

**ECONOMIC ANALYSIS OF COTTON-WHEAT
ROTATION IN HARYANA**

By

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of the requirements for the degree of:**

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in

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CERTIFICATE I

This is to certify that this thesis entitled, "**Economic analysis of cotton-wheat rotation in Haryana**", submitted for the degree of Master of Science in the subject of Agricultural Economics of Chaudhary Charan Singh Haryana Agricultural University, Hisar, is a bonafide research work carried out by Mr. Vinod Kumar under my supervision and that no part of this thesis has been submitted for any other degree.

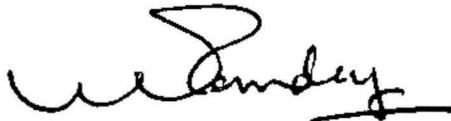
The assistance and help received during the course of investigation have been fully acknowledged.



[R.S. Pannu]
Major Advisor

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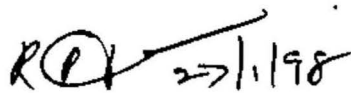
This is to certify that this thesis entitled, "**Economic analysis of cotton-wheat rotation in Haryana**", submitted by Mr. Vinod Kumar to the Chaudhary Charan Singh Haryana Agricultural University, Hisar, in partial fulfilment of the requirements for the degree of Master of Science, in the subject of Agricultural Economics has been approved by the Student's Advisory Committee after an oral examination on the same.



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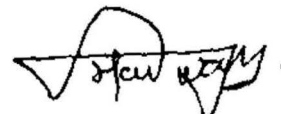
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(Vinod Kumar)

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INTRODUCTION

In Haryana agricultural sector dominates its economy. State has registered a tremendous progress in this sector particularly after green revolution in terms of both production and productivity. Green revolution, also known as 'wheat revolution' was brought about by high yielding varieties of wheat in seventies. Prior to green revolution India depended upon other countries to fulfil the food requirements of its people. Now a days India is not only self reliant in food production but also exporting it. With the extension of ambit of research programmes to other crops and evolution of high yielding varieties, multiple cropping came at forefront started shifting their attention towards other crops. With development in infrastructural facilities in agriculture, farmers are practising various crop rotations.

Cotton-wheat rotation is one of the most important rotations in southern and western Haryana. Cotton is one of the important commercial crops. Due to lucrative returns obtained from this rotation, more and more land is coming under this rotation. Wheat is important food crop and cotton supports textile and oil industries. So, keeping in view the importance of this rotation, this study ~~has been~~^{was} taken to examine the economics of this rotation.

But, accomplishing sustainable development has been a major challenge confronting the world community. Idea of sustainability has developed due to concern for depleting and degrading natural resources and using them in such a way as to safe guard the interest of future generations. The implied key to sustainable development thus lies in managing the resource base efficiently not only for present but for future as well. In order to make suggestions for optimum resource use for making the agriculture sustainable, it is necessary to study the existing resource use pattern and to suggest its optimal use.

Existing resource use is defined as what crop activities farmers are undertaking, how much land they are allocating to each crop activity and what methods and combinations of inputs they are using on each crop. Whereas, in a traditional agriculture few allocative inefficiencies are reported, in a growing economy maladjustments in resource allocation may found. These inefficiencies arise mainly because of lags in adjusting to the changing resource structure and their new allocation opportunities which do not fit

into the experience based decision frame of farmers. The significant changes in the biological and economic environment consequent upon the advent of improved technology in agriculture have provided new alternatives, which, in turn, have brought up the need for various adjustments in allocating land and other resources among their competing uses. Hence, keeping in view all these aspects present study has been undertaken with following objectives:

1. Economic analysis of cotton wheat rotation vis-a-vis other crop rotation(s)
2. To study the existing resource use pattern.
3. To suggest optimum resource use.

REVIEW OF LITERATURE

2.1 ECONOMICS OF DIFFERENT CROPS

To get the maximum profit from farming sector, it is of paramount importance to know the comparative economics of alternative crops.

Shelley (1970) in a study of agricultural production trends and components observed that the trends in the production of food grain and non-food grain crops were positive and statistically significant. He further indicated that, notably groundnut, sugarcane and up to some extent rapeseed and mustard contributed to increase in production of non-food grain crops.

Nandal *et al.* (1985) studied the economics of production and marketing of rapeseed and mustard and groundnut in Haryana and found that the compound growth rates for area, production and productivity of these crops were positive but non-significant.

In a study of economics of production of groundnut in the region of south Saurashtra in Gujarat state, Patel (1973) observed that there was a perceptible and consistent trends towards declining average cost with increase in the size of holding in both irrigated and dry farming conditions of groundnut due to economics of scale, but he could not find any consistent relationship between the holding size, gross and net returns.

On the basis of studies conducted in 1976, 1977 and 1978 on intercropping of sesamum with other oilseed crops like groundnut, castor, soyabean and sunflower, Desai and Goyal (1980) concluded that intercropping increased the total oilseed production as well as economic returns. The highest return on money invested, however, was found to be from pure sesamum crop.

In an economic analysis of mustard production with new technology, Rai and Kumar (1981) reported that there was an increase in area sown under this crop and they further reported on specific qualities of Varuna and Laha 101 varieties, and the studies which showed that the adoption of new technology was economically profitable and that the farmers could benefit from its adoption.

Prasad *et al.* (1982) in a benefit cost appraisal of rainfed groundnut in Andhra Pradesh reported that the farmers incurred the cost amounting Rs.1861 to grow one hectare rainfed groundnut. The per hectare gross returns and net returns from rainfed ground nut were Rs.2055 and Rs.194, respectively.

Based on field experiments conducted to find out the comparative economics of selected competitive crops under three different dates of sowing during the kharif season of 1977-78 and 1978-79 and summer season of 1979-80 at TNAU farm, Coimbatore, Arunachalam and Subramaniam (1984) showed that sunflower when sown on September 25 was significantly superior to the other crops and the dates of sowing was also significant.

In a study of yield and economics of sunflower in comparison with ragi groundnut and maize at different sowing dates conducted at GKVK, Bangalore, Krishna Gowda *et al.* (1984) reported that ragi gave higher net returns (Rs.2973/ha) than sunflower (Rs.1011/ha) groundnut (Rs.1017/ha) and maize (Rs.1086/ha) which were at par. According to them ragi was the most competitive crop and could be sown up to end of August, while sunflower as a second alternative crop for commercial purpose could be sown during July.

On the basis of study conducted at research farms, All India Coordinated Research project for Dryland Agriculture, Hyderabad, Reddy and Korwar (1985) analysed a comparative economic evaluation of agroforestry, silo agriculture and silvo-pastoral systems in drylands and found that all these systems were economical and viable, the annuity value was worked out to Rs.799/- in case of agroforestry, Rs.598/- in case of silvo-agriculture and Rs.1142/- in case of silvo pastoral system and on the other hand silvo pastoral system helped in producing such nutritional commodities as milk and mutton in the country.

Licksko (1987) in a study of income/returns^{per} gram, wheat, maize and sunflower grown on the co-operative farms under both good and poor natural conditions in Hungary reported that in the last 10 years, the area under sunflower had increased rapidly, first at the expense of maize, and then displacing many other commodity crops. He reported that, however, sunflower production was more profitable for producers but the expansion of sunflower did not comply with national economical interests as long as there existed the market potential for cereal exports.

Sharma and Thakur (1988) analysed the comparative economics of important commercial crops of Himachal Pradesh and indicated high returns from these crops and suggested that there was huge potential to expand the production of these crops. In case of commercial crops, Kuth and in off season vegetable tomato was the most profitable.

Sudha and Reddy (1990) analysed the comparative economics of casuarina cashew vs annual dryland crop in Prakasam district of coastal Andhra Pradesh by the technique of discounting and compounding, and, they concluded that casuarina was more profitable than groundnut crop, while cashew was less profitable as compared to groundnut.

In an economic analysis of groundnut production in rainfed area in Tiruchirapalli district of Tamilnadu, Thiruvengkatachari *et al.* (1991) revealed that overall groundnut production was profitable. They reported that marginal farmers had lesser benefits than the small and big farmers. Over 95 per cent of total sample farms had lower yield (23% less) than the yield that was

obtained in demonstration plots. In terms of productivity per hectare, per man day and also in terms of cost benefit ratio, smaller farms enjoyed more advantage than other two categories of farms.

In an economic analysis of rice based rabi crops under assured irrigation for a field trial conducted at the Regional Agricultural Research Station, Sarkanda, Ram *et al.* (1991) compared the relative economics of wheat, pigeon peas, cotton, groundnut, maize and soyabeans after wet season (kharif) rice. The highest net profit was obtained with ground nut (Rs.61319/ha) followed by cotton wheat and maize. Pigeon peas yielded a negative net profit during trial period.

Grover *et al.* (1992) in an economic analysis of milk production on different size groups of farms in Bhatinda district of Punjab, reported that farmers were maintaining on an average three milch cattle worth of Rs.10489/-. The average annual net maintenance costs of buffalo and a cow worked ~~at~~ ^{out} ~~Rs.~~ ^{was} Rs.5291/- and Rs.4681/-, respectively. The average yields of milk per buffalo and per cow were 1216 and 926 litres, respectively. The yield of milk per milch cattle did not show any definite relationship with the farm size. Milch cattle were maintained in this area more for domestic consumption of milk rather than for sale. The average total cost of production per litre of milk from buffaloes and cows came at Rs.4.34 and Rs.5.05, respectively. On an average, the sample farms incurred a net annual loss of Rs.1016 per buffalo and Rs.1902 per cow. These losses showed a tendency to increase with an increase in farm size. The yield of milk per milch cattle was very low and

there was a scope for increasing the yield further by following suitable breeding and feeding programmes to raise the profitability of dairying enterprise.

Prasad *et al.* (1993) in their study ^{on} ~~for~~ farm planning for poultry egg production calculated the costs and returns from 1500 layers which laid 1000 eggs daily. According to them, the overall cost for said number of layers was found to be Rs.307500 which in turn resulted into the gross income equal to Rs.391750/- giving a net profit of Rs.84250/-. The annual net return was calculated at Rs. 56150/-.

Analysing the production and marketing of Poovan banana in Tiruchirapalli district of Tamilnadu, Senthilnathan and Srinivasan (1994) found that on an average Rs.47421/- per hectare was spent for raising the crop during the first year. It was Rs.37202/- during the second year and Rs.40055/- in the third year. Total receipt during the first year was ~~Rs.104927/-~~ ~~at~~ Rs.104927/- and net income realised amounted to Rs. 57506/- per hectare. In the second year both the receipts and cost of cultivation decreased but the net income received increased to Rs.60740 per hectare. In the second ratoon plant, in spite of higher bunch yield, return was only Rs.84045 /- due to low price received per bunch. In the whole three years, per hectare total returns amounted to Rs.286914/-, while total cost was worked at Rs.124668/- and net income received was Rs.162236/-. The study clearly showed the high profitability of raising poovan banana ^{gave} ~~having~~ a high return cost ratio of 2.3:1 in the study.

During the analysis of profitability of tomato cultivation in Ahmadnagar district of Maharashtra, Khemnar *et al.* (1994) calculated the cost of cultivation and cost of marketing to find out the net profitability of the crop on different categories of farms. This study revealed that at the overall level the per hectare cost of cultivation of tomato was worked out to be Rs.60379/ha while the cost of marketing was Rs.41949/ha. Thus, total cost of production and marketing per hectare was equal to Rs.102328/- generating net return of Rs.26816/ha.

2.2 EXISTING RESOURCE USE PATTERN AND SUGGESTING OPTIMUM RESOURCES DAILY

Prior to technological breakthrough in Indian agriculture, farming was, by and large, of subsistence type and the farmers used those inputs which were mostly available on the farm itself. Today, agriculture requires a lot of capital investment and needs to be considered as a business proposition for better returns. The concept of relative profitability from different activities, has become the most important factor governing the choice of different products. So, the allocation of scarce farm resources among competing enterprises needs a careful examination. It was reckoned that farmers could reach higher levels of efficiency in production even with existing resources and technology. For optimizing resource use, the linear programming models have been found to be highly versatile under different farm situation as well as set of resource constraints.

Randhawa and Heady (1964) developed a linear programming model for agricultural planning in India with the objectives of allocating production of 16 major crops among regions in a manner to maximise food output from a given collection of resources. The programming results provided for important allocations of production among the regions. They indicated a projected gain of 12.5 per cent in total food production from given resources even when limits were placed on the magnitudes of shifts which could take place.

Radhakrishnan *et al.* (1971) conducted a study on optimum resource allocation for maximising farm income in Coimbatore taluk of Tamilnadu, using linear programming model for maximizing the income through the optimum farm plans. The optimal crop size increased the farm income by 5.7 per cent for small farms and 21.1 per cent for large farms. A comparison between present plan and optimal plan for small and large farms was made which indicated a substantial increase over present plan in net income, cropping intensity and labour use. The study revealed that there existed a great scope for increasing the income of farmers by re-organising the existing resources with the already available technical know-how. Permanent men labour and irrigation water were the major limiting factors which influenced the cropping plan.

Sankhayan and Sidhu (1974) examined the effect of imposition of self sufficiency constraints of food grains on the pattern of cultivation of commercial crops in Punjab by making use of linearing programming

technique. Nineteen crop activities and five types of constraints were included in the model. Self sufficiency constraints were imposed on ten crops. The optimum plans were developed ~~with an~~ without self sufficiency constraints. The study revealed that had the Punjab state followed a policy of self sufficiency in each of food grains, the production of these foodgrains would have fallen from 76.90 lakh to 68.27 lakh tonnes.

Making use of linear programming techniques, Manmohan and Johl (1979) developed normative production plans for three synthetic farm situations (A,B,C) at improved level of technology with dairying as a competitive enterprise to crops and estimated the capital and credit requirements for these plans which were then compared with the capital and credit requirements under the existing situation. Results of the normative production plans for situation A, B (rural, without impact of milk plant) and (rural with impact of milk plant) showed an increase of about 923, 484, 218 per cent of short term capital requirement over the actual base period situation, respectively. The study highlighted the need of heavy investment for obtaining the advantage of improved technology particularly with dairy as a competitive enterprise.

Singh (1978) conducted a study on optimum land use pattern and resource allocation in growing economy in Punjab in their size and classes drawn from bullock and tractor operated categories in six farming regions. Five synthetic farm situations were planned for each region and a linear programming model for profit maximization was used to find the optimal

normative solutions. The actual land use pattern during the base period was found to be suboptimal especially in relatively less developed areas. The optimum resource use, in addition to increasing farm incomes, was also more labour intensive. Development efforts were needed to bring about the necessary adjustments in cropping pattern and creating more employment in economy. The optimum cropping pattern indicated a trend towards specialisation which was in conflict with the then common emphasis being given on diversification. While in another paper, he had reported that return over variable cost could have increased by 346 per cent over the base period situation on a typical farm through adoption of the optimal production plans consisting the combination of crop livestock and poultry enterprises. A shift of area from economically less paying crops to economically more paying crops such as sugarcane, groundnut, mustard and lentil was also reported by Dahiya (1976). Almost similar study was made by Chatterjee (1987) also.

Pandey and Gangwar (1982) reported that appropriately modified forms of linear programming model having substantial flexibility to take care of varying situations seemed to be the best tool for deriving optimal production plans for the individual farm firms as well as for the area/region as a whole. For this purpose, the preparation of a detailed qualitative and quantitative inventories of various farm resources and other personal, social, institutional and market constraints, existing as well as the potential production processes along with their input output coefficients formed the very first step in exploring the alternatives and the possibilities for the modernisation of

agriculture in concerned region. By using the partial budgeting technique, input output coefficients of various alternative production processes could be synthesized.

Singh (1989) developed optimal crop and livestock production plan for Hisar district for 1994-95 and projected for a gradual shift in cropping pattern in favour of the commercial crops. The relative importance of milch buffaloes as the main source of milk would further increase on typical mixed farms. With the increase in commercialisation of agricultural sector, the demand for crucial inputs like HYV seeds fertilizer, plant protection, chemicals, fuel, feeds, etc. would necessitate further strengthening of various infrastructures with respect to input supply system and processing and marketing of farm products.

In an analysis of interstate disparities and agro-climatic zonal planning for agricultural development, Gangwar and Pandey (1990) reported that at microlevel the optimal production plans for various categories of farms need to be developed in such a way so that these also synchronise with the macro level optimal plans derived for the district zone/subzone/state, through suitable linear programming models developed for deriving optimal production plans.

Using linear programming models, Santhayan and Cheema (1991) prepared an optimum plan for the farm of a typical Punjab farmer in Ludhiana district. Detailed budgets on per acre basis for each of crop activities and necessary details on various activities, constraints and technical coefficients

were analysed. The optimal farm plans were obtained for the illustrative farm by restricting the working capital use to that of the actual base period plant i.e., Rs.41033/- and then by allowing working capital use to the extent that it was profitable, which amounted to Rs.44347/-.

Singh (1994) examined the prospects of increasing net farm income in Hazaribagh district of Bihar, on different categories of farms, by use of profit maximization model of linear programming technique. Two optimal plans yielding about double and triple net income over the actual base period plan, were developed to fulfil the objective of getting maximum possible net income. The study revealed that no additional inputs were required for these optimal plans, even under best available technology and there existed a large potential for increasing the net farm income by mere reallocation of existing resources in the form of optimum crop mix.

METHODOLOGY

To study the economic analysis of cotton wheat rotation vis-a-vis other crop rotation(s), stratified random sampling technique was used. From whole of the Haryana having seventeen districts two districts, i.e. Bhiwani and Hisar, which have the largest number of growers following this rotation were selected purposively. Depending upon suitability of agro-climatic conditions and irrigation water availability for this rotation one tehsil from each district i.e. Bawani Khera from Bhiwani and Fatehabad from Hisar, which are also highest yielder of this rotation in these two districts were selected.

Selection of tehsils form first stage of sampling. Two villages from each tehsil were selected ^{randomly} and selection of villages form second stage of sampling. List of cultivators of these four villages was prepared. Ten per cent of total farmers were selected for data collection. Selected farmers were

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divided into three categories viz. small, medium and large by cumulative total method.

Selection of cultivators from these villages form third stage of sampling.

CLASSIFICATION OF LAND HOLDINGS INTO FARM SIZE GROUPS

A list of farmers from the selected villages along with their operational holdings was prepared. The operational holdings were classified into small, medium and large size groups by cumulative total method.

SELECTION OF CULTIVATORS

From each set of two villages fifty cultivators distributed into different holding size groups were randomly selected in the sample. Thus from both the districts 100 cultivators were selected.

DATA COLLECTION

The primary data with regards to land inventory i.e. soil type, cropping pattern, sources of irrigation, water availability and requirements for different crops and crop yield etc., labour inventory i.e. family labour available in man days, wage rates in peak and lean periods etc., capital inventory i.e. owned and borrowed capital, cash receipts, cash expenses etc. were collected from selected cultivators.

The secondary data with regard to the prices of agricultural commodities, prices of insecticides and pesticides from dealers, fertilizers prices and relevant data from cooperative societies and canal authorities were collected.

Synthetic farm situations were developed to represent each farm size group i.e. small, medium and large.

ANALYTICAL TECHNIQUE

To analyse the data linear programming technique was applied. The following model was used in the present study.

$$\text{Maximize } z = \sum_{j=1}^n C_j X_j \dots\dots\dots(1)$$

$$\text{subject to } \sum_{j=1}^n a_{ij} X_j \geq b_i \quad (i = 1, 2, 3 \dots m) \dots\dots\dots (ii)$$

$$\sum_{j=1}^n a_{ij} X_j \geq b_i \quad (j = 1, 2, 3 \dots n) \dots\dots\dots (iii)$$

$$X_j \geq 0 \dots\dots\dots (iv)$$

where

z = returns over operating expenses

c_j = Net returns from one unit of j th real activity.

x_j = j th real activity

a_{ij} = Amount of the j th resource required to produce one unit of j th activity;

and

i = available quantity of i th resource

(i) Selection of crop activities

To find out optimum crop rotations under restricted conditions, it was necessary to consider all the crops which the cultivators had already tried or

grown in the area and a few new crops which can be easily grown. Instead of taking individual crop as a separate activity, crop rotations were taken as the real activities. Milch cattle have not been considered as a separate activity for profit maximization of the farmers but have been considered as an essential requirement for the farmer's family.

(ii) Input output coefficients

Input output coefficients for the crop rotations at existing level of technology were developed for each synthetic farm situation by taking the average quantity of various production inputs used and output obtained from the farm business data collected from the sample farmers for the year 1995-96. From these data for the individual crops, the input output coefficients for the major crop rotations being followed in the area were derived.

To derive input-output coefficients for the crop production processes grown under the improved technology, the relevant data were collected from experiment stations and the National demonstrations plots conducted in Bhiwani and Hisar districts by experts of farm advisory services of HAU, Hisar. Since there exists a considerable gap between production levels obtained from research/demonstration plots under the expert guidance and farmer's field, the yield coefficients at improved level of technology were suitably adjusted in consultation with crop scientists and concerned specialists working in the area.

(iii) Resource and other restrictions

The most limiting resources in crop production were land irrigation and capital. Labour in general is not so much of restrictive resource. Though, on medium and large size farms labour turned out a restrictive resource specially in peak periods.

(a) Land

The various land restrictions are given below:

- i) The restriction of minimum green fodder for animals on the farm.
- ii) The restriction of maximum area under certain processes to avoid risk and uncertainty and stabilization of income.
- iv) Restriction on area owned plus/minus rented in/out.

(i) Restriction of minimum fodder

Jowar barseem rotation was one of the most important fodder crop rotations in the area for supplying green fodder to milch cattle. However, the dry fodder can be supplied from wheat bhusa bajra karbi and other crops. Under such circumstances the minimum fodder requirement, which the farmer should provide for his livestock must be taken into consideration on the basis of milch cattle maintained by the farmers, the requirement of green fodder was worked out. Minimum area was computed for each size group.

ii) Restriction of minimum food requirement

In the study area, bajra and wheat are consumed throughout the year. Thus the restriction of area under food crops has been used. The minimum

requirements were computed on the basis of average family size on different size groups.

iii) Maximum area restriction

Because of the highest per hectare net returns, same rotations may not allow other activities to enter into the process. Hence, the maximum area restriction was imposed on this activity.

iv) Restriction on area owned plus/minus rented in/out

The actual operational holdings in each size group were considered as land restrictions.

(b) Irrigation

Irrigation restrictions were according to months when irrigation water was the real restriction for increasing farm output/income. In summer and rainy seasons, irrigation requirement was not too high and water was required mainly for cotton and paddy in submersible land. On the basis of the availability and requirement of irrigation water as crucial input in all the important crops on different farm situations, irrigation restrictions were divided into six time periods of one month each. The irrigation restrictions in critical periods were measured in hectare centimetres. The periods were October, November, December, January, February, March and May.

(c) Capital

The existing capital availability include the farmer's own capital out of his saving and any other source of income during the year under study. Since the capital was one of the most limiting resource in crop production in

the area. The capital borrowing activity was also introduced at 12 per cent rate of interest per annum on all the synthetic farm situations at both the levels of technology. This was due to the fact that the activities entered in the model were annual crop rotations and as such capital requirements were worked out on the basis of annual requirements of each crop rotation on each size group keeping in view the input requirements of each activity at the existing and improved level of technology.

(d) Other restriction

(i) Human labour

Labour was not a very important restriction on small farms. However, in case of medium and large size groups, the labour shortage was felt in peak work load periods. A total of family, permanent and hired labour were considered as labour restriction in man-days. The labour restriction in man days were considered in this study for the period of October, November, mid March to mid April and mid April to mid May.

The labour hiring activity was also introduced in the model to derive the optimal plans at both the levels of technology at current wage rate on medium and large farms for peak periods.

RESULTS AND DISCUSSION

The distribution pattern of land on different size of farms is shown in Table 4.1. Table shows that land available for cultivation to small, medium and large farmers was 2.62 ha, 5.29 ha and 8.67 ha, respectively. Entire operational holding on each of the three holding size group was irrigated.

Table 4.1: Distribution of land under different farm situations

| | (in ha) | | |
|---------------------------|---------|--------|-------|
| Particulars | Small | Medium | Large |
| Land irrigated | 2.62 | 5.29 | 8.67 |
| Land unirrigated | - | - | - |
| Total operational holding | 2.62 | 5.29 | 8.67 |

Availability and existing water use pattern on sample farms is given in Table 4.2. Availability of irrigation water ranged from 18 to 24 ha/cm on small farms, 32 ha/cm to 44 ha/cm on medium farms and 48 ha/cm to 68 ha/cm on large farms. Availability of irrigation was highest in month of October on all the farm situations partly due to the concern of government to ensure sufficient irrigation water through canals to ensure timely sowing of Rabi crops and partly due to low evaporation and percolation losses. Table shows under utilization at available irrigation water indicating mismanagement of this scarce resource. Utilization was less than availability in December and January on small farms, in January and February on medium farms and in October, January and March on large farms. This may be on account of poor land use planning at the part of the farmers.

Table 4.2: Availability and existing water use pattern in critical months on different sized farms

(in ha c.m.)

| Months | Small farmers | | Medium farmers | | Large farmers | |
|----------|---------------|----------|----------------|----------|---------------|----------|
| | Availability | Utilized | Availability | Utilized | Availability | Utilized |
| October | 24 | 24 | 44 | 44 | 68 | 66 |
| November | 22 | 22 | 36 | 36 | 54 | 54 |
| December | 20 | 19 | 32 | 32 | 48 | 48 |
| January | 20 | 19 | 36 | 34 | 54 | 52 |
| February | 18 | 18 | 32 | 30 | 48 | 48 |
| March | 22 | 21 | 36 | 36 | 54 | 52 |
| May | 23 | 23 | 38 | 40 | 54 | 54 |

Table 4.3 reveals that cotton-wheat and sugarcane were the major crops grown by farmers of various category. Table shows that crop rotations for small and medium farmers was same. Crop rotations of large farmers indicate that farmers of this category practised more diversified agriculture. Large farmers raised arhar-wheat, maize-jai, bajra-barley and okra-wheat rotations which were not ~~grown~~^{adapted} by small and medium farmers. Extensive diversification by large farmers was due to their access to more developed technology in comparison to small and medium farmers and their concern to fulfil the family, labour and livestock requirements.

The availability of farm labour on various size groups are indicated in Table 4.4. Table shows that family labour was the major source of labour supply on medium farms as compared to small and large farms. It was least on the large farms. On the other hand, hired labour engaged was the lowest on small farms and highest on large farms. The man land ratio was higher on large farms as compared to small and medium farms. When compared to operations holding, for 2.62 ha of land, 2.92 workers were available on the small farms whereas, for 5.29 ha of land 4.00 workers were available on medium farms and for 8.67 ha of land 4.13 workers were available on large farms. In other words, 0.89 ha, 1.32 ha and 2.09 ha area were available per worker on small, medium and large groups, respectively. This shows that labour on small farms was not fully employed.

Table 4.4: Labour resource available on various farm size groups

| Size group | Family labour available in mandays/day | Average hired labour in mandays/day | Total labour days/day | Total operational holding (ha) | Area per farm worker (ha) |
|------------|--|-------------------------------------|-----------------------|--------------------------------|---------------------------|
| Small | 1.92 | 1.00 | 2.92 | 2.62 | 0.19 |
| Medium | 2.38 | 1.62 | 4.00 | 5.29 | 1.32 |
| Large | 1.52 | 2.61 | 4.13 | 8.67 | 2.09 |

Table 4.5 reflect average cost of cultivation of cotton-wheat rotation vis-a-vis sugarcane and Arhar-wheat rotations. Table reflects that fertilizer cost constitute major portion of variable costs in all the three rotations, but in case of cotton-wheat rotation the expenses incurred on controlling weeds and insect pests were maximum, which was Rs 3088. But in case of Arhar-wheat rotation it was not so perceptible. Total cost was more in case of sugarcane (Rs.31288.04) followed by cotton-wheat (Rs.24000.87) and Arhar-wheat (Rs.25524.79). Gross returns were also of the same order viz sugarcane (Rs.39440), cotton-wheat (Rs.38674) and arhar-wheat (Rs.33114). But net

Table 4.5 : Average cost of cultivation per hectare of cotton wheat rotation vis-a-vis competing rotations : 1986-87

| Sr No | Item | Cotton-wheat | | Sugarcane | | Arhar wheat | |
|-------|-----------------------------|---------------|------------|---------------|------------|---------------|------------|
| | | Avg. qty (No) | Value (Rs) | Avg. qty (No) | Value (Rs) | Avg. qty (No) | Value (Rs) |
| 1. | Preparatory tillage | 7.2 | 1800 | 6.3 | 1575 | 6.82 | 1710 |
| 2. | Pre-sowing irrigation | | 180 | | 90 | | 180 |
| 3. | Ridging | | 90 | | 45 | | 90 |
| 4. | Seed (kg) | 11.52*105.3 | 1082.7 | 87.50* | 7000 | 12.8*105.3 | 1185.10 |
| 5. | Sowing | | 500 | | | | |
| 6. | FYM(cart load) | 13.1 | 770 | 10 | 250 | 11.1 | 720 |
| 7. | Fertilizers (kg) | | | | | | |
| a) | DAP | 225 | 1867.50 | 150 | 1245 | 125 | 1037.50 |
| b) | Urea | 250 | 1162.00 | 250 | 830 | 195 | 647.50 |
| c) | Zinc sulphate | 4.9 | 49.00 | | 1 | 2.4 | 24.00 |
| d) | Total fert investment | | 3078.50 | | 2075 | | 1708.00 |
| 8. | Use of fertilizers | | 64.00 | | 32.00 | | 32.00 |
| 9. | Irrigation(s) | | 770.00 | | 740.00 | | 690.00 |
| 10. | Hoing/weeding | | 3088.00 | | 1060.00 | | 500.00 |
| 11. | Harvesting | | 1890.00 | | 1620.00 | | 1440.00 |
| 12. | Threshing/winnowing | | 1430.00 | | | | 1900.00 |
| 13. | Interest on working capital | | 1032.50 | | 1159.34 | | 641.74 |
| 14. | Management expenses | | 1475.00 | | 1656.20 | | 1202.49 |
| 15. | Risk factor | | 1475.00 | | 1656.20 | | 1202.49 |
| 16. | Transportation expenses | | 526.10 | | 512.30 | | 503.20 |
| 17. | Rental value of land | | 9750.00 | | 9750.00 | | 9750.00 |
| 18. | Total cost | | 29008.00 | | 31268.09 | | 25524.19 |
| 19. | Production (in qtls) | | | | | | |
| (a) | Main product (C) | 10.8 | 19980.00 | 232 | 39440.00 | 12.1 | 14520.00 |
| (b) | Main product (W) | 36.8 | 13944.00 | | | 34.8 | 13164.00 |
| (c) | Byproduct | | | | | | |
| | Wheat | 38.0 | 4750.00 | | | 36.0 | 4500.00 |
| | Arhar | | | | | | 86.00 |
| 20. | Gross returns | | 38674.00 | | 39440.00 | | 33064.00 |
| 21. | Net returns | | 9665.20 | | 8152.00 | | 7539.21 |

*Sugarcane (in quintals)

return was more in case of cotton-wheat (Rs 9665.20) followed by sugarcane (Rs 8152) and arhar-wheat (Rs 7539.21).

Table 4.6 indicates the level of available resources of land, human labour available in peak months, irrigation availability in critical irrigation months, working capital minimum area under fodder, minimum area under cereals for family requirements and maximum area under mustard

Taking the above facts in view and with the available resources at existing level, an attempt has been made to optimise the resource use and maximise the net returns on different farms under the following sub-head (i) existing and optimum crop rotations (ii) Net returns from existing and optimum plans.

Table 4.7 shows that with the optimal allocation of resources at existing and improved level of technology, considerable changes might be taken in crop rotation. It further indicates that with the rational use of scarce resources, system of farming becomes more specialised. After permitting labour hiring and capital borrowing resources, it has been examined whether or not the increased availability of labour and capital resources would have any significant impact in the optimal crop rotations. Table indicates that with existing resource restrictions, crop rotations at existing and improved level of technology remains the same. But change in allocated land was observed at improved level of technology. Area under cotton-wheat rotation decreased at improved level of technology, but area under fallow-mustard rotation increased from 0.634 ha to 0.824 ha.

Table 4.6: Level of resource restrictions on different farm situations at existing level of technology

| Sr No | Resource restriction | Situation I | Situation II | Situation III |
|----------|---|-------------|--------------|---------------|
| | | Small | Medium | Large |
| 1 | Land (ha) | 2.62 | 5.29 | 8.67 |
| 2 | Operational holding (ha) | 2.62 | 5.29 | 8.67 |
| 3 | Human labour available in peak months (man hrs) | | | |
| i) | Mid March - Mid April | 360 | 640 | 720 |
| ii) | Mid April - Mid May | 360 | 640 | 720 |
| iii) | October | 360 | 640 | 720 |
| iv) | November | 360 | 720 | 960 |
| 4 | Irrigation availability in critical months (ha cm) | | | |
| i) | October | 24 | 44 | 68 |
| ii) | November | 22 | 40 | 54 |
| iii) | December | 20 | 32 | 48 |
| iv) | January | 20 | 36 | 54 |
| v) | February | 18 | 32 | 48 |
| vi) | March | 22 | 36 | 54 |
| vii) | May | 23 | 38 | 54 |
| 5 | Working capital | | | |
| | Availability per annum (Rs.) | 26400 | 48640 | 72920 |
| 6 | Minimum area under fodder (ha) | 0.10 | 0.15 | 0.30 |
| 7 | Minimum area under cereal for family requirement (ha) | 0.20 | 0.40 | 0.80 |
| 8 | Maximum area under mustard (ha) | 0.40 | 0.80 | 1.00 |

Table 4.7: Optimum and existing crop rotations with existing resource restrictions and relaxed resource restrictions on small farms

(in ha)

| Crop rotations | Existing crop rotations | Optimum crop rotation with existing resource restrictions | | Optimum crop rotation with relaxed resource restrictions | |
|----------------|-------------------------|---|------------------------------|--|------------------------------|
| | | Existing level of technology | Improved level of technology | Existing level of technology | Improved level of technology |
| Cotton-Wheat | 1.000 (38.16) | 1.649 | 1.496 | 1.395 | 1.373 |
| Jowar-Barseem | 0.100 (3.89) | 0.100 | 0.100 | 0.100 | 0.100 |
| Bajra-Wheat | 0.300 | 0.236 | 0.200 | 0.200 | 0.200 |
| Bajra-Gram | 0.310 | - | - | 0.145 | 0.482 |
| Sugarcane | 0.410 | - | - | 0.800 | 0.545 |
| Fallow-Mustard | 0.200 | 0.634 | 0.824 | - | - |
| Jowar-Gram | 0.300 | - | - | - | - |

Bajra-gram and sugarcane rotations entered as new crop activities with relaxed resource restrictions at both level of technology. fallow-mustard rotation was completely replaced with relaxed resource restrictions. Area under cotton-wheat and bajra-gram rotations increased.

Table 4.8 reveals that crop rotation at both levels of technology with existing resources restrictions is more or less same. It can be seen from table that area under jowar-barnum, bajra-wheat rotations is same at both level of technology. But a shift in area under fallow-mustard, fallow-gram and cotton-wheat is appreciable. Area under fallow-gram grain and fallow-mustard rotations decreased considerably but area under cotton-wheat rotation more than doubled at improved level of technology thereby, allowing the use of irrigation water and land more judiciously. But sugarcane was completely replaced at improved level of technology with existing resource restrictions.

But when labour hiring and capital borrowing activities are incorporated arhar-wheat and bajra-gram rotations entered as new crop activities at existing level of technology but fallow-mustard, sugarcane were completely replaced at this level of technology. Area under jowar-barnum and bajra-wheat rotations remained same at both the levels of technology. Fallow-gram and bajra-gram rotations were completely replaced in favour of sugarcane and okra-wheat rotations. With relaxed resource restrictions area under cotton-wheat rotations remained nearly at the same level but area under arhar-wheat rotations increased indicating shift towards more paying crops.

Table 4.8: Optimum and existing crop rotations with existing resource restrictions and relaxed resource restrictions on medium farms

(in ha)

| Crop rotations | Existing crop rotations | Optimum crop rotation with existing resource restrictions | | Optimum crop rotation with relaxed resource restrictions | |
|----------------|-------------------------|---|------------------------------|--|------------------------------|
| | | Existing level of technology | Improved level of technology | Existing level of technology | Improved level of technology |
| Jowar-Barseem | 0 200 | 0 150 | 0 150 | 0 150 | 0 150 |
| Bajra-Wheat | 0 480 | 0 400 | 0 400 | 0 400 | 0 400 |
| Fallow-Mustard | 0 600 | 1 141 | 0 790 | - | - |
| Sugarcane | 0 940 | 1 535 | - | - | 0 593 |
| Fallow-Gram | - | 1 002 | 0 283 | 0 623 | - |
| Cotton-Wheat | 1 600 | 1 062 | 2 677 | 2 000 | 2 622 |
| Arhar-Wheat | - | - | - | 0 917 | 1 221 |
| Bajra-Gram | 0 170 | - | - | 0 400 | - |
| Chira-wheat | - | - | - | - | 0 304 |
| Jowar-Gram | 0 760 | - | - | - | - |

Table 4.9: Optimum and existing crop rotations with existing resource restrictions and relaxed resource restrictions on large farms

(in ha)

| Crop rotations | Existing crop rotations | Optimum crop rotation with existing resource restrictions | | Optimum crop rotation with relaxed resource restrictions | |
|----------------|-------------------------|---|------------------------------|--|------------------------------|
| | | Existing level of technology | Improved level of technology | Existing level of technology | Improved level of technology |
| Jowar-Barsoom | 0.400 | 0.300 | 0.300 | 0.300 | 0.300 |
| Bajra-Wheat | 1.090 | 0.800 | 0.500 | 0.800 | 0.800 |
| Fallow-Mustard | 0.800 | . | . | . | . |
| Fallow-Gram | . | 3.653 | 0.863 | . | . |
| Cotton-Wheat | 2.400 | 1.159 | 1.557 | 3.600 | 2.217 |
| Sugarcane | 1.390 | 2.758 | 1.044 | 1.700 | 1.928 |
| Maze-Jai | 0.300 | . | . | 1.033 | . |
| Bajra-Barley | 0.430 | . | . | 1.237 | . |
| Okra-wheat | 0.360 | . | . | . | 0.513 |
| Arhar-Wheat | 0.800 | . | . | . | 2.013 |
| Jowar-Gram | 0.700 | . | . | . | . |

Table 4.9 shows a considerable change in area from existing level of technology to improved level of technology. It can be seen from the table that area under jowar-berseem remained same at both level of technology but area under bajra-wheat rotation decreased from 0.800 ha to 0.500 ha. Table further shows that except cotton wheat rotation, area under all other decreased considerably at improved level of technology. But when labour hiring and capital borrowing activities are incorporated, land is fully utilized at both level of technology. Area under jowar-berseem and bajra-wheat rotations remained same at both level of technology. Area under cotton wheat rotation decreased from 3.600 ha to 2.217 ha at improved level of technology, but area under sugarcane increased from 1.700 ha at existing level of technology to 1.928 ha at improved level of technology. Maize-jai and bajra-barley rotations were completely replaced at improved level of technology. Okra-wheat and arhar wheat rotations entered as new crop activities. Area under arhar-wheat increased to 2.413 ha at improved level of technology.

SUMMARY AND CONCLUSION

It is needless to emphasize the importance of crop rotations, particularly in agriculture dominated state like Haryana. After green revolution, farmers are practising and judging the reliability of different rotations. During this process cotton-wheat rotation has emerged as major crop rotation. It is one of the most important rotations in Southern and Western Haryana. Wide scale raising of this rotation has necessitated to conduct an experimental study on this rotation to judge its profitability and competence in comparison to other rotations. So the present study was undertaken with the following specific objectives:

1. Economic analysis of cotton-wheat rotation vis-a-vis other crop rotations.
2. To study the existing resource use pattern.
3. To suggest optimum resource use.

To draw a representative sample of farmers, two districts, Bhiwani and Hisar were selected, depending upon area under this rotation, soil type intensity of land dunes and cropping pattern. One tehsil having maximum area under this rotation were selected purposively. Two villages from each tehsil were selected randomly. List of cultivators of these villagers along with their operational holdings was prepared and classified into small, medium and a large size groups. Fifty farmers from each tehsil of different size groups were selected randomly in the sample. Thus, in all 100 cultivators were included in the sample from two districts. The primary data with regards to land, labour and capital availability, cropping pattern, source and number of irrigation, cash receipts and cash expenses were collected from the selected farmers. The secondary data with respect to prices of agricultural commodities, insecticides, fertilizers and irrigation from concerned agencies were also collected for the year 1996-97.

Synthetic farm situations were developed to represent each farm size group. Linear programming technique was used for the synthetic farm situations at existing and improved levels of technology under the frame work of existing resources as well as the relaxed capital and labour constraints.

There existed considerable variation in cost of cultivation, gross and net returns during the year on all the size groups. Gross return was more in case of sugarcane but net returns was more in cotton-wheat rotation. Net return was lowest in case of arhar-wheat rotation. Existing available irrigation water remained underutilized mainly in months ⁴December, January and March

on small farms, January and February on medium farms, October, January and March on large farms. Under cotton-wheat rotation was maximum on all the size groups.

When capital and labour restrictions were relaxed, the available land was relatively better allocated under the optimal plans at improved level of technology as compared to the plans at existing level of technology on small, medium and large farms. However, the allocation of land was almost equally efficient even at existing level of technology in case of all farms.

Thus, the necessary steps should be taken by the financial agencies to release the capital constraints faced by the farmers particularly through liberalization of the credit facilities. This would help a lot in adoption of the improved technology which might ultimately result into better and more productive use of the land for increasing farm income.

The cropping pattern under the existing level of resource supplies would move towards specialised farming in optimum plans at existing level of technology and decreased at improved level of technology on small, medium and large farms. This shows that more capital is required to improve the cropping patterns of the area.

After the relaxation of capital and labour restrictions, significant shifts in the crop rotations in favour of more paying crops like arhar-wheat, olive-wheat, jowar-gram, was observed.

CONCLUSION

The following conclusion may be drawn from the study

Utilization of water was less than availability in one or two critical months on all the size groups reflecting poor management of this scarce resource. In existing cropping system, the area under cotton-wheat rotation was comparatively more than the area under other rotations. In the same way, it was most sought after rotation after optimization at both existing as well as improved level of technology. Net returns obtained from this rotation were comparatively more than other crop rotations. Although gross returns were more in case of sugarcane but expenses also increased proportionately.

Study also revealed that number of rotations ~~given~~ by farmers increased as farm size increased. Study suggested that in spite of capital and labour intensive rotation was most beneficial and could do a lot to decrease water table particularly in the areas where high water table was becoming a problem.

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DEPARTMENT OF AGRICULTURAL ECONOMICS

TOPIC: Economic analysis of cotton-wheat rotation in Haryana

1. Name of Respondent

i) Father's Name

ii) Name of village

iii) Block

iv) Distance of village from the town kms

2. Personal and Family information

i) Total family members of the family

ii) Number of non-workers in the family

iii) Age of respondents (years)

iv) Educational status Illiterate/Literate

If literate - Middle/Matric/Intermediate/Graduate

3. Land Inventory

| | Area in acres | | | Rental value of land (Rs.) |
|-------------------------|---------------|-------------|-------|-------------------------------|
| | Irrigated | Unirrigated | Total | |
| i) Land | | | | |
| ii) Land leased in | | | | |
| iii) Land leased out | | | | |
| iv) Operational holding | | | | |

4. Labour

i) Availability of labour on farm

ii) Family labour (days)

iii) Permanent labour (days)

iv) Total casual labour hired (days)

- v) (a) Wage rate of permanent labour if any (Rs.)
 (b) Do you feel shortage of labour Yes/No
 If yes, specify the period

vi) What is wage rate in your village ?

a) Normal period : Male (Rs.)

: Female (Rs.)

b) Peak period : Male (Rs.)

: Female (Rs.)

5. Source of irrigation Tubewell / Canal
 If tubewell : Power operated / Engine operated

i) Cost of canal (Rs./hrs)

ii) Cost of irrigation

a) Power operated (Rs.)

b) Engine operated (Rs.)

iii) Total irrigation water
 available (ha cm)

6. Source of income

a) Agriculture and livestock Rs

b) Service Rs

c) Others Rs

7. i) Capital in hand (Rs.)
 ii) Capital in Bank (Rs.)
 iii) Capital available for (a) Kharif crops (Rs.)
 (b) Rabi crops (Rs.)

7. Cropping patterns

| Crop | Kharif | | Remarks | Rabi | | Remarks |
|---------------------------|--------|-------|---------|------------|-------|---------|
| | Area | Yield | | Area | Yield | |
| 1) Cotton | | | | Wheat | | |
| 2) Bajra | | | | Barley | | |
| 3) Jowar | | | | Gram | | |
| 4) Guar | | | | Lentil | | |
| 5) Arhar | | | | Toria | | |
| 6) Mung | | | | Mustard | | |
| 7) Mosh | | | | Vegetables | | |
| 8) Urad | | | | Barnum | | |
| 9) Lobis | | | | Others | | |
| 10) Til | | | | | | |
| 11) Others | | | | | | |
| Total cropped area | | | | | | |

7. i) What are your normal crop rotations ?
 a)
 b)
 c)
 d)
 e)

8. Did you practise the following

- i) Inter cropping Yes/No
 ii) Mixed cropping Yes/No

9. Cost of production:

Crop _____ Variety _____ Area _____ (in acres)
 Time of sowing _____ Previous crop _____
 Irrigated or unirrigated _____

| Item | Material used | | Human labour | | Bullock labour | | Tractor | | Total expense (Rs) |
|------|---------------|-----------|--------------|------------|----------------|-----------|---------|------|--------------------|
| | Qty | Rate (Rs) | Family | Hired Rate | No | Rate (Rs) | No | Rate | |

- a) Preparatory tillage
- b) Ploughing planking
- c) Pre-sowing irrigation
- d) Ridging
- e) Sowing
 " "
- f) Seed (kg)
- g) Seed treatment
- h) Fertilizer
 - i)
 - ii)
 - iii)
 - iv)

- i) Irrigation
 - i) Canal
 - ii) Tubewell
- j) Hoeing weeding
 - i) Manual
 - ii) Chemical
- k) Spray
- l) Harvesting/
plucking
- m) Threshing/
winnowing
- n) Interest on
working
capital
- o) Miscellaneous
- p) Total cost
- q) Total production

| i) Main product | Qty | Value |
|-----------------|-----|-------|
| ii) By-product | | |

Gross returns (Rs) _____

Net returns (Rs) _____

