FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

EFFICIENCIES CROPPING SYSTEMS AND THEIR EVALUATION

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

Land use efficiency or assessment of land use

The main objective is to use available resources effectively. Multiple cropping which include both inter and sequential cropping has the main objective of intensification of cropping with the available resources in a given environment. Several indices have been proposed to compare the efficiencies of different multiple cropping system in turns of land use, and these have been reviewed by Menegay *et al*. 1978.

1. Multiple cropping index or multiple cropping intensity (MCI)

It was proposed by Dalrymple (1971). It is the ratio of total area cropped in a year to the land area available for cultivation and expressed in percentage (sum of area planted to different crops and harvested in a single year divided by total cultivated area times 100).

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

Where, n is total number of crops, a_i is area occupied by i^{th} crop and A is total land area available for cultivation.

It is similar to cropping intensity.

$$MCI = \frac{a_1 + a_2 + ... + a_n}{A} \times 100$$

Where $a_1 + a_2 + \ldots + a_n$ is the gross cropped area and A the net cultivated area.

2. Cultivated land utilization index (CLUI)

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

$$CLUI = \frac{\sum_{i=1}^{n} a_i d_i}{A \times 365}$$

Where, i = 1,2,3,……,n.

n = Total number of crops.

a_i = Area occupied by i^{th} crop.

A = Total cultivated land area available for 365 days.

3. Crop intensity index (CII)

Crop intensity index assesses farmers actual land use in area and time relationship for each crop or group of crops compared to the total available land area and time, including land that is temporarily available for cultivation. It is calculated by summing the product of area and duration of each crop divided by the product of farmers total available cultivated land area and time periods plus the sum of the temporarily available land area with the time of these land areas actually put into use (Menegay *et al.* 1978). The basic concept of CLUI and CII are similar. However, the latter offers more flexibility when combined with appropriate sampling procedure for determining and evaluating vegetable production and cropping pattern data.

$$CII = \frac{\sum_{i=1}^{N_c} a_i t_i}{A_0 + \sum_{j=1}^{M} A_j T_j}$$

Where, Nc = total number of crops grown by a farmer during the time period T; a_i = area occupied by i^{th} crop (months that the crop i occupied an area a_i); ti , duration occupied by ith crop (months that crops occupied area a_i); T = time period under study (usually one year), A_j= Total cultivated land area available with the farmer for use during the entire time period T; M= total number of fields temporarily available to the farmer for cropping during time period T_j=1, 2, 3…….. M, A_j=land area of j^{th} field and T_j= time period when A_j is available.

When, CII = 1 means that area or land resources have been fully utilized and less than 1 indicates under utilization of resources. CII and LER are used to assess the efficient cropping zone.

Cropping intensity/intensity of cropping (CI) indicates the number of times a field is grown with crops in a year. It is calculated by dividing gross cropped area with net area available in the farm, region or country multiplied by 100.

$$CI = \frac{\text{Gross cropped area}}{\text{Net sown area}} \times 100 = \frac{\text{Area under } kharif + rabi + zaid \text{ crops}}{\text{Net sown area}} \times 100$$

When long duration crop is grown, crop remains for a longer time in field. This is the drawback of CI. So time is not considered. Thus, when long duration crops like sugarcane and cotton are grown, the cropping intensity will be low. When long duration crop is grown, crop remains for a

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Biological Potential

1. Crop equivalent yield (CEY)

Many types of crops/cultivars are included in a multiple cropping sequences. It is very difficult to compare the economic produce of one crop to another. To cite an example, yield of rice cannot be compared with the yield of grain cereals or pulse crops and so on. In such situations, comparisons can be made based on economic returns (gross or net return). The yield of protein and carbohydrate equivalent can also be calculated for valid comparison. Efforts have also been made to convert the yields of different crops into equivalent yield of any one crop such as wheat equivalent yield.

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

$$\text{CEY (kg/ha)} = \text{Yield (main crop)} + \frac{\text{Yield (intercrop)} \times \text{Price (intercrop)}}{\text{Price (main crop)}}$$

2. Land equivalent ratio (LER)

This is the most frequently used efficient indicator. LER can be defined as the relative land area under sole crop that would be required to produce the equivalent yield under a mixed or an intercropping system at the same level of management.

$$\text{LER} = La + Lb = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where, La and Lb are LER of crop a and crop b, respectively; Yab = yield of crop an in intercropping, Yba = yield of crop b in intercropping, Yaa = yield of crop an in pure stand and Ybb = yield of crop b in pure stand.

LER of more than 1 indicates yield advantage, equal to 1 indicates no grain or no gain or no loss and less than 1 indicates yield loss. It can be used both for replacement and additives series of intercropping. LER is the summation of ratios of yields of intercrop to the yield of sole crop.

LER gives a better picture of the competitive abilities of the component crops. It also gives actual yield advantage of intercropping. In other words LER is the measure of production

efficiency of different system by convening the production in terms of land acreage. LER gives an accurate assessment of the biological efficiency of intercropping.

Example: Let the yields of groundnut and Sesame grown, as pure crops are 1,200 and 1,000 kg/ha, respectively. Let yields of these cops when grown, as intercrop be 1,000 and 600 kg/ha, respectively. The land equivalent ratio of groundnut + Sesame intercropping system is

$$\text{LER of Groundnut} = \frac{\text{Yield of intercrop}}{\text{Yield of sole crop}} = \frac{1000}{1200}$$

$$\text{LER of sesame} = \frac{\text{Yield of intercrop}}{\text{Yield of sole crop}} = \frac{600}{1000}$$

$$\text{LER of system} = \frac{1000}{1200} + \frac{600}{1000} = 1.43$$

LER of 143 indicates that a 43 percent yields advantage is obtained when grown as intercrop compared to growing as sole crops. In other words the sole crops have to be grown in 1.43 ha to get the same yields level that is obtained from 1.00 ha of intercropping.

Economic viability

Following terms can be used to evaluate profitability of cropping system.

1. Gross returns or gross profit

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.

2. 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.

3. Rupees per rupee invested

This is also called benefit-cost-ratio or input- output ratio.

$$\text{Returns per rupee invested} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

4. 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).

$$\text{Per day return} = \frac{\text{Net return}}{\text{Cropping period (days)}}$$

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.