CROPPING SYSTEM – TYPES, ADVANTAGES AND
DISADVANTAGES, INDICES FOR EVALUATION OF CROPPING
SYSTEM

Cropping system:

Cropping system is defined as the order in which crops are cultivated on a piece of land over a fixed period of time. Cropping system represents cropping pattern used on a farm and their interaction with other farm enterprises and available technology which determine their makeup.

Types or Classification of cropping system

Depending upon resources and technology available, different types of cropping systems adopted on farms listed as below.

1. Mono-cropping:

Mono-cropping refers to growing of only one crop on a piece of land year after year. It might be due to climatological and socio economic conditions or due to specialization of farmers in growing a particular crop. E.g. growing of Tobacco in Guntur (A.P.) due to specialization of farmers in cultivation tobacco, rice crop is grown in Konkan as it is not possible to grow other crop due to waterlogged condition.

The reason for mono-culture:

1) The cultivators have no choice to cultivate many crops as holding is very small.
2) The soil and climatic conditions do not permit successful cultivation of other crops.
3) The crop grown is main article in diet and Specialization of farmer.

Disadvantages of monoculture:

1) Sometimes fertility and productivity of the soils is lowered, if suitable soil management practices are not followed.
2) Soil structure may be deteriorated.
3) Increases infestation of pests, diseases and weeds.

2. Multiple cropping or poly cropping:

   It is a cropping system where two or more crops are grown annually on the same piece of land using high input without affecting basic fertility of the soil. **Growing of two or more than two crops on the same piece of land in a one calendar year known as multiple cropping.**

A. Parallel Multiple Cropping:

   Under this cropping system two or more crops are grown simultaneously in the same land which have different growth habits and have a zero competition between each other and both of them express their full yield potential. e.g. green or black gram in maize.

Subtypes of parallel multiple cropping

a. Mixed Cropping:

   Mixed cropping is defined as the process of growing two or more crops simultaneously in the same piece of land without keeping their identity with respect to field area or without row arrangement. It is common practice in dry land tracts of India.

   The basic objective of mixed cropping is minimization of risk and insurance against crop failure due to aberrant weather conditions.

b. Intercropping:

   Growing of two or more than two crops simultaneously in the same piece of land with a definitely row pattern. For example, growing Lablab bean + Mustard in 4:1 ration i.e. after every 4 rows of Lablab bean, 1 row of Mustard is sown. Thus, cropping intensity in space dimension is achieved. Intercropping includes companion cropping, Multi-storied cropping, synergetic cropping.

Types of intercropping:

i. Companion Cropping:
In companion cropping the yield of one crop is not affected by other, in other words, the yield of both the crops is equal to their pure crops. E.g. Mustard, Wheat, potato with sugarcane.

**ii. Multistoried Cropping or Multi-tier cropping:**

Growing plants of different height, rooting pattern and duration in the same field at the same time is termed as multistoried cropping. The main objective of this system is to utilize vertical space more effectively. E.g. Coconut + Black paper + Cocoa + Pineapple.

**iii. Synergetic Cropping:**

Here the yields of both crops, grown together are found to be higher than yield of their pure crops on unit area basis. E.g. Sugarcane + potato.

**Additive series:** It is mostly adopted in India. In this system one crop is sown with 100 per cent of its recommended population in pure stand which is known as the base crop. Another crop known as intercrop is introduced into the base crop by adjusting or changing crop geometry. The population of intercrop is less than its recommended population in pure stand.

**Replacement series:** In this system both the crops are called component crops. By scarifying certain proportion of population of one component, another component crops is introduced.

**Advantages of Inter-cropping :-**

i. Better use of growth resources including light, nutrients and water
ii. Suppression of weeds
iii. Reduces pest and disease incidence
iv. Yield stability
v. Ecological stability i.e. improvement of soil health and agro-ecosystem
vi. It provides more employment and distribution of labour, by growing and harvesting different crops at different intervals.

**Disadvantage of Inter-cropping:-**

i. Labour intensive.
ii. Chemical weed control may be difficult.
iii. Mechanization is difficult
iv. Sometime Competition occurs.

**B. Sequential Multiple Cropping:**

In this type of multiple cropping two or more crops are grown in the same piece of land at different time period or in sequence manner.

**i. Sequence Cropping:**

In this cropping system two or more crops are grown in sequence one after another on the same piece of land in a farming year.

Depending on the number of crops grown in a year, it is called as double, triple and quadruple cropping.

**a) Double cropping:** Growing of two crops in sequence on the same piece of land in a year. e.g. In assured rainfall areas on moisture retentive soils (Rainfed Crops)

<table>
<thead>
<tr>
<th>Crop 1</th>
<th>Crop 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black gram (K)</td>
<td>Jowar (R)</td>
</tr>
<tr>
<td>Black gram (K)</td>
<td>Wheat (R)</td>
</tr>
<tr>
<td>Green gram (K)</td>
<td>Wheat or Jowar (R)</td>
</tr>
<tr>
<td>Rice (K)</td>
<td>Gram or Wal (R)</td>
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**b) Triple cropping:** Growing of three crops in sequence on the same piece of land in a year.

**c) Quadruple cropping:** Growing of four crops in sequence on the same piece of land in a year.

**ii. Ratoon cropping:** It refers to raising a crop with regrowth coming out of roots, stem or stubbles after harvest of the crops. It is generally followed in sugarcane, sorghum, pigeon pea etc.

**Advantages of sequence cropping:**

i. There is no competition for light, water and nutrients

ii. In sequence cropping, sole crops are sown in sequence and so competition for soil factor is not a problem. But management of water and nutrients is modified by the effect of the preceding crop on succeeding crop.
C. Relay Cropping:

It is the cropping system in which succeeding crop (Next crop) is sown or planted when the first crop (Preceding crop) has reached its physiological maturity stage or before it is ready for harvest or In this system, the succeeding crop is sown in the standing crop before harvesting of preceding crop. e.g. paddy- Lucerne, Cotton-Berceem.

Advantages of Relay cropping:

i. minimum tillage is needed for relay cropping and primary cost of cultivation is less.
ii. Weed infestation is less, as land engaged with crops year round.
iii. Crop residues are added in the soil and thus increases organic matter.
iv. Residual fertilizer of previous crops benefits for succeeding crop.

D. Alley cropping: Food crops are grown in alleys formed by hedgerow intercropping. It is recommended for humid tropics. In semiarid regions of India alley cropping provides fodder during dry period. This system is mostly suitable for marginal and sub-marginal lands.

Advantages of alley system:

i. Provision of green fodder during dry period of the year.
ii. Higher biomass production per unit area than arable crops.
iii. Efficient use of season rainfall in the absence of crop.
iv. Additional employment during off-season.
v. Soil and moisture conservation.

3. Fallowing or fallow in rotation:

In scarcity (Dry farming) where the rainfall is very low only two crops are taken in three years as against one crop every year. A fallow years or season is one in which field is not cultivated with any crop left without crop. The field may be left undisturbed in a ploughed condition or kept clean by frequent harrowing. This practice is useful for conservation of soil moisture and maintaining fertility of the soil.
Crop rotation:

Crop rotation is a process of growing different crops in succession on a piece of land in specific period of time, with an object to get maximum profit from least investment without impairing the soil fertility. One cycle may take one or more farming years to complete. Farming year is 12 months for irrigated areas and is limited to period of adequate soil water availability for crops growth in rain fed areas.

Principles of Crop rotation:

- The crops with tap roots should be followed by those which have fibrous root system. This helps in proper and uniform use of nutrients from the soil.
- The leguminous crops should be grown after non-leguminous crops because legumes fix atmospheric N into the soil and more organic matter to the soil.
- More exhaustive crops should be followed by less exhaustive crops because crops like potato, sugarcane, maize etc. need more inputs such as better tillage, more fertilizers, greater number of irrigations etc.
- Selection of crops should be demand based.
- The crop of the same family should not be grown in succession because they act like alternate hosts for insects, pests and diseases.
- An ideal crop rotation is one which provides maximum employment to the family and far in labour, the machines and equipment’s are efficiently used and all the agricultural operations are done timely, simultaneously maintain soil productivity.
- The selection of the crops should be problem based.
- One sloppy land which are prone to erosion an alternate cropping of erosion promoting and erosion resisting crops like legumes should be adopted.
- Under dry farming the selection of crops should be such which can tolerate drought.
- In low-lying and flood prone areas the crops should be such which can tolerate water stagnation.
The selection of crops should suit farmer’s conditions.

- The crop selected should also suit the soil and climatic conditions.

**Advantages of crops rotation:**

- Agricultural operation can be done timely for all crops because of less competition.
- Soil fertility is restored by fixing atmospheric nitrogen, encountering microbial activity, avoiding accumulation of toxins (HCN etc), and maintaining physical properties of soil.
- An ideal crop rotation helps in controlling insects, pests and diseases. It also controls the weeds in the field.
- Proper utilization of all the resources and inputs could be made by following crops rotation.
- The farmers get better prices for his produce because of its higher demands in the locality or market.

**INDICES FOR EVALUATION OF CROPPING SYSTEM:**

Some of the important indices to evaluate the cropping systems are as below:

Since several crops are involved in intercropping system, it is not logical to compare total yield of different crops in one system with the other. Sever indices are developed to evaluate cropping systems.

**1. Crop Equivalent Yield (CEY):**

The yields of different intercrops are converted into equivalent yield of any one crop based on price of the produce.

\[ CEY = \sum_{i=1}^{n} (Y_i \times e_i) \]

Where \( Y_i \) = Yield of \( i^{th} \) component and \( e_i \) = equivalent factor of \( i^{th} \) component or price of \( i^{th} \) crops

Example : Let the yields of groundnut and redgram in hectare of intercropping be 1,000 and 600 kg respectively. The total yield of intercropping system can be expressed as groundnut equivalent yields by

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knowing the price of each produce. If the price of groundnut and redgram are Rs. 6 and Rs. 4 per kg respectively

\[
EY \text{ of groundnut} = \frac{1000 \times 6}{6} = 1000 \text{ kg}
\]

\[
EY \text{ of redgram} = \frac{600 \times 4}{6} = 400 \text{ kg}
\]

EY of system = 1,000 + 400 = 1,400 kg of groundnut

2. Land equivalent ratio (LER):

Land equivalent ratio (LER) is the relative land area under sole crops that is required to produce the yields achieved in intercropping. LER can be mathematically represented as follows

\[
LER = \sum_{i=1}^{m} \frac{Y_i}{Y_{ij}}
\]

Where \( Y_i \) = yield of \( i^{th} \) component from a unit area grown as intercrops and \( Y_{ij} \) = yield of \( i^{th} \) component grown as sole crop over the same area. LER is the summation of ratios of yields of intercrops to the yield of sole crop.

Example: Let the yield of groundnut and redgram grown as pure crops be 1,200 and 1,000 kg/ha respectively, let the yield of these crops when grown as intercrops be 1,000 and 600 kg/ha respectively. The land equivalent ratio of ground + redgram intercropping system is as follows

\[
LER \text{ of groundnut} = \frac{\text{Yield of inter crop}}{\text{Yield of sole crop}} = \frac{1,000}{1,200} = 0.83
\]

\[
LER \text{ of redgram} = \frac{\text{Yield of inter crop of redgram}}{\text{Yield of inter crop of groundnut}} = \frac{600}{1,000} = 0.60
\]

\[
LER \text{ of system} = \frac{\text{Yield of inter crop}}{\text{Yield of sole crop}} + \frac{\text{Yield of inter crop of redgram}}{\text{Yield of inter crop of groundnut}} = \frac{1,000}{1,200} + \frac{600}{1,000} = 1.43
\]

LER of the 1.43 indicates that 43 per cent yield advantage is obtained when grown as intercrops compared to growing as sole crops. In other
words, the sole crops have to be grown in 1.43 ha to get the same yield level that is obtained from 1.00 ha of intercropping.

**3. Relative Yield Total (RYT):**

In pastures, different spices of plants are grown for grazing in different proportions. The yield of these crops are higher when they are grown as sole crops with 100 per cent population compared to their yield in pastures reduced population. The accommodate more number of crops in pastures, certain amount of population of intercrops are reduced. It is necessary to know which crop combination gives higher forage yield. The yield advantages are therefore, measured not only based on unit area, but also based on unit population which is estimated by relative yield total. This is mainly used for replacement series of experiments. It is mathematically expressed as:

\[
RYT = \frac{Y_{ab} + Y_{ba}}{Y_{aa} + Y_{bb}}
\]

Where \(Y_{aa}\) = Yield of component ‘a’ as sole crop, \(Y_{bb}\) = Yield of component ‘b’ as sole crop; \(Y_{ab}\) = Yield of component ‘a’ as inter crop in ‘b’ and \(Y_{ba}\) = is yield of component ‘b’ as intercrops in ‘a’

Example: In pasture, mixture of stylo and anjana grass were grown in 1:1 ratio i.e. 50 per cent of sole crops population of both crops. Yield of stylo and anjana grass in mixtures are 6 and 4 t of green fodder per ha respectively from first cut. Their sole crop yields at 100 per cent population are 10 and 8 t/ha respectively

\[
RYT = \frac{Yield\ of\ stylo + Yield\ of\ anjana\ grass\ in\ mixture}{Yield\ of\ stylo + Yield\ of\ anjana\ grass\ in\ pure\ stand}
\]

The yield of crops in mixture at 50 per cent population of stylo and anajana grass were 6 and 4 t, respectively and their corresponding yield would be 12 and 8 at 100 per cent population

\[
RYT = \frac{12 + 8}{10 + 8} = \frac{20}{18} = 1.11
\]

RYT of 1.11 indicates that 11 per cent extra fodder yield was obtained by mixture.
4. **Multiple Cropping Index or Multiple Cropping Intensity (MCI):**

It was proposed by Dalarymple (1971). It measures the sum of areas planted to different crops and harvested in a single year divided by total cultivated area times 100.

\[
MCI = \frac{\sum_{i=1}^{n} ai}{A} \times 100
\]

Where \( i = 1, 2, 3, n \), \( n \) = total number of crops, \( ai \) = area occupied by crop and \( A \) = total land area available for cultivation.

Or MCI is the sum of area planted to different crops and harvested in a single year divided by total cultivable area and expressed as percentage. Or MCI means the sum of areas under various crops raised in a single year divided by net area available for that cropping pattern multiplied by 100. It is similar to cropping intensity.

\[
MCI = \frac{\text{Total number of crops + with their respective area}}{\text{Net cultivable area}} \times 100
\]

5. **Cropping intensity/intensity of cropping (CI):**

Cropping intensity assesses farmers actual land use in area and time relationships for each crop or group of crops compared to the total available land area and time including the land temporarily available for production.

\[
CI = \frac{\text{Total cropping area}}{\text{Net cultivated area}} \times 100
\]

\[
CI = \frac{\text{Area under kharif+rabi+summer crops}}{\text{Net cultivated area}} \times 100
\]

6. **Cultivated Land /Utilization Index (CLUI):**

Cultivated land utilization Index (Chuang, 1973) is calculated by summing the products of land area to each crop, multiplied by the actual duration of that crop divided by the total cultivated land times 365 days.

\[
CLUI = \frac{\sum_{i=1}^{n} ai di}{A \times 365}
\]

Where, \( i = 1, 2, 3, n \), \( n \) = total number of crops. \( ai \) = area occupied by the \( i^{th} \) crop, \( di \) = days that the \( i^{th} \) crop occupied \( ai \) and \( A \) = total cultivated land area available for 365 days.
CLUI can be expressed as a fraction or percentage. This gives an idea about how the land area has been put into use. If the index is 1 (100%), it shows that the land has been left fallow and more than 1, tells the specification of intercropping and relay cropping. Limitation of CLUI is its inability to consider the land temporarily available to the farmer for cultivation.

**Economic evaluation:**

1. **Gross returns:**
   
The total monetary value of economic produce and by product obtained from the crops raised in the cropping system is calculated based on local market prices.

2. **Cost of cultivation:**
   
   Cost of cultivation is the total expenditure incurred for raising crops in a cropping system. The cost included for this purpose consists of own or hired human labour, owned or hired bullock labour, value of seed, manures, fertilizers, pesticides and herbicides and irrigation charges.

3. **Net returns:**
   
   Net returns are obtained by subtracting cost of cultivation from gross returns. It is good indicator of suitability of cropping system since this represents the actual income to the farmer.

4. **Cost : Benefit Ratio:**
   
   Cost benefit ratio is the ratio of gross returns to cost of cultivation, which can also be expressed as returns per rupee invested. This index provides as estimate of the benefit a farmer derives for the expenditure he incurs in adopting particular cropping system.