into equivalent yield of any one crop based on price of the produces.

$$\text{Crop Equivalent Yield (CEY)} = \frac{\sum_{i=1}^n (y_i * v_i)}{P(B)}$$

Where

n = Number of crop grown

y_i = yield of i^{th} crop (kgs.)

v_i = value of i^{th} crop produce (₹ kg⁻¹)

P(B) = Price of the produce ((₹ kg⁻¹)

2. System productivity

System productivity is calculated by dividing crop equivalent yield from a system of unit area in an year with 365 days and expressed as kg ha⁻¹ day⁻¹

3. Relative Production Efficiency

Relative productive efficiency is calculated by the following formula and expressed in percentage

$$= \frac{\text{Crop equivalent yield from improved system from unit area} - \text{Crop equivalent yield from traditional system from unit area}}{\text{Crop equivalent yield from traditional system from unit area}}$$

Indices for assessing energy efficiency

$$\text{Energy Efficiency} = \frac{\text{Energy Output (MJ per ha)}}{\text{Energy input ((MJ per ha))}}$$

$$\text{Net energy (MJ per ha)} = \text{Energy output} - \text{Energy input}$$

$$\text{Energy Productivity (MJ per ha)} = \frac{\text{Energy Output (grain + by products)}}{\text{Energy input}}$$

Sustainable Yield Index

Indices for assessing Economics of Integrated farming System

Gross Returns

The total monetary returns of the economic produce such as grain, tuber, bulb, fruit, etc. and byproducts viz. straw, fodder, fuel etc. obtained from the crops included in the system are calculated based on the local market prices. The total return is expressed in terms of unit area, usually one hectare. The main draw back in this calculation is that market price of the produce is higher than that actually obtained by the farmer.

Net returns or net profit

This is worked out by subtracting the total cost of cultivation from the returns. This value gives the actual profit obtained by the farmer. In this type of calculation only the variable costs are considered. Fixed costs such as rent for the land, land revenue, interest on capital etc. are not included. For a realistic estimate, however, fixed costs should also be included.

Return Per Rupee Invested:

This is also called benefit-cost-ratio or input- output ratio. This index provides an estimate of the benefit derived and expenditure incurred by the farmer in adopting a particular cropping system. Anything above the value of 2.0 (meaning that the farmer can get RS.2 as return for every rupee invested) can be considered profitable.

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (₹)}}{\text{Cost of cultivation (₹)}}$$

Per Day Return:

This is called as income per day and can be obtained by dividing the net return by number of cropping period (days). This gives the efficiency of the cropping system in terms of monetary value. If the system is stretched over one year, the denominator can be replaced by 365 days and per day for the whole year can be calculated.

$$\text{Per day returns} = \frac{\text{Net returns (₹)}}{\text{Cropping period (Days)}}$$

Sustainable yield index:

Sustainable yield index is calculated by the formula

$$\text{Sustainable yield Index} = \frac{\text{Mean of yields} - \text{Standard deviation for yields}}{\text{Maximum yield over years}}$$

Instead of yields, if net returns are used in the formula, it is referred as sustainable value index

Diversity Index

It was suggested by Strought (1975) and Wang and Yu (1975). It measures the multiplicity of crops or farm products, which are planted in a single year by computing the reciprocal sum of squares of the share of gross revenue received from each individual farm enterprises in a single year.

$$DI = \frac{1}{\text{Sum of squares of gross returns from crops or enterprises from the farm in a year}}$$

Employment Generation

Recycling potential

Evaluation of integrated farming system models: Irrigated upland and dryland ecosystems.

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Employment Generation

Recycling potential

Ex. No: 16

Date:

On-farm visit to cropping fields and integrated farming system units
