AN ECONOMIC ANALYSIS OF SELECTED AGRICULTURAL SYSTEMS IN TUNGABHADRA PROJECT AREA, KARNATAKA

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CERTIFICATE

This is to certify that the thesis entitled **"AN ECONOMIC ANALYSIS OF SELECTED AGRICULTURAL SYSTEMS IN TUNGABHADRA PROJECT AREA, KARNATAKA"** *submitted by* **Mr. YERRISWAMY J.,** *for the degree of* **MASTER OF SCIENCE** *in* **AGRICULTURAL ECONOMICS** *to the University of Agricultural Sciences, Dharwad, is a record of research work carried out by him during the period of his study in this university, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.*

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Dharwad

November, 1999 *(Yerriswamy,.J)*

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INTRODUCTION

I INTRODUCTION

In India, where changes in agricultural practices are occurring rapidly, traditional and modern systems frequently co-exist in adjacent areas of the country. As agricultural and rural development continues, the momentum is behind the adaptation of modern systems because of their demonstrated efficiencies in terms of production. On the other hand, some traditional practices are better attuned to the local culture and environment and could be more sustainable and perhaps more beneficial to the population as a whole. Indian rural society is in a period of transition. Villages in parts of Punjab and Haryana, in the Godavari and Cauvery/Krishna Deltas and in other areas scattered throughout the sub-continent have adopted Green revolution agriculture practices, and are producing record breaking yields of cereals and other crops.(Rajesh Kaul and Tripati, 1997)

Prior to the green revolution, Indian agriculture was in the form of traditional or subsistence farming which was characterized by use of local seeds or planting materials, harnessing the rainfall water resources, locally available resources and non- modern methods of agricultural operations in the production of various crops. These types of production process did not succeed in feeding the ever-increasing population of our country. The farmers were forced to switch over to modern methods of agriculture. The basis of Modern Agriculture are new technological options which include the use of chemical fertilizers, plant protection chemicals, mechanical implements and High Yielding Varieties (HYV). To boost the production, excessive use of these new technologies was made. The results were also good in initial stages. But after a certain gap the returns were decreased or started diminishing.

Simultaneously these increased use of inputs of new technologies have caused manifold environmental problems (Sumedha Naswa, 1998).

Modernization of agriculture has led to excessive use of nitrogenous fertilizers. Addition of nitrates in agricultural fields has become a serious health hazard. During the past few decades the use of fertilizers has increased at an alarming rate. During 1970-71, the consumption of chemical fertilizers in India was 2.18 million tonnes. After two decades in 1990, the consumption was approximately 12.00 million tonnes. These rising figures itself determine the adverse affects of fertilizers on human environment.

Therefore, modern agriculture which apparently looks beneficial in terms of increase in production, income and employment etc., is really beneficial ? Such modern agriculture systems are seen in irrigated canal commands of the country. India has the largest irrigated area (115.26 million ha) in the world but more than 53 per cent of the land area in India is sick due to water-logging and other degradations (Sumedha Naswa ,1998).

Tungabhadra project in Karnataka is one of the important major irrigation project commissioned during 1952. Even before the construction of dam across the river, the area all along the river belt was irrigated by the Vijayanagara canals which were diversion dams and existed in 1700 AD during Vijayanagara Kingdom. This area is under irrigation for the last three centuries. By the side of this, the newly irrigated system, the Tungabhadra project (TBP) was developed after 1950. In the Tungabhadra project command area, those areas nearer to the dam (head region) got irrigation early and were developed by 1960's. Because of their locational advantage, the head region gets assured supply of canal water even today (Hugar, 1997). However, in the tail end of the project, the area is still under development. Therefore, there are distinct differences in the agricultural systems prevailed in the ancient irrigated areas, head and tail regions of the newly irrigated areas.

The agricultural system in the head region of the Tungabhadra project is highly intensive with excessive use of irrigation water coupled with chemical fertilizers and plant protection chemicals. Due to indiscriminate use of these inputs, this region is affected by salinity, waterlogging, increase in the incidence of pests and diseases, changes in bio-diversity, human health hazards, etc. Added to all these, there is a stagnation in the yield of major crops in recent years (Itnal,1998).

Such phenomena are moderate in the tail region of the Tungabhadra project area. However, in the Vijayanagar canal irrigated systems such problems apparently looks to be minimum inspite of their irrigation for last 3 centuries.

Therefore, a critical examination of these distinct agricultural systems is essential to throw light on the future developmental strategies. In this regard, an attempt has been made in the present study to assess the performance of these three agricultural systems and to find out their socio-econnmic impact. More specifically, the objectives of the study are as follows.

Specific objectives of the study :

1. to identify cropping and land use pattern in selected agricultural systems;
2. to find out input use pattern, costs and returns structure in different crops under selected agricultural systems;
3. to estimate the resource-use efficiency of various inputs in different crops;
4. to find out the efficiency of selected agricultural systems; and
5. to determine the socio-economic impact of selected agricultural systems.

Scope of the study :

The focus of this study was on economic analysis of selected agricultural systems existed in Tungabhadra Project (TBP), Karnataka. This study was proposed to study the cropping pattern, resource use pattern and their efficiency, returns and socio-economic benefits realised under selected agricultural systems. Such a study is likely to throw adequate insights into the technical and economical structure of farmers in selected agricultural system. It is likely to help the farmers in attaining sustainable cropping pattern through a more efficient use of available resources.

Limitations of the study :

The present study has limitations of the time and other resources commonly faced by a student researcher. However, considerable care and thought have been exercised in making the study as objective and systematic as possible. Even though the estimates were provided by the recall memory because of the non-maintenance of the farm records, sincere efforts have been made to elicit the information as accurate and reliable as possible by cross questioning. It may however, be recognized that the findings of the study may not be generalised beyond the boundaries of the area under investigation and such other areas having dissimilar agro-climatic and socio-economic conditions.

Presentation of study :

This study is presented in six chapters

Chapter -I deals with the introduction to the topic, objectives, scope and limitations of the study.

Chapter – II contains the review of literature relating to the objectives of the present study.

Chapter –III describes the main features of the study area, the sources from which the relevant data were collected and the tools and techniques with which the data collected have been analyzed and interpreted. This chapter also presents the definitions of the terms and concepts used in the study.

Chapter –IV is devoted to the presentation of the results through a variety of tables into which relevant details have been compressed. Here, a brief indication of major findings has been given.

Chapter - V discusses the findings of the study presented in the chapter –IV.

In the final chapter (chapter-VI), a brief summary of the main findings has been presented along with the policy implications that emerge from the findings of the study.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

In this chapter, an attempt is made to critically review the past studies on economics of different agricultural systems under the following heads keeping in view the objectives of the present study.

2.1 Cropping pattern

2.2 Costs and returns structure in different crops

2.3 Resource use efficiency

2.1 Cropping pattern

Anand (1960) reported that area under foodgrains was replaced by non-food and commercial crops like vegetables, sugarcane, spices and fruits wherever there was supplementary irrigation facilities through wells in Chambal valley (Madhya Pradesh) and Bhind and Kotha districts (Rajasthan). In general, cropping intensity increased from 90 – 105 per cent to 130-180 per cent with the supplementary irrigation.

Shah (1963) in his study on cropping pattern in relation to irrigation in Amritsar and Ferozpur districts of Punjab observed a shift in the cropping pattern from food crops to non-food crops and inferior crops were replaced by superior and commercial crops, leading to greater agricultural production through intensive use and increased productivity of variable resources.

Singh *et al.* (1973) studied the impact of new technology on cropping pattern in Mahindergarh, a typical dry farming district of Haryana state. He reported that area under foodgrains had increased considerably without any technological break-through, which was explained by the price incentive that prevailed during the study period.

Jodha (1977) indicated that cropping patterns were affected by multiplicity of factors, of which, resource base was one. Within the resource base, the land types, irrigation and rainfall played the most important role. These basic resources together with the availability of crop varieties, markets and relative prices of commodities determined the comparative advantage of different crops and crop mixes on various soil types and also the rate of return to investment.

Acharya and Lodha (1986) studied the cropping pattern of head, middle and tail end groups of farmers of Gudda irrigation project of Rajasthan. They found a decreasing trend in the proportion of area under maize, wheat and sugarcane as they moved from head to middle and tail end farmers. While a reverse trend was observed with respect to the proportion of area under pulses like blackgram, greengram and pigeonpea.

According to Dantwala (1986) a number of factors influenced the changes in cropping pattern. The most important ones among them were the differentiated rate of technological change among crops, the spread area of irrigation leading to area shrinkage of dry crops, market intervention and support by the government in certain crops, relative prices between different crops.

Rajkumar and Panda (1986) studied the use of water and its impact on cropping pattern at different locations for the canal irrigation systems in Bamnal minor canal

(Orissa). He reported that, due to the availability of adequate water at the head reach and the middle reach, the farmers had devoted a considerable proportion of area to labour and capital intensive crops like high yielding paddy and potato. In contrast, because of inadequacy and uncertainty of water at the tail reach, the farmers resorted to low duty crops like pulses and groundnut on a larger scale. The cultivation of vegetables occupied a higher percentage of area in the head reach. In the middle reach, potato had higher percentage of area while the pulses and groundnut had higher percentage at the tail reach.

Reddy and Hiremath (1986) found that cotton was the most important crop in Sindhanur and Raichur talukas occupying about 37.20 and 45.16 per cents of the gross cropped area with DCH-32 hybrid wherever assured irrigation available. By contrast, the area under Laxmi variety of cotton was more predominant under rainfed conditions. The nature and the extent of crops grown particularly on large farms were based on the profitability of other alternative crops.

Patil (1987) analysed the cropping pattern under different sources of irrigation in Mudhol taluk of Karnataka. He found that *kharif* was the main cropping season for the canal irrigated farms in which maize occupied 46.05 per cent of total cropped area while jowar and wheat were grown during *rabi* season to a smaller extent. On well-irrigated farms, *rabi* was the main cropping season with wheat and greengram accounting for 59.05 and15.85 per cents of the total cropped area, respectively. On canal and well-irrigated farms, sugarcane, banana and cotton occupied 47.50 per cent of the total cropped area.

Kaligouda (1989) studied the economics of cropping pattern in Ghataprabha command area. He reported that cropping pattern on the lands with conjuctive use of water in all the size groups of farmers were practically identical with the highest proportion of area under annual and perennial crops. Where as, *rabi* crops were dominant on the lands without conjunctive use of water. The study also revealed that there was an inverse relationship between the farm size and cropping intensity.

Krishnakumari (1992) examined the changes in cropping pattern, crop combination, crop area and diversification of crop enterprises in Tamilnadu and found that changes were mainly due to change in agricultural inputs like HYV, fertilizers, pesticides, tractor use, and irrigation intensity. He also reported that in the western and north western regions, modernization was low because of low rainfall, poor soils, interior location and poor irrigation facilities.

Umrani *et al.* (1992) examined the sustainability of cropping systems under rainfed condition in Solapur (Maharashtra) and reported that gram crop was more suitable than other crops in dry land conditions. It was concluded that inclusion of gram in the cropping system resulted in an additional monetary returns and thus more beneficial

2.2 Costs and returns structure in different crops

Hiremath *et al.* (1984a) found higher profits on irrigated farms of Sorapur taluk than non-irrigated farms in the case of jowar, groundnut, sunflower and wheat. The per hectare profit turned out to be maximum for groundnut (Rs.5559) followed by jowar (Rs.390.65), wheat (Rs.348.75) and sunflower (Rs.136.45).

Hiremath *et al.* (1984b) estimated gross returns, costs and profits per acre of major crops in Malaprabha command area and reported that the total cost of cultivation of hybrid varalaxmi cotton worked out to Rs. 1706.53 and net profit of Rs.2051.67 with gross returns of Rs. 3757.70. The net profit (Rs. 406.83/acre) in hybrid maize was found to be marginal with a gross returns of Rs. 1082.22 per acre and total cost of Rs. 675.39. In the cultivation of hybrid jowar, farmers obtained net profit of Rs. 426.92 by incurring a total cost of Rs. 637.45 per acre. Net profit from cultivation of local cotton was Rs. 1974.03

Dhongade and Dangat (1985) studied the cost and income structure of farm business in Sina command area (Maharashtra). The per hectare cost of irrigated *kharif* hybrid jowar worked out to Rs.4303.49. With an average yield of 23.75 quintals, gross returns was Rs.6329 and profit obtained at cost-C formed Rs.2024.40 per hectare. In the case of irrigated *rabi* jowar, farmers incurred Rs.2144.70 as cost and obtained grain yield of 8.15 quintals per hectare. Thus, the net profit at cost-C worked out to be Rs.583.05 with gross returns of Rs.2723.75. The per hectare total cost of cultivation of wheat worked out to Rs.2778.61. With the gross value of produce being Rs.2932.30 per hectare, the net returns worked out to be marginal (Rs.153.69). The net returns in sugarcane was found to be relatively higher (Rs.21560.3/ha) with an average cost of cultivation being Rs.9443.70.

Gadre and Mahale (1988) worked out the per hectare returns from cotton and its non-commercial competing crops in Vidarbha region and reported that the cost of cultivation (Cost-C) per hectare was Rs. 3848.00 for hybrid cotton followed by mung-safflower (Rs.1984) and tur as sole crop (Rs.1845). The same for desi improved cotton, mung- gram and mung-wheat worked out to Rs.1541, Rs.1495 and Rs.1404, respectively. Measuring the profitability of different cropping systems on the basis of net returns per hectare, tur (sole crop) gave the highest returns per hectare (Rs.2905) followed by mung-safflower (Rs.2627) and mung-wheat (Rs.1805). Net returns for hybrid cotton, desi improved cotton and mung – wheat sequence worked out to Rs.1062, Rs.888 and Rs.948, respectively. They inferred that on the basis of net returns per hectare, all the substitute crops were more profitable than hybrid cotton (except mung – wheat sequence) as well as desi improved cotton too. They also concluded that for cotton crop, there are economically good substitute crops like tur, mung-safflower and mung – gram available for the Vidarbha region.

Chahal and Chahal (1989) studied the economics of irrigated crops in Punjab and concluded that the variable costs per hectare were highest for paddy followed by maize, sugarcane, wheat, cotton and groundnut. While the gross returns to fixed resources were maximum for sugarcane followed by wheat, paddy, cotton, groundnut and maize. Among the crop combinations, the annual returns to fixed farm resources were highest for sugarcane followed by paddy-wheat, cotton-wheat, groundnut-wheat and maize- wheat.

The returns to fixed farm resources per unit of irrigation were the lowest for paddy-wheat combination followed by cotton-wheat, sugarcane and maize-wheat. They concluded that cotton and groundnut should be encouraged in their respective farming areas, as their returns per unit of irrigation were higher than sugarcane.

Kaligouda (1989) based on his study in Ghatprabha command area (Karnataka) reported that sugarcane, *kharif* maize, cotton and chilli were the most important crops yielding a net income of Rs.4100.00, Rs.205.41, Rs. 296.00 and Rs.470.82 per acre respectively. Similarly, wheat, khalpi, bengalgram and *rabi* maize were major crops in the *rabi* with a net income of Rs.160.78, Rs.153.25, Rs.239.88 and Rs.540.52 per acre, respectively.

Singh and Grover (1992) in their study on wheat based crop sequences in different agro-climatic area of Punjab observed that variable costs of wheat – paddy (Rs. 2027.35/ha) sequence were higher than wheat – cotton (Rs.2002.13/ha), wheat – maize (Rs. 1887.35/ha) and in wheat- potato (Rs.1503/ha) sequences. However, returns over variable costs were higher in wheat-maize (Rs.2023.56/ha) sequence followed by wheat-paddy (Rs.1823/ha), wheat –cotton (Rs.1248.65/ha) and wheat-potato (Rs.857.35/ha) sequences.

2.3 Resource use efficiency

Singh and Sirohi (1973) made a comparative study of resource use in paddy, sugarcane and wheat farms of Sharapur and Meerut districts and reported that all the resources except capital on paddy farm, machinery and implements on sugarcane farms were by and large efficiently used.

Patil and Acharya (1974) used the cost concepts generally used in farm management studies in India to estimate and compare the cost of cultivation between sugarcane and banana in two districts of Maharastra. A modified Cobb-Douglas type of function was employed for estimating the resource productivities of land, human labour, manure and fertilizers and seeds. The analysis revealed that in no case did the coefficients exceeded unity thereby indicating diminishing returns to individual factors in both crops.

Singh and Patel (1974) examined the productivity of resources and allocation efficiency of different sizes of farms adopting new technology and reported that irrigation was the most profitable resource, offering prospects of further investments. The optimal allocation of limited capital indicated an increasing trend in the returns over the existing returns with an increase in the farm size.

Verma and Pareek (1975) studied the resource use efficiency in Jaipur district and observed higher marginal value productivity of land on small farms. The explanation given for this was that in an effort to get more income from the limited area of land available with them, the small farmers cultivated their land more intensively.

Singh (1975) used Cobb-Douglas type production function to study the productivity of resource use. The results revealed that the productivity per unit of land, seed, fertilizer and manure on the progressive farms were significantly higher than its acquisition cost and on the less progressive farms only the productivity of bullock labour was significantly higher than its acquisition costs, reflecting thereby the scope for increasing the use of resources to realize greater returns from crop production.

Arunkumar *et al.* (1980) studied the economic efficiency of large and small farms, using data from the hybrid sorghum and potato farms in Karnataka state. The study compared the profit of a farm firm as a function of the normalized prices (unit prices of inputs divided by the unit prices of output) of variable inputs and of land. Cobb-Douglas functions were also fitted. Both the methods supported the hypothesis that there was no difference in the efficiency between the two farm size groups. This finding was reinforced by the "chow test".

Kademani (1983) in his study on economics of intercropping in Bijapur and Dharwad districts measured the resource use efficiency of various intercropping systems by using the Cobb-Douglas type production function by considering the various variables in their value terms. The regression coefficients worked out for different inputs used in various crop combinations indicated that land was used more efficiently, compared to other inputs. Traces of over- utilization were found in the case of seeds, fertilizers, human labour as well as bullock labour in a number of crop combinations.

Khunt and Raju (1984) in their study on resource use efficiency of dry land farming in Rajkot district (Gujarath) observed that there was over-utilization of human labour in the case of groundnut and cotton production. The ratios of marginal value products of cash and kind expenditure relative to their cost were higher than unity for crops studied, indicating under utilization of these inputs.

Adhinarayana (1989) studied the resource use efficiency of *kharif* versus *rabi* rice fitting a Cobb-Douglas production function per farm. The ratio of marginal value product to opportunity cost pertaining to land in two seasons were greater than unity (*kharif* 2.5 and *rabi* 3.89), while it was less than unity in labour and fertilizers.

Radha *et al.*(1989) evaluated the resource use efficiency in rice–rice and rice-pulse farming systems of Krishna district in Andhra Pradesh employing Cobb-Douglas production function. All the variables were considered in their value terms. It was found that manures, fertilizers and irrigation were quite productively used in both the farming systems. The sum of elasticities indicated the operation of constant returns to scale in both the farming systems.

Saini *et al.* (1989) examined the influence of location factors on pattern of input use in right bank Giri canal irrigation project of Siramar district (Himachal Pradesh). They observed that the farmers in the tail reach and mid reach applied a larger quantity of seeds of maize, rice and wheat than the recommended dose due to the non availability of moisture. However, the use of chemical fertilizers was highest in the head reach and lowest in the tail reach. The average yield levels of major crops were higher in head reach and lower in tail reach.

Singh and Srinivas (1989) studied the effect of water distribution in different reaches of canal irrigation systems in Vamsadhara irrigation project command area of Andhra Pradesh and reported that manures and fertilizers had higher productivity in head reach, while it was relatively lesser in tail end.

Chandra Reddy *et al.* (1990) fitted a Cobb-Douglas production function to study the resource-use efficiency in betelvine cultivation in Cuddaph district of Andhra Pradesh. The study revealed that there was a potential for further use of labour, manures and fertilizers upto its optimum level. However, further investment in seed was found undesirable as reflected from their insignificant co-efficients.

Mahitha and Hemachandradu (1992) found that there was high degree of in-efficiancy in resource use on paddy farms in Andhra Pradesh and thereby need for reorganization of farm resources. There was good scope to reorganize the farm resources since ratios of MVP to MFC for most of the resources were more than unity.

Shareef (1993) studied the resource use efficiency of paddy crop in three regions of Krishna canal irrigation system in Andhra Pradesh. The estimates of production functions with R^2 values of 0.86, 0.68 and 0.79 for head, middle and tail region, respectively, clearly indicated that variables included in the function have explained the variation in paddy production considerably. The regression coefficient of fertilizer (0.9855) and labour (0.3470) was found significant in head and middle region. Even though the fertilizer input influenced paddy production significantly, its marginal value product to factor cost was more than unity both in head and middle regions, indicating their under utilization.

Srinivas *et al.* (1994) employed Cobb-Douglas type of production function to measure the efficiency of various inputs used in the production of wheat in Cuddaph district of Andhra Pradesh. They reported that ratio of MVP to MFC for land was less than unity for labour and fertilizers indicating their over utilization.

Nagaraj *et al.* (1995) studied the resource use efficiency in different cropping systems in Tungabhadra project command area (Karnataka) and reported that due to the operational differences in the cultivation practices, the use of labour in all the crops differed. In case of cotton and maize-sunflower system, the tail reach farmers had used relatively lower quantity of fertilizers due to the inadequacy of water supply. Farmers in the head reach situation were using the recommended dose of fertilizer to the crops as they did not face in-adequacy of water at any stage. They also reported the interaction between fertilizers and irrigation was positive and significant. Small farmers generally applied more fertilizer per unit area in order to maximize the returns per unit area.

Koppad *et al.* (1997) in their study on resource use efficiency in maize crop in three locations of Malaprabha command area (Karnataka State) noticed that land was over utilized in head reach as revealed by negative MVP to MFC ratios (-0.0843) and under utilized in middle and tail reaches (1.7780 and 2.2185 respectively). However, human labour was over-utilised in all the three locations (-0.0843, -0.7780 and 0.8587). In the case of manures and fertilizers, they were over-utilized in head reach (0.0489) and under utilized in middle and tail reaches (1.8013 and 2.5340 respectively). Further, the results of the functional analysis indicated that the variables included in the function explained 97, 96 and 93 per cent variation in the gross income in head, middle and tail reaches, respectively.

METHODOLOGY

III METHODOLOGY

This chapter briefly describes the study area, sampling procedure adopted, method of survey, nature and sources of data and the various tools and techniques employed in analyzing the data collected and its evaluation for results. At the end, the important concepts used in the study are also defined and explained to facilitate a clear understanding of the issues with which a present study is related. The chapter is presented under following headings :

3.1 Description of the study area

3.2 Sampling procedure

3.3 Nature and sources of data

3.4 Analytical techniques employed

3.5 Efficiency indicators

3.6 Definitions of the terms and concepts used

3.1 Description of the study area

3.1.1 Location

The Tungabhadra Project (TBP) command area is located in northern part of Karnataka and lies between $15^{o}09^{1}$ and $16^{0}\ 34^{1}$ north latitude and $75^{0}\ 35^{1}$ east longitude. The command area covers Raichur, Koppal and Bellary districts in Karnataka state.

3.1.2 Agro-climatic features

The major soils of this tract are deep to medium and shallow black soils with reddish sandy soils confined to some areas. Nearly 75 per cent of the study area comprises of black soils and remaining 25 per cent constitutes red and sandy loam soils.

The climate of Tungabhadra Project area is characterized by low rainfall, high annual temperature with diurnal variation and generally with low humidity. It resembles the characteristics of arid to semi-arid region. Seventy percent of the total rainfall is received during the South – West monsoon season. The average annual rainfall is about 635 mm. as recorded during 1998-99.

3. 1. 3 Salient features of Tungabhadra Project (TBP)

The river Tungabhadra derives its name from two tributaries viz,Tunga and Bhadra which originates in Varaha Parvatha in Western Ghats and join at Kudali village in Shimoga district. The Tungabhadra river is 640 kms in length and joins the river Krishna at Sangameshwaram near Kurnool in Andhra Pradesh. For proper utilization of this large river flows, the Tungabhadra Dam was constructed across the river Tungabhadra near Mallapur village (now submerged) about 5 kms. from Hospet, Karnataka.

This multi-purpose project was started in the year 1945 by erstwhile Government of Hyderabad and Madras and completed during the year 1953. The Tungabhadra Project comes under the Krishna River Basin. The Tungabhadra command encompasses 597 villages of Koppal, Devadurga, Sindhanoor, Gangavati, Manvi, Raichur talukas of erstwhile Raichur district and Siruguppa, Sandur, Hospet and Bellary talukas of Bellary district. The Tungabhadra Irrigation Project at present has three main canals viz.,

i) Tungabhadra Left Bank Canal (LBC)

ii) Tungabhadra Right Bank Low Level Canal (RBLLC)

iii) Tungabhadra Right Bank High Level Canal (RBLLC)

3.1.4 Salient features of selected agricultural systems

For the purpose of this study, three different agricultural systems prevailed in Tungabhadra Project area were identified based on the period of practice of irrigated agriculture. The three different agricultural systems are as follows.

a) Ancient Irrigated Agricultural System (AIAS) : This system is characterized by practice of irrigated agriculture for the last three centuries from Vijayanagara canals constructed as diversion dam across Tungabhadra river during Vijayanagara empire in 17^{th} century. Presently, part of Vijayanagara canal systems gets water from newly constructed Tungabhadra dam. This area is spread out all along the banks of Tungabhadra river in Gangavati taluka of Koppal district and Hospet and Siruguppa talukas of Bellary district in Karnataka.

b) Highly Intensive Agricultural System : This system is located in the head end of the Tungabhadra left bank canal command area where- in irrigated agriculture is in practice for the last more than four decades. This region includes command area in Koppal and Gangavati talukas of Koppal district and parts of Sindhanur taluk of Raichur district, Karnataka.. Hereafter, this system is referred as HIAS.

c) Semi Intensive Agricultural System : This system is located in tail end of the Tungabhadra left bank canal system which is characterized by the practice of irrigated agriculture for the last two to three decades with limited availability of canal irrigation and includes command area in Manvi and Raichur talukas of Raichur district. Hereafter, this system is referred as SIAS.

3.2 Sampling procedure

The random sampling technique was adopted for the selection of villages and farmers for the study. Three villages were randomly selected in each of the three agricultural systems based on their homogeneity with respect to water availability and cropping pattern. From each of the village, ten farmers were chosen at random. Thus, the total size of the sample comprised of 90 farmers. The details of villages and number of farmers in each of these selected villages are given in Table 3.1 and Figure 1.

Table 3.1 Sample villages and farmers in selected agricultural systems

Sl. No.	Agricultural System	Village	No. of farmers
1.	SIAS	Purthipli	10
		Ashapur	10
		Jalibenchi	10
			30
2.	HIAS	Herur	10
		Kesaratti	10
		Bapureddy camp	10
			30
3.	AIAS	Anegundi	10
		Chikjantkal	10
		Tirumalapur	10
	Grand Total		90

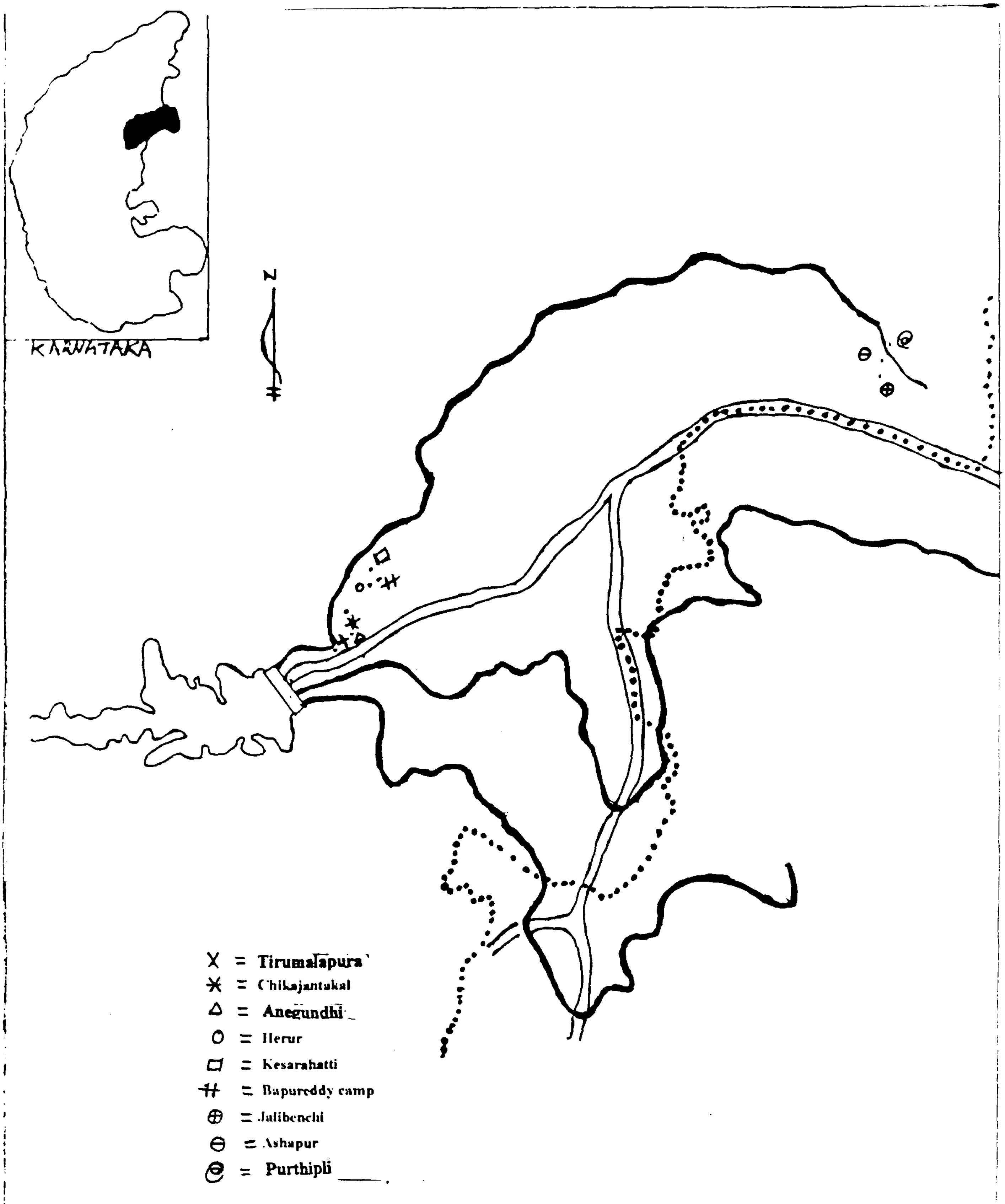
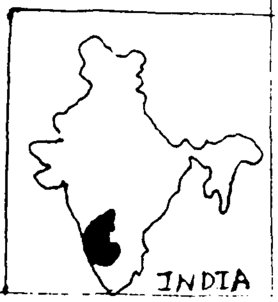


Fig.1 Location of the study area



3.3 Nature and sources of data

For evaluating the objectives of the study, necessary field level data relating to production of various crops were obtained from the sample farmers by personal interview method using pre-tested structured schedule (Appendix I).

Data were collected regarding the socio-economic status of sample farmers including size of holding, size of family, general information of the farmers, their assets including land, cropping pattern, costs and returns structures of crops grown, borrowings, pesticide application and its effects on the agro-ecosystem, etc. The data pertained to the agricultural year 1998-99.

Secondary data with regard to general information of the study area such as population, geographical area, cropping pattern, area, production, etc., were also collected from the offices of Directorate of Agriculture, Bangalore, District Statistical Offices, Raichur and Koppal, State Irrigation Department ; taluka revenue offices and others concerned.

3.4 Analytical techniques employed

For the purpose of evaluating the objectives of study, data were analyzed with the following techniques.

1. Tabular presentation.
2. Production function analysis.
3. Use of efficiency indicators.

3.4.1 Tabular presentation

For identification of the various cropping pattern and to find out input use patter, socio-economic status of sample farmers etc., tabular presentation was used with simply statistical tools like averages, percentages, etc. To estimate the costs, returns and profits of different crops and different cropping pattern in the selected agricultural systems, the cost concepts employed in Farm Management studies were followed.

3.4.2 Functional analysis

The technique of functional analysis was employed for evaluating the resource productivities and resource use efficiency of various inputs of different crops. The Cobb-Douglas type production function was employed for this purpose. Separate functions were fitted for each crop. However, the functions were fitted for such of the crops with more than 10 samples.

Before fitting the function, the zero order correlation coefficients were estimated to test for the multicollinearity.

The general form of the function fitted was specified as follows.

$$Y = A\ X_1^{b1}\ X_2^{b2}\ X_3^{b3}\ X_4^{b4}\ X_5^{b5}\ X_6^{b6}\ e^u$$

On the logarithmic scale the function takes a linear form as given under:

$$\text{Log}Y = \log A + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + u \log e.$$

where,

Y = Gross return of main product and by-product (Rs. /farm)

A = Intercept term.

X_1= Area under crop in hectares.

X_2= Value of seeds in (Rs. /farm).

X_3= Value of labour (Rs. /farm).

X_4= Value of manures (Rs. /farm).

X_5= Value of fertilizer (Rs. /farm).

X_6= Value of plant protection chemicals (Rs. /farm).

U = Error term.

bi = The regression coefficients of the i^{th} independent variable (i=1 to 6) and indicates elasticity coefficients of respective inputs.

In respect of jowar and bajra, the variable plant protection chemicals (X_6) was omitted as it did not figure.

The marginal value products were calculated at the geometric mean level of the variables by using the following equation.

$$\text{MVP of } X_i = b_i * (\bar{Y}/\bar{X}_i)$$

Where,

Y = Geometric mean of gross returns of the crop.

X_i = Geometric mean of i^{th} independent variable.

bi = Elasticity coefficient of i^{th} independent variable.

After computation of marginal value product of a variable, it was compared with its acquisition cost or opportunity cost. Since, the variable in the production function is taken in rupee terms, opportunity cost or marginal cost of input will be one rupee. The average per hectare rental value of land was taken as its marginal cost.

3.4.3 Efficiency indicators

The Composite Efficiency Index (CEI) was developed to determine the efficiency of selected agricultural systems based on the Composite Index of Agricultural Development adopted by Tiwari and Singh, 1985. The various components of the composite efficiency index were selected in such a way as to depict the over all performance of agriculture in selected systems. The selected indicators for the construction of composite efficiency index with the formula used to compute them as follows:

1) Cropping Intensity (CI) $= \dfrac{\text{(Area under different crops) X (duration of the crops)}}{\text{Net cropped area}}$

2) Irrigation Intensity (II) $= \dfrac{\text{Gross irrigated area}}{\text{Net sown area}}$

3) Fertilizer Use Intensity (FUI) $= \dfrac{\text{Value of fertilizers}}{\text{Total area sown}}$

4) Plant Protection Chemicals Use Intensity (PPC UI) $= \dfrac{\text{Value of plant protection chemicals}}{\text{Total area sown}}$

5) High Yielding Variety Use Intensity (HYVUI) $= \dfrac{\text{Area under High Yielding Variety}}{\text{Total area sown}}$

6) Organic Manure Use Intensity (OMUI) $= \dfrac{\text{Expenditure on organic manures}}{\text{Total area sown}}$

7) Machine Power Use Intensity (MPUI) $= \dfrac{\text{Expenditure on machine power used}}{\text{Total area sown}}$

8) Commercial Crops Intensity (CCI) $= \dfrac{\text{Area under commercial crops}}{\text{Total area sown}}$

9) Composite Yield Index (CYI) $= \left(\dfrac{\text{Total yield of sample farms / Total area of sample farms}}{\text{Yield as per package of practices}} \right) \times 100$

10) Labour Use Intensity (LUI) $= \dfrac{\text{Expenditure on human labour}}{\text{Total area sown}}$

Composite Efficiency Index (CEI) of selected agricultural systems was worked out by taking into account of efficiency indices of various indicators as defined above. The CEI indicates the overall efficiancy of different agricultural systems. Higher the CEI , higher the efficiancy of agricultural system and vice-versa. The formula used for working out of CEI of SIAS is as follows.

$$\text{CEI of SIAS} = \frac{1}{10}\left[\frac{CI_{SIAS}}{CI_{AAS}} + \frac{II_{SIAS}}{II_{AAS}} + \frac{FUI_{SIAS}}{FUI_{AAS}} + \frac{PPCUI_{SIAS}}{PPCUI_{AAS}} + \frac{HYVUI_{SIAS}}{HYVUI_{AAS}} + \frac{OMUI_{SIAS}}{OMUI_{AAS}} + \frac{MPUI_{SIAS}}{MPUI_{AAS}} + \frac{CCI_{SIAS}}{CCI_{AAS}} + \frac{CYI_{SIAS}}{CYI_{AAS}} + \frac{LUI_{SIAS}}{LUI_{AAS}}\right] X\ 100$$

where,

AAS = Aggregate of all agricultural systems.

The CEI of other two systems namely HIAS and AIAS were worked out in a similar way.

3.6 Definition of the terms and concepts used

Cultivable Land Utilization Index (CLUI) :

CLUI is calculated by summing the products of land area planted to each crop and actual duration (days) of the crop which is divided by the product of total cultivated land area and number of days in an year (Yellamanda and Sankar, 1996).

$$CLUI = \sum_{i=1}^{n} a_i\ d_i\ /A\ {*}365$$

where,

a_i - Area under different crops of a sample farmer (ha)

d_i = Duration of the i^{th} crop occupied (days)

A = Total area under different crops of a farmer (ha)

Higher the CLUI, higher will be the land use efficiency and vice versa.

Gross returns

They were computed on the basis of actual prices at which individual farmers sold their main and by-products where only a part of the output was sold, the unsold output was valued at the rate at which a part of the output sold. In order to arrive at gross return per hectare, the total gross returns were divided by the total cropped area devoted to the given crop.

Cost concepts :

The cost concepts used in Farm Management studies were used in this study.

Cost - A

For computing cost A, the following items were included and aggregated.

a) Cost of farm yard manure valued at market price.

b) Cost of fertilizers purchased and used.

c) Cost of plant protection chemicals purchased and used.

d) Wages paid to hired labour.

e) Wages paid for bullock labour. The wages of owned bullock labour were imputed at the rates at which the bullocks were hired in that region.

f) Cost of repairs, replacement and maintenance of implements and equipments.

g) Value of seeds. Farm produced seeds were valued at the prevailing market prices.

h) Hiring charges of implements and machinery.

i) Land revenue.

Cost – B

This was computed by adding the following items to cost-A, as calculated above.

a) Interest on fixed capital owned by the farmer.

b) Imputed rental value of owned land.

Cost –C

This was ascertained by adding the value of imputed human labour supplied by the family to Cost –B, as computed above. The value imputed to family labour was taken at the prevailing wage rate for hired labour.

Net income

The profit at cost-C, that is, the difference between gross income and cost-C represented the net income of the farm enterprise.

Land rent

It was estimated on the basis of rent paid to similar land in that locality.

Benefit cost ratio

The benefit cost ratio is the ratio between gross returns and total costs, which indicate the returns per rupee of investment.

$$\text{B.C. Ratio} = \frac{\text{Gross returns}}{\text{Total costs}}$$

Farm business income

The difference between the gross income and cost-A, that is, profit at Cost-A repr esented the farm business income of the cultivators.

RESULTS

IV RESULTS

The results obtained from the analysis of the data are presented in this chapter under the following heads as per the set objectives.

4.1 Cropping and land use pattern

4.2 Input use pattern in different crops

4.3 Costs and returns structure in various crops

4.4 Resource use efficiency of various inputs in different crops

4.5 Efficiency indicators in selected agricultural systems

4.6 Socio-economic status of sample farmers

4.1 Cropping and land use pattern

The cropping pattern, cropping intensity and cultivable land use index (CLUI) were computed to know the pattern of land use and cropping intensities in selected agricultural systems and results are presented in Table 4.1 through 4.3.

4.1.1 Cropping pattern

It is evident from the Table 4.1 that the highest total area devoted to different crops, in general, was as high as 327.11 hectares in HIAS followed by SIAS and AIAS with 187.00 and 136.42 hectares, respectively. Similar pattern of gross cropped area was observed in *rabi* season. In *kharif* season, however, the gross cropped area under HIAS (160.72 ha.) was

Table 4.1 Cropping pattern of sample farmers in different agricultural systems.

Sl. No.	Season / crops	AIAS		HIAS		SIAS	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
A)	*KHARIF*						
	1) Bajra	--	--	--	--	13.36	7.19
	2) Jowar	--	--	--	--	15.38	8.28
	3) Greengram	--	--	--	--	10.93	5.88
	4) Sunflower	--		--	--	17.40	9.37
	5) Paddy *	54.25	39.76	160.72	49.13	21.86	11.77
	SUB TOTAL	54.25	39.76	160.72	49.13	78.93	42.02
B)	*RABI*						
	1) Jowar	--	--	--	--	33.60	18.10
	2) Hybrid jowar *	--	--	--	--	17.00	5.66
	3) Hybrid sunflower*	--	--	--	--	16.19	8.94
	4) Groundnut *	--	--	--	--	10.52	8.72
	5) Paddy	44.53	32.64	166.39	50.87	--	--
	SUB TOTAL	44.53	32.64	166.39	50.87	77.31	41.42
C)	BI-SEASON						
	1) Desi-cotton	--	--	--	--	14.57	7.84
	2) Hybrid cotton *	--	--	--	--	16.19	8.72
	3) Banana	14.97	10.96	--	--	--	--
	4) Sugarcane	22.67	16.64	--	--	--	--
	SUB TOTAL	37.64	27.60	--	--	30.76	16.56
GRAND TOTAL		136.42	100.00	327.11	100.00	187.00	100.00

Note : * Irrigated crops

highest followed by SIAS (78.93 ha.) and AIAS (54.25 ha.). The total cropped area in HIAS was almost equal under *kharif* (49.13%) and *rabi*/summer (50.87%) seasons mainly due to assured canal water irrigation. Similarly, the total cropped area in SIAS was distributed in *kharif* (42.02%) and *rabi* (41.42%) with 16.56 per cent as bi-season crop. In the case of AIAS, the total cropped area under *kharif* (39.76%) was highest followed by *rabi* (32.64%) and bi-season crops (27.60%).

The cropping pattern in SIAS under *kharif* season was highly diversified with sunflower (9.37%), jowar (8.28%), bajra (7.19) and greengram (5.88%) under rainfed situation and paddy (11.77%) under canal irrigated situations. The diversified cropping pattern was observed in *rabi*/summer with jowar under rainfed situation and hybrid sunflower (8.94%), groundnut (8.72%) and hybrid jowar (5.56%) under irrigated situation.

In the case of AIAS, eventhough two crops of paddy was observed both in *kharif* (39.76%) and *rabi* (32.64%) seasons, diversification with sugarcane (16.64%) and banana (10.96%) as bi-season crops were also noticed. In contrast, monocropping of paddy was observed both in *kharif* (49.13%) and *rabi*/summer (50.87%) seasons in HIAS mainly due to assured canal water supply as stated earlier.

4.1.2 Cropping intensity

The cropping intensity which indicates the number of crops grown in a year (Table 4.2) was found to be higher in AIAS (329.20) followed by HIAS (227.84) and SIAS (180.82).

Table 4.2 Cropping intensity of sample farmers in selected agricultural systems

Sl. No.	Agricultural systems	Net cropped area (ha)	Gross cropped area (GCA)*	Cropping Intensity
1)	AIAS	81.30	26764.20	329.20
2)	HIAS	168.63	38421.25	227.84
3)	SIAS	124.54	22519.50	180.82

Note : * Gross cropped area was computed by multiplying the area under different crops with their duration.

4.1.3 Cultivable Land Utilization Index (CLUI)

In order to know the extent of occupancy of the land by different crops, CLUI was estimated and presented in Table 4.3. A perusal of the table revealed that CLUI was found highest in SIAS (1.7524) followed by AIAS (1.7053) and HIAS (0.6300). The cultivation of long duration crops like cotton in SIAS and sugarcane and banana in AIAS have contributed for the higher CLUI in these systems. In HIAS, the CLUI was found to be lower eventhough the gross cropped area was higher mainly due to growing of seasonal crop of paddy. In the case of *kharif* season, the CLUI was found to be highest in HIAS (0.3287) followed by AIAS (0.3187) and SIAS (0.2719). Similar trend was also noticed during *rabi* season.

4.2 Input use pattern in different crops

The input use pattern in different crops under selected agricultural systems were computed and presented in Table 4.4 through 4.7

4.2.1 Input use pattern in AIAS

From Table 4.4 it can be observed that the total cost on inputs used in paddy during *kharif* (Rs.12034.04/ha.) was relatively higher than that of *rabi*/summer (Rs.9786.68/ha). Among the inputs, the use of human labour (31.58%) was found to be a major component of total costs followed by cost on use of fertilizers (22.52%), plant protection chemicals (14.32%), bullock labour (10.45%), machine power (9.89%) and manures (5.01%). Similar inputs use pattern was observed during *rabi*/summer season.

Table 4.3 Cultivable Land Utilization Index (CLUI) under different seasons in selected agricultural systems

Season	Crops	AIAS		HIAS		SIAS	
		Area (ha)	CLUI	Area (ha)	CLUI	Area (ha)	CLUI
Kharif	Rainfed	--	--	--	--	57.07	0.1017
	Irrigated	54.25	0.3187	160.72	0.3287	21.86	0.1702
	Sub-total	54.25	0.3187	160.72	0.3287	78.94	0.2719
Rabi	Rainfed	--	--	--	--	33.60	0.1441
	Irrigated	44.53	0.3013	166.39	0.3013	43.71	0.1040
	Sub-total	44.53	0.3013	166.39	0.3013	77.31	0.2481
Bi-season	Rainfed	--	--	--	--	14.57	0.5745
	Irrigated	37.64	1.0853	--	--	16.59	0.6575
	Sub-total	37.64	1.0853	--	--	30.76	1.2324
	Total	136.42	1.7053	327.11	0.6300	187.00	1.7524

Table 4.4 Input use pattern in different crops under AIAS (Rs./ha)

Sl. No.	Items	*Kharif*	*Rabi*/summer	Bi-season	
		Paddy	Paddy	Banana	Sugarcane
1)	Seeds	745.48 (6.19)	676.48 (6.91)	2773.14 (8.49)	6509.00 (19.00)
2)	Manures	603.85 (5.01)	--	3851.51 (11.80)	2260.67 (6.60)
3)	Fertilizers	2711.25 (22.52)	2328.40 (23.79)	7582.31 (23.23)	4410.50 (12.87)
4)	Plant protection chemicals	1724.24 (14.32)	1432.60 (14.63)	--	--
5)	Human labour	3800.61 (31.58)	3260.80 (33.31)	13936.69 (42.70)	15814.00 (46.16)
6)	Bullock labour	1258.03 (10.45)	1096.40 (11.20)	2556.00 (7.83)	3041.00 (8.87)
7)	Machine power	1190.58 (9.89)	992.00 (10.13)	1937.75 (5.93)	2215.50 (6.46)
8)	Irrigation *	27.50	24.35	52.50	65.75
	Total	12034.04	9786.68	32637.40	34250.65

Note : 1) Figures in parentheses indicates percentage to total.
2) * = Number of times

In addition to paddy, banana and sugarcane were grown as bi-season crops in this system. The total cost of inputs used in sugarcane (Rs.34252.65/ha.) was relatively higher than that of banana (Rs.31110.82/ha.). The use of human labour formed the major component of total cost of inputs in both the crops. In banana, it constituted about 43.78 per cent of total cost, while it was 46.16 per cent in sugarcane. The expenditure on fertilizers in banana (22.22%) and seeds in sugarcane (19.00%) formed the second highest component of total cost of inputs. The extent of use of manures varied from 6.60 per cent to 12.38 per cent, while in case of machine power it varied from 5.97 per cent to 6.46 per cent.

4.2.2 Input use pattern in HIAS

It can be observed from the Table 4.5 that the total cost on inputs used in paddy was marginally higher in *kharif* (Rs.15952/ha.) as compared to *rabi*/summer (Rs.14908/ha.). The expenditure on plant protection chemicals (30.20%) was found to be a major component of total cost of inputs in paddy under *kharif* season followed by cost on fertilizers (24.94%), human labour (22.82%), machine power (9.37%), bullock labour (5.69%) and seeds (4.30%). Similar pattern of input use was noticed in *rabi*/summer season.

4.2.3 Input use pattern in SIAS

4.2.3.1 *Kharif*

It can be observed from the Table 4.6 that the total cost on inputs used in rainfed crops was found to be highest in sunflower (Rs.6498.40/ha) and lowest in bajra with Rs.3067.47 per hectare. However, the total cost on inputs was found to be Rs.5046.25 and

Table 4.5 Input use pattern in paddy under HIAS

(Rs./ha)

Sl. No.	Items	*Kharif*		*Rabi*/summer	
		Rs.	%	Rs.	%
1)	Seeds	770.80	4.62	661.96	4.34
2)	Manures	412.08	2.47	--	--
3)	Fertilizers	4178.00	25.08	4004.00	26.29
4)	Plant protection chemicals	5060.33	30.37	4670.08	30.66
5)	Human labour	3712.00	22.28	3596.80	23.61
6)	Bullock labour	954.00	5.72	871.20	5.72
7)	Machine power	1570.00	9.42	1424.40	9.35
8)	Irrigation*	25.37	--	21.50	--
	Total	16657.21	100.00	15228.44	100.00

Note : * = Number of times

Table 4.6 Input use pattern in different crops under rainfed situations of SIAS –

(Rs./ha)

Sl No.	Items	*Khari*				*Rabi*	Biseason
		Bajra	Jowar	Greengram	Sunflower	Jowar	Cotton
1)	Seeds	87.52 (2.85)	72.70 (1.98)	467.80 (9.12)	267.90 (4.09)	77.42 (2.41)	820.70 (5.83)
2)	Manures	206.25 (6.72)	262.50 (7.15)	360.30 (7.02)	235.45 (3.60)	---	310.00 (2.20)
3)	Fertilizers	325.30 (10.60)	378.32 (10.30)	860.50 (16.77)	1765.30 (27.00)	423.75 (13.22)	3294.70 (23.41)
4)	Plant protection chemicals	--	--	910.20 (17.74)	1310.75 (20.05)	---	4845.50 (34.43)
5)	Human labour	1652.00 (53.85)	2021.25 (55.06)	1618.70 (31.56)	1995.75 (30.53)	1768.00 (55.17)	3313.60 (23.54)
6)	Bullock labour	796.40 (25.96)	936.00 (25.49)	910.75 (17.75)	962.00 (14.71)	935.25 (29.18)	1487.00 (10.56)
	Total	3067.47	3670.77	5128.25	6536.25	3204.17	14071.50

Note : Figures in parentheses indicates percentage to total.

greengram and jowar, respectively. Among the different inputs, the use of human labour was found to be a major component of total cost of inputs in all the crops under *kharif* season. The expenditure on bullock labour (25.49%) in jowar, fertilizers in sunflower (27.00%), bullock labour in bajra (25.96%) and greengram (17.75%) formed the second highest component of total cost on inputs. The extent of use of manures varied from 2.20 per cent to 7.15 per cent of the total cost in all rainfed crops, whereas in the case of seeds, it varied from 1.98 per cent to 9.12 per cent.

Paddy was the only crop cultivated under irrigated situation in this system (Table 4.7). The total cost on inputs amounted to Rs.13281.81 per hectare. Out of which, more than 26 per cent was constituted by plant protection chemicals followed by cost on human labour (22.55%), fertilizers (23.09%), bullock labour (09.70%), machine power (8.74%) and seeds (5.16%).

4.2.3.2 Rabi

The cultivation of jowar was the only rainfed crop identified in this system (Table 4.6). Out of total cost on inputs (Rs.3204.17/ha), more than 55 per cent was constituted by human labour followed by bullock labour (29.18%), fertilizers (13.22%) and seeds (2.41%).

Hybrid jowar, hybrid sunflower and groundnut were the other crops grown under irrigated condition in this system (Table 4.7). The total cost on inputs was found to be highest in groundnut (Rs.9549.25/ha.) and lowest in hybrid jowar with Rs.5628.65 per hectare. The total cost on inputs was found to be Rs.7980.30 in sunflower. The use of human labour was

Table 4.7 Input use pattern in different crops under irrigated situation of SIAS (Rs./ha)

Sl No.	Items	*Kharif*	*Rabi* / summer			Bi-season
		Paddy	Jowar	Sunflower	Groundnut	Cotton
1)	Seeds	686.21 (5.16)	296.40 (5.26)	535.40 (6.70)	1802.00 (18.87)	1270.40 (6.48)
2)	Manures	355.10 (2.67)	–	–	–	375.00 (1.91)
3)	Fertilizers	3067.50 (23.09)	714.00 (12.68)	1760.00 (22.05)	1150.00 (12.04)	4815.43 (24.58)
4)	Plant protection chemicals	3726.50 (28.05)	–	1310.00 (16.41)	971.25 (10.17)	5394.00 (27.53)
5)	Human labour	2995.50 (22.55)	2528.75 (44.92)	2257.50 (28.28)	3409.00 (35.69)	4632.25 (23.64)
6)	Bullock labour	1289.00 (9.70)	1319.50 (23.44)	1262.00 (15.81)	1389.50 (14.55)	1875.00 (9.57)
7)	Machine power	1162.00 (8.74)	770.00 (13.68)	855.40 (10.71)	827.50 (8.66)	1227.50 (6.26)
8)	Irrigation *	12.75	10.25	8.25	10.90	14.90
	Total	13281.81	5628.65	7980.30	9549.25	19589.58

Note : 1) Figures in parentheses indicates percentage to total.

2) * = Number of times

found to be a major component of total cost of inputs in all the crops under irrigated situation in *rabi*/summer season. However, the expenditure on bullock labour in jowar (23.44%), fertilizers in sunflower (22.05%) and seeds (18.87%) in groundnut constituted the second highest component of the total cost.

4.2.3.3 Bi- season

In the case of desi-cotton grown as bi-season crop under rainfed situation in SIAS (Table 4.6), the total cost on inputs (Rs.14071.50/ha) was lower than hybrid cotton (19589.58/ha.) grown under irrigated situation (Table 4.7). However, the cost on plant protection chemicals formed the major constituent of total cost in both desi cotton (34.43%) and hybrid cotton (27.53%). In case of desi cotton, the expenditure on human labour (23.54%) formed the second major component of total cost followed by fertilizers (23.41%), bullock labour (10.56%) and seeds (5.83%). However, the expenditure on fertilizers (24.58%) formed the second major component of total cost in hybrid cotton followed by human labour (23.64%) and seeds (6.48%). The extent of use of manures was found to be marginal with 1.91 per cent to 2.20 per cent of total cost.

4.2.4 Input use pattern in paddy under AIAS, HIAS and SIAS

4.2.4.1 Kharif

It can be observed from the Table 4.8 that the total cost of inputs used was found to be highest in HIAS (Rs.16657.21/ha.) followed by SIAS (Rs.13281.81/ha.) and lowest in AIAS (Rs.12034.04/ha.). The use of plant protection chemicals was highest in HIAS

Table 4.7 Input use pattern in different crops under irrigated situation of SIAS (Rs./ha)

Sl No.	Items	*Kharif*	*Rabi* / summer			Bi-season
		Paddy	Jowar	Sunflower	Groundnut	Cotton
1)	Seeds	686.21 (5.16)	296.40 (5.26)	535.40 (6.70)	1802.00 (18.87)	1270.40 (6.48)
2)	Manures	355.10 (2.67)	–	–	–	375.00 (1.91)
3)	Fertilizers	3067.50 (23.09)	714.00 (12.68)	1760.00 (22.05)	1150.00 (12.04)	4815.43 (24.58)
4)	Plant protection chemicals	3726.50 (28.05)	–	1310.00 (16.41)	971.25 (10.17)	5394.00 (27.53)
5)	Human labour	2995.50 (22.55)	2528.75 (44.92)	2257.50 (28.28)	3409.00 (35.69)	4632.25 (23.64)
6)	Bullock labour	1289.00 (9.70)	1319.50 (23.44)	1262.00 (15.81)	1389.50 (14.55)	1875.00 (9.57)
7)	Machine power	1162.00 (8.74)	770.00 (13.68)	855.40 (10.71)	827.50 (8.66)	1227.50 (6.26)
8)	Irrigation *	12.75	10.25	8.25	10.90	14.90
	Total	13281.81	5628.65	7980.30	9549.25	19589.58

Note : 1) Figures in parentheses indicates percentage to total.

2) * = Number of times

found to be a major component of total cost of inputs in all the crops under irrigated situation in *rabi*/summer season. However, the expenditure on bullock labour in jowar (23.44%), fertilizers in sunflower (22.05%) and seeds (18.87%) in groundnut constituted the second highest component of the total cost.

4.2.3.3 Bi- season

In the case of desi-cotton grown as bi-season crop under rainfed situation in SIAS (Table 4.6), the total cost on inputs (Rs.14071.50/ha) was lower than hybrid cotton (19589.58/ha.) grown under irrigated situation (Table 4.7). However, the cost on plant protection chemicals formed the major constituent of total cost in both desi cotton (34.43%) and hybrid cotton (27.53%). In case of desi cotton, the expenditure on human labour (23.54%) formed the second major component of total cost followed by fertilizers (23.41%), bullock labour (10.56%) and seeds (5.83%). However, the expenditure on fertilizers (24.58%) formed the second major component of total cost in hybrid cotton followed by human labour (23.64%) and seeds (6.48%). The extent of use of manures was found to be marginal with 1.91 per cent to 2.20 per cent of total cost.

4.2.4 Input use pattern in paddy under AIAS, HIAS and SIAS

4.2.4.1 Kharif

It can be observed from the Table 4.8 that the total cost of inputs used was found to be highest in HIAS (Rs.16657.21/ha.) followed by SIAS (Rs.13281.81/ha.) and lowest in AIAS (Rs.12034.04/ha.). The use of plant protection chemicals was highest in HIAS

Table 4.8 Input use pattern in paddy in selected agricultural systems (Rs./ha)

Sl. No.	Items	*Kharif*					*Rabi*/summer		
		AIAS	% change in SIAS over AIAS	HIAS	% change in HIAS over AIAS	SIAS	AIAS	% Change in HIAS over AIAS	HIAS
1)	Seeds	745.48 (6.19)	-7.95	770.80 (4.62)	3.39	686.21 (5.16)	676.48 (6.91)	-2.10	661.96 (4.34)
2)	Manures	603.85 (5.01)	-41.19	412.08 (2.47)	-13.82	355.10 (2.67)	--		--
3)	Fertilizers	2711.25 (22.52)	13.13	4178.00 (25.08)	54.09	3067.50 (23.09)	2328.40 (23.79)	71.96	4004.00 (26.29)
4)	Plant protection chemicals	1724.24 (14.32)	116.12	5060.33 (30.37)	193.48	3726.50 (28.050)	1432.60 (14.63)	226.08	4670.08 (30.66)
5)	Human labour	3800.61 (31.58)	-21.18	3712.00 (22.28)	-2.33	2995.50 (22.55)	3260.80 (33.21)	10.30	3596.80 (23.61)
6)	Bullock labour	1258.03 (10.45)	2.46	954.00 (5.72)	-24.16	1289.00 (9.70)	1096.40 (11.20)	-20.54	871.20 (5.72)
7)	Machine power	1190.58 (9.89)	-2.40	1570.00 (9.42)	31.86	1162.00 (8.74)	992.00 (10.13)	43.54	1424.40 (9.35)
8)	Irrigation *	27.50		25.37		127.50	24.50		21.50
	Total	12034.04	10.36	16657.21	38.41	13281.81	9786.68	55.60	15228.44

Note : 1) Figures in parentheses indicates percentage to total.

2) * = Number of times

(Rs.5060.33/ha) followed by SIAS (Rs.3726.50 /ha.) while it was human labour which was highest in AIAS (Rs.3800.61/ha.). However, the expenditure on fertilizer was found to be second highest component of total cost in all the agricultural systems. The extent of use of bullock labour varied from 5.72 per cent to 10.45 per cent, whereas in case of manures it varied from 2.47 per cent to 5.01 per cent.

4.2.4.2 *Rabi* /summer

The total cost of inputs was highest in HIAS (Rs.15228.44/ha.) and lowest in AIAS with Rs.9786.68 per hectare. The use of plant protection chemicals (30.66%) formed the major component of total cost in HIAS, while, it was human labour (33.21%) in AIAS. Similarly, the expenditure on human labour in HIAS (23.61%) and fertilizers (23.79%) in AIAS formed the second highest component of total cost of inputs. It is worth noting that the expenditure on plant protection chemicals in AIAS (Rs.1432.60/ha.) was found to be lowest as compared to HIAS (Rs.4670.08 /ha.). The use of bullock power was higher in AIAS (11.20%) as compared to HIAS (5.72%). The use of machine power was on par.

4.3 Costs and returns structure of different crops

Costs and returns structures were worked out for different crops in all the agricultural systems and results are presented in Table 4.9 through 4.13.

4.3.1 AIAS

Costs and returns structure of different crops were computed and presented in Table 4.9. and Fig. 2.

In case of paddy in *kharif*, the per hectare total cost of cultivation (Cost-C) and gross returns were Rs. 20475.00 and Rs.40477.00, respectively. Whereas in *rabi*/summer paddy, they were Rs.18222.97 and Rs.41063.75, respectively. The profits at Cost- C in *kharif* was found to be Rs.20002.00 while it was Rs. 22840.78 in *rabi*/summer. The benefit cost ratio was highest in *rabi*/summer (2.25) and lowest in *kharif* (1.98).

In case of bi-season crops, the per hectare Cost- A, Cost- B and Cost- C were found to be higher in sugarcane as compared to banana, but gross returns per hectare was found to be highest in banana (Rs.77299.35) as compared to sugarcane (Rs.72685.67). The profits at different costs were found to be highest in banana and lowest in sugarcane. The benefit cost ratio in banana (1.88) was higher than sugarcane (1.67).

4.3.2 HIAS

The costs and returns structure of paddy was computed for both *kharif* and *rabi*/summer and results are presented in Table 4.10. and Fig. 3. From the table it is evident that, the per hectare total cost of cultivation (Cost-C), gross returns, net income and benefit cost ratio were found higher in *rabi*/summmer season than that in *kharif* season. The per hectare total cost of cultivation for *kharif* paddy was Rs.24242.04 while, it was Rs. 23145.25

Table 4.9 Costs and returns structure of different crops in AIAS

(Rs./ha)

Sl. No.	Items	*Kharif*	*Rabi*/summer	Bi-season	
		Paddy	Paddy	Banana	Sugarcane
1)	Cost - A	12034.04	9786.68	32637.40	34250.65
2)	Cost - B	19620.00	17286.68	39533.00	41386.63
3)	Cost - C	20475.00	18222.97	41032.00	43281.63
4)	Gross returns	40477.00	41063.75	77299.35	72682.67
5)	Profit at				
	Cost - A	28442.96	31277.07	49299.62	41855.29
	Cost - B	20857.00	23777.07	37766.35	31296.04
	Cost - C	20002.00	22840.78	36267.35	29401.04
6)	Benefit cost ratio	1.98	2.25	1.88	1.67

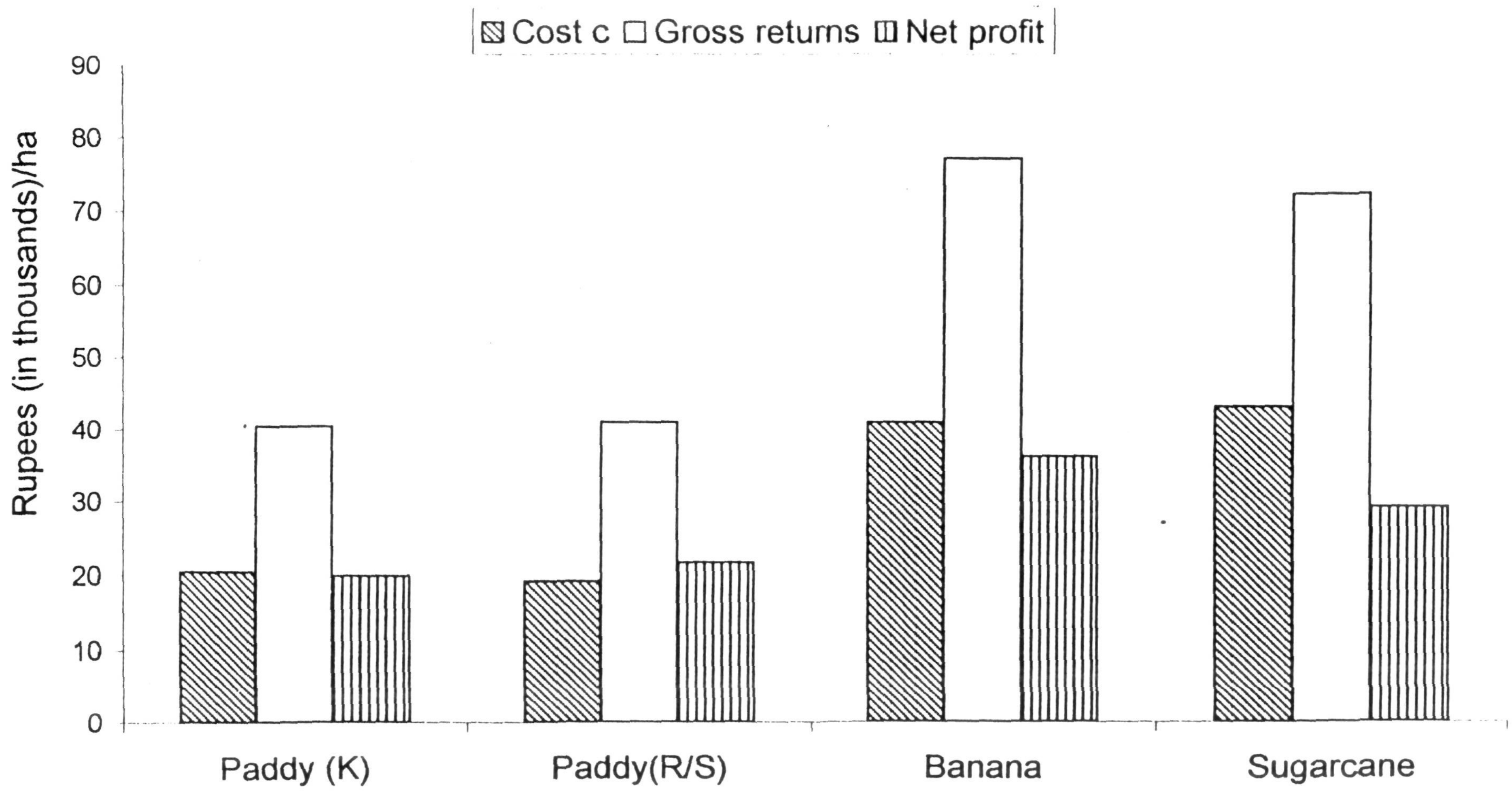


Fig. 2 Total costs, gross returns and net profits of different crops in AIAS

Table 4.10 Cost and Returns structure of paddy in HIAS

(Rs./ha)

Sl.. No.	Items	*Kharif*	*Rabi*/summer
1)	Cost - A	16657.21	15228.44
2)	Cost - B	23452.04	22408.00
3)	Cost - C	24242.04	23143.35
4)	Gross returns	41650.50	44845.54
5)	Profit at		
	Cost - A	24993.29	29617.10
	Cost - B	18198.46	22437.54
	Cost - C	17408.49	21701.11
6)	Benefit cost ratio	1.72	1.93

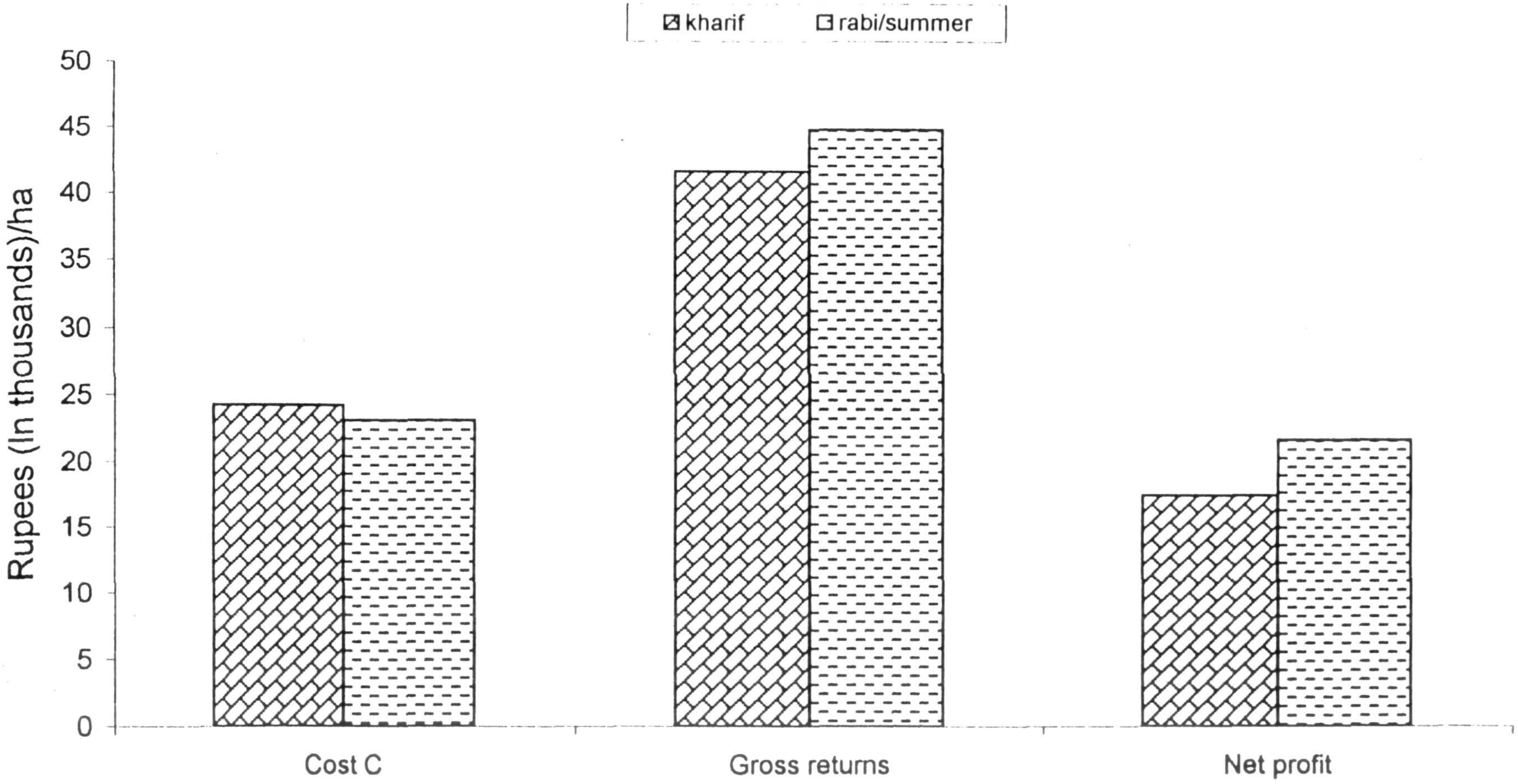


Fig. 3 Total costs, gross returns and net profits of paddy in HIAS

for *rabi*/summer paddy. The gross returns for *kharif* paddy (Rs.41650.50/ha) was found to be marginally lower than that of *rabi*/summer paddy (Rs.41845.54). The profit at Cost-C was Rs.17408.49 for *kharif* paddy as against Rs.21701.11 for *rabi*/summer. The benefit cost ratio was also lower in *kharif* (1.72) than *rabi*/summer (1.93).

4.3.3 SIAS

From Table 4.11 it is evident that the per hectare cost - A, cost - B and cost - C and also the corresponding profits at these costs (Fig. 4.) were found to be highest in jowar among the seasonal irrigated crops. In the case of *kharif* paddy, the per hectare gross returns obtained amounted to Rs.35784.12 with total cost of cultivation (Cost -C) of Rs.21381.17 resulting in net returns of Rs.14402.95. The benefit cost ratio was found to be 1.67.

Among the different crops grown in *rabi*/summer, the per hectare Cost - A, Cost - B and Cost - C were found to be highest in groundnut (Rs.15901.75/ha) followed by sunflower (Rs.15640.60/ha) and jowar (Rs.10873.25/ha). Similar trend was observed with respect to the gross and net returns obtained. However, the benefit cost ratio was found to be the highest in sunflower (1.68) followed by groundnut (1.58) and jowar (1.57). In case of cotton, the per hectare total cost of cultivation was found to be Rs.25208.94. The profit at Cost-C was Rs14621.19 with gross returns of Rs.39380.13. The benefit cost ratio was 1.19.

Table 4.11 Costs and returns structure of different crops under irrigated situations of SIAS (Rs./ha)

Sl. No.	Items	*Kharif*	*Rabi*/summer			Bi-season
		Paddy	Jowar	Sunflower	Groundnut	Cotton
1)	Cost - A	13281.81	5628.65	7980.30	9549.25	19589.58
2)	Cost - B	20781.81	10188.70	14802.85	15311.75	23860.33
3)	Cost - C	21381.17	10873.25	15640.60	15901.75	25208.94
4)	Gross returns	35784.12	17689.65	24555.42	26735.00	39830.13
5)	Profit at Cost - A	22502.31	12061.00	16575.12	17187.75	20240.55
	Cost - B	15402.95	755.95	9752.57	11423.25	15969.80
	Cost - C	14402.95	6816.40	8914.82	10833.25	14621.19
6	Benefit cost ratio	1.67	1.57	1.68	1.58	1.19

Table 4.12 Costs and returns structure of different crops under rainfed situations in SIAS

(Rs./ha)

Sl. No.	Items	*Kharif*				*Rabi*	Bi-season
		Bajra	Jowar	greengram	Sunflower	Jowar	Cotton
1)	Cost - A	3067.47	3670.77	5128.25	6536.25	3204.17	14071.50
2)	Cost - B	4394.00	5990.47	6846.25	8248.40	5850.55	17571.50
3)	Cost - C	4624.00	6343.90	7034.75	8571.60	6151.43	18046.50
4)	Gross returns	5502.00	8620.20	9356.23	12685.96	8126.25	21475.33
5)	Profit at Cost - A	2435.09	4949.43	4227.98	6149.71	4922.08	7403.83
	Cost - B	1108.00	2629.73	2509.98	4437.56	2275.75	3903.80
	Cost - C	878.00	2273.30	2321.48	4114.36	1969.82	3428.83
6	Benefit cost ratio	1.19	1.35	1.33	1.48	1.32	1.20

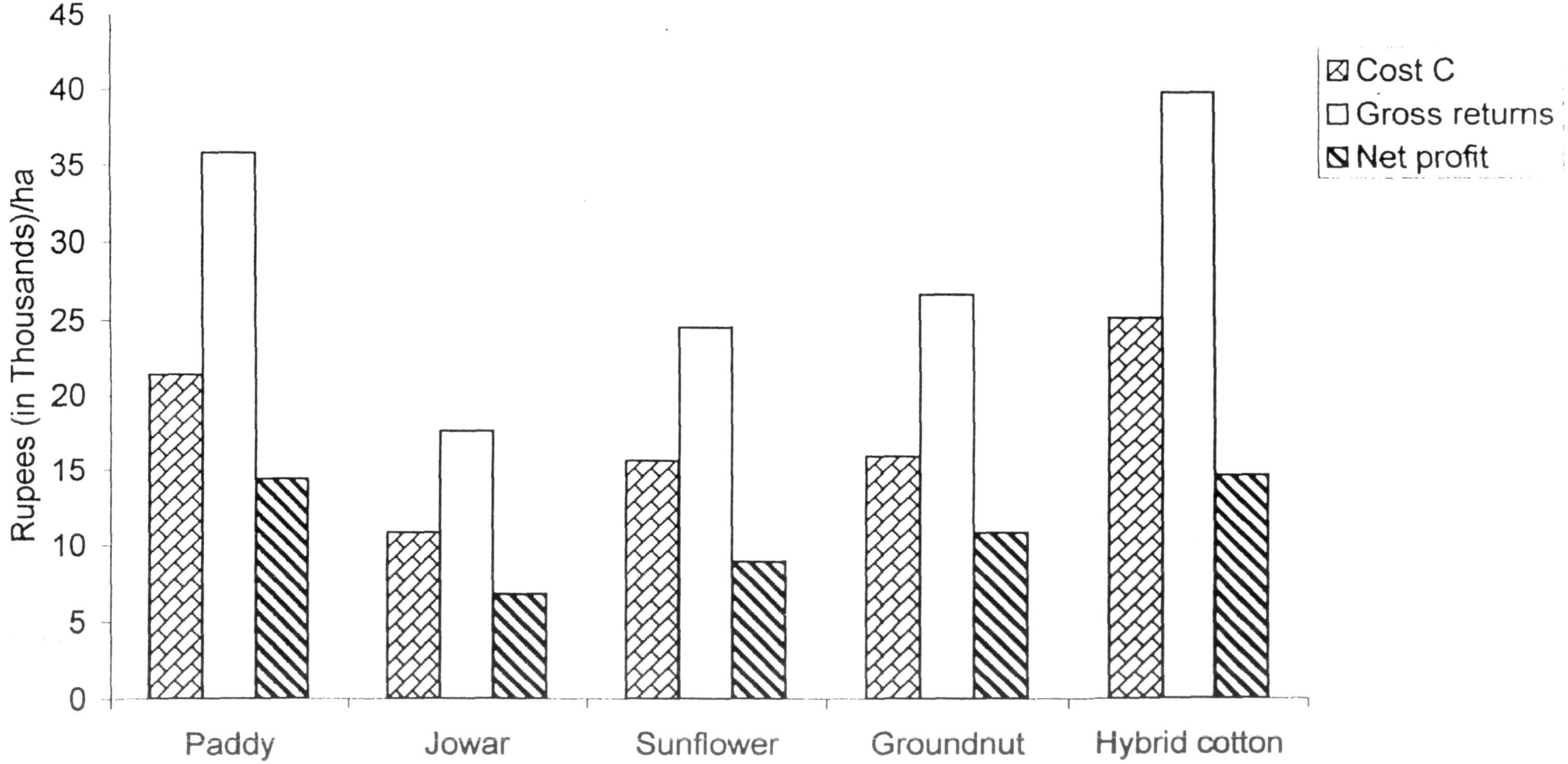


Fig. 4 Total costs, gross returns and net profits of irrigated crops in SIAS

4.3.4 Costs and returns of paddy in AIAS, HIAS and SIAS

Costs and returns structure of paddy in selected agricultural systems namely SIAS, HIAS and AIAS were presented in Table 4.13 and Fig. 5. In *kharif,* the per hectare total cost of cultivation (Cost - C) was highest in HIAS (Rs.24242.04) followed by SIAS (Rs.21381.17) and AIAS (Rs.20475.00). Whereas, the gross returns were found to be highest in HIAS (Rs.41650.50) followed by AIAS (Rs.40477.00) and SIAS (Rs.35784.12). However, the profits at Cost- C was found to be highest in AIAS (Rs.20002.0) followed by HIAS (Rs.17408.49) and lowest in SIAS (14402.95). The magnitude of benefit cost ratio was highest in AIAS (1.98) followed by HIAS (1.72) and lowest in SIAS (1.67). Similar trend was observed in *rabi*/summer between HIAS and AIAS. The per hectare total cost (cost C) and gross returns were found highest in HIAS than AIAS. However, the profit at cost C in AIAS (Rs.22840.78/ha) was marginally higher than that of HIAS (Rs.18702.11/ha).

4.4 Resource use efficiency of various inputs in different crops

The resource use efficiency was found out by using production function analysis and ratio of marginal value product (MVP) to factor costs (FC).

4.4.1 Production Function Analysis

The Cobb-Douglas production function was used to estimate the resource use efficiency of various inputs in different crops under selected agricultural systems.

Table 4.13 Costs and returns structure of paddy in selected agricultural systems

(Rs./ha)

Sl. No.	Items	*Kharif*					*Rabi*/summer		
		AIAS	% change in SIAS over AIAS	HIAS	% change in HIAS over AIAS	SIAS	AIAS	% change in HIAS over AIAS	HIAS
1)	Cost - A	12034.04	10.36	16657.21	38.41	13281.81	9786.68	55.60	15228.44
2)	Cost - B	19620.00	5.92	23542.04	19.99	20781.81	17286.68	29.62	22402.00
3)	Cost - C	20475.00	4.42	24242.04	18.39	21381.17	18222.97	27.00	23143.35
4)	Gross returns	40477.00	-11.59	41650.50	2.89	35784.12	41063.75	1.90	44845.54
5)	Profit at								
	Cost - A	28442.96	-20.65	24993.29	-12.12	22502.31	31227.07	-5.30	29617.10
	Cost - B	20857.00	-26.15	18198.46	-12.74	15402.95	23777.07	-18.22	19443.54
	Cost - C	20002.00	-28.00	17408.49	-12.96	14402.95	22840.78	-18.11	18702.11
6)	Benefit cost ratio	1.98	-15.66	1.72	-13.13	1.67	2.25	-19.55	1.81

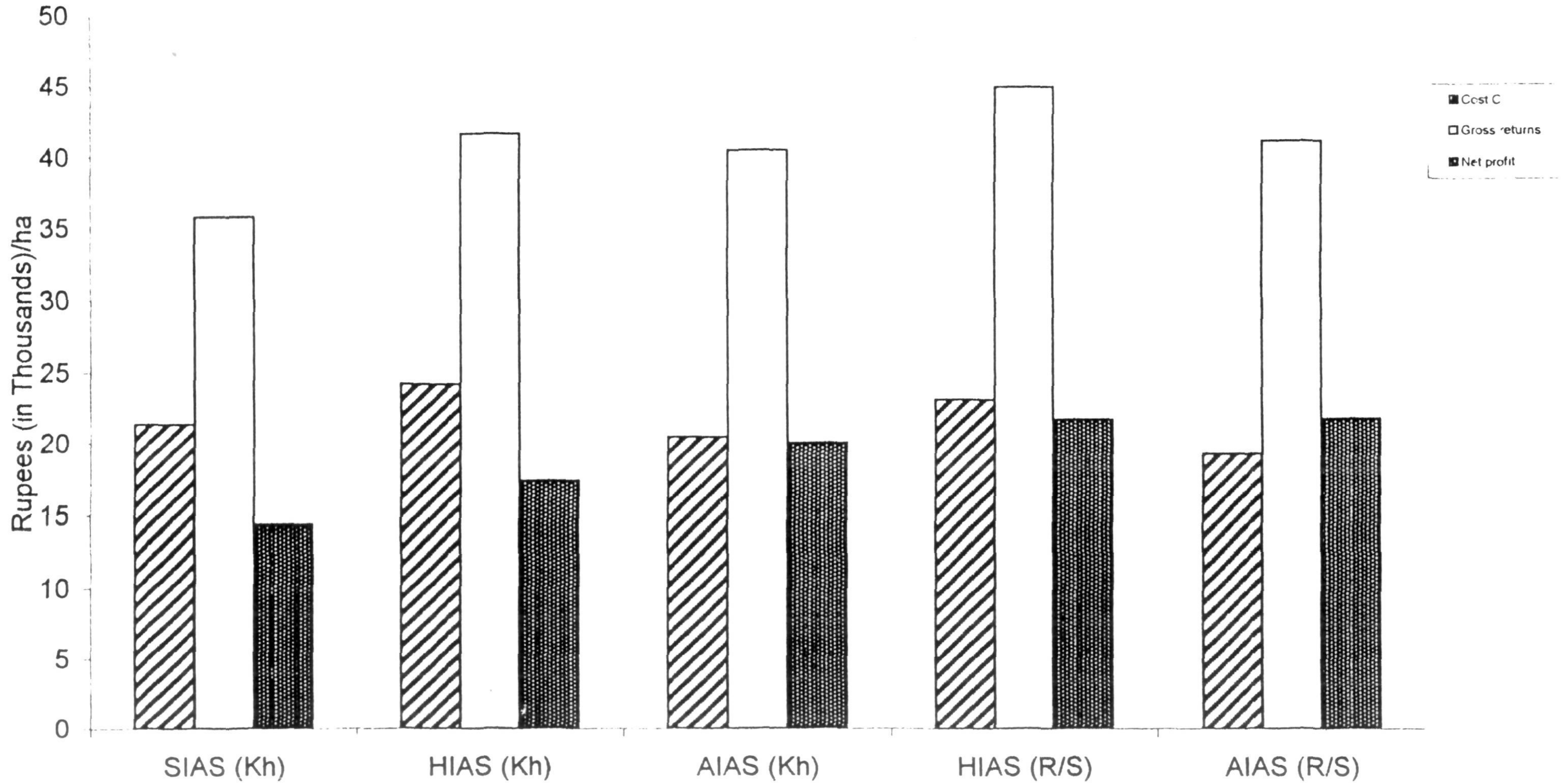


Fig. 5 Total costs, gross returns and net profits of paddy in selected agricultural systems

4.4.1.1 AIAS

Table 4.14 gives the regression coefficients of various inputs in paddy, banana and sugarcane in respective seasons. In case of *kharif* paddy, it was found that the regression coefficients were positive and non-significant for al inputs except fertillizers(0.9375) which was found to be significant and seeds (-1.3629) and labour (-1.3723) had negative coeffients. The regresssion coefficients of land (0.5740) and labour (1.1067) were found to be positive and statistically significant in the case of rabi/summer paddy and for all other inputs except fertillizers (-0.3925) were positive and non-significant. The R^2 being 0.9627 was found to be very high.

In bi-season crops, the regression coefficients were positive in all inputs except manures (-0.0279) and labour (-0.4190) in banana. However, it was significant for seeds (0.6432) and labour (-0.4190). The R^2 was high with 0.9352. In the case of sugarcane, regression coefficients were positive and Non-significant for all the inputs except for seeds (-1.6491), manures (0.1162) and labour (1.1473) which were statistically significant.

4.4.1.2 HIAS

Table 4.15 gives the regression coefficients of various inputs in paddy in both *kharif* and *rabi*/summer. In case of *kharif* paddy, it was found that seeds (0.0942) and plant protection chemicals (-0.3740) had significant influence whereas all other inputs except fertilizers (-1.0627) has positive and Non-significant regression coefficient. However, In rabi /summer, none of the inputs were found to be statistically significant except fertilizers

Table 4.14 Regression coefficient of various inputs in different crops under AIAS

Sl. No.	Items	*Kharif*	*Rabi*/summer	Bi-season	
		Paddy	Paddy	Banana	Sugarcana
1)	n	25	25	10	10
2)	Intercept	2.0286	3.0614	0.7417	1.0241
3)	Land	0.0923 (0.2471)	0.5740* (0.2326)	1.0075 (1.2490)	0.3743 (0.9174)
4)	Seeds	-1.3629 (2.4230)	1.4107 (4.7963)	0.6432* (0.1942)	-1.6491* (0.5570)
5)	Manures	0.0934 (0.1765)	–	-0.0279 (0.0140)	0.1162 (0.0093)
6)	Fertilizers	0.9375* (0.4063)	-0.3925 (0.6145)	1.4073 (0.8961)	2.0763 (1.1930)
7)	Plant protection chemicals	0.4193 (1.3093)	1.0623 (2.2963)	–	–
8)	Labour	-1.3723 (0.8451)	1.1067* (0.4190)	-0.4190* (0.0973)	1.1473* (0.2950)
9)	R^2	0.9560	0.9627	0.9352	0.9702

Note : 1) Figures in parentheses indicates respective standard errors.

2) *= Significant at 5% level, ** = Significant at 1% level

Table 4.15 Regression coefficients of various inputs in paddy under HIAS

Sl. No.	Items	*Kharif*	*Rabi*/summer
1)	n	30	30
2)	Intercept	1.9605	4.0310
3)	Land	0.2085 (0.7831)	-0.6310 (0.8154)
4)	Seeds	0.0942* (0.0407)	1.0713 (1.4690)
5)	Manures	0.0149 (0.1362)	--
6)	Fertilizers	-1.0627 (2.7192)	0.4372* (0.2017)
7)	Plant protection chemicals	-0.3740 (0.1372)	0.1154 (0.2479)
8)	Labour	1.2073 (2.5630)	-0.8937 (1.4965)
9)	R^2	0.9520	0.9673

Note : 1) Figures in parentheses indicate respective standard errors

2) * = Significant at 5% level ** = Significant at 1% level

(0.4372). The coefficient of multiple determination (R^2) in Kharif and rabi/summer paddy were 0.9520 and 0.9643, respectively

4.4.1.3 SIAS

Table 4.16 gives the regression coefficients of various inputs in rainfed crops under SIAS. In the case of jowar under *kharif* season, only land was found to be statistically significant, whereas all other inputs except seeds (-0.0915) and labour (-0.7764) had positive and non-significant regression coefficients. The coefficient of multiple determination (R^2) was 0.9127.

Similarly, the regression coefficients were positive and non-significant for all the inputs in plant protection chemicals (1.0214) which had significant influence on sunflower. In case of greengram, the land and fertilizers were found to influence significantly. The coefficient of multiple determination (R^2) was 0.8629. In the case of bajra, regression coefficients of all the inputs were positive and non-significant.

In case of *rabi* jowar, regression coefficient of fertilizers was found to be statistically significant,while all other inputs except land (-0.4785) were positive and non-significant.The R^2 was 0.9100. In case of cotton under rainfed situation, it was found that both seeds and fertilizers were statistically significant. The regression coefficients were positive and non-significant for all other inputs. The R^2 was 0.9268.

Table 4.16 Regression coefficients of various inputs in different rainfed crops under SIAS

Sl. No.	Items	*Kharif*				*Rabi*	Bi-season
		Bajra	Jowar	Greengram	Sunflower	Jowar	Cotton
1)	n	17	13	11	12	19	18
2)	Intercept	3.3061	5.9888	0.8629	0.6324	-0.5785	0.3129
3)	Land	0.3229 (0.1669)	1.8390* (0.6246)	0.6312* (0.2072)	-0.5618 (1.6760)	-0.4785 (0.9776)	0.1617 (0.3874)
4)	Seeds	0.0679 (0.0635)	-0.0915 (0.0423)	0.0977 (0.2060)	1.0112 (1.6101)	1.3021 (1.1490)	0.3275** (0.0823)
5)	Manures	0.1651 (0.2092)	0.0401 (0.0347)	0.0996 (0.0955)	0.1327 (0.0960)	--	0.0457 (0.0314)
6)	Fertilizers	0.5264 (0.3999)	0.0121 (0.1579)	0.2073** (0.0421)	0.0495 (0.3164)	1.3324** (0.4293)	-0.3756* (0.1490)
7)	Plant protection chemicals	--	--	-0.1310 (0.1482)	1.0214* (0.2547)	--	0.0955 (0.3911)
8)	Labour	0.1235 (0.2724)	-0.7764 (0.2908)	0.2826 (0.2420)	-0.4500 (0.7235)	1.3624 (1.1916)	1.0780 (0.6088)
9)	R^2	0.8312	0.9127	0.8629	0.8533	0.9100	0.9268

Note : 1) Figures in parentheses indicates standard errors.

2) *= Significant at 5% level, ** = Significant at 1% level

Table 4.17 gives the regression coefficients of various inputs in irrigated crops under SIAS. In the case of paddy under *kharif*, it was found that regression coefficients of labour was statistically significant, whereas all other inputs, except fertilizers (-0.0371) and plant protection chemicals (-0.1535) had positive and non-significant regression coefficients. The R^2 however, non-significant. The R^2 being 0.9480, clearly indicated that the selected variables have explained about 95 per cent of the variation in paddy output.

In case of sunflower under *rabi*/summer, the regression coefficients were positive and non-significant for all inputs except land (-4.0810) and labour (-0.9275), while it was statstically significant in fertilizers (-0.3827) with negative sign. The coefficient of multiple determination found to be 0.9315. In case of groundnut, it is very interesting note that the regression coefficients were statistically significant in land (2.4461) and labour (-1.9753). However, the influence of labour was negative. For all other inputs it was positive, it was positive and non-significant except fertilizers (-0.0467). The coefficient of multiple determination (R^2) was 0.9460.

In the case of bi-season crop of cotton, it was found that the regression coefficients of plant protection chemicals (0.4994) and labour (0.3808) were positive and statistically significant. For all other inputs except land (-0.2352) and manures (-0.0532), the regression coefficients were positive and non-significant. The R^2 being 0.9478 was found to be relatively high.

Table 4.17 Regression coefficient of various inputs in different irrigated crops under SIAS

Sl. No.	Items	*Kharif*	*Rabi*/summer			Bi-season
		Paddy	Jowar	Sunflower	Groundnut	Cotton
1)	n	14	13	13	11	16
2)	Intercept	5.9959	-0.8743	-8.8292	0.9460	0.3893
3)	Land	2.2210 (1.5719)	1.0932 (3.4961)	-4.0810 (4.1548)	2.4461** (0.4652)	-0.2352 (0.3122)
4)	Seeds	-2.6952 (1.5140)	0.0985 (1.7340)	4.3370 (4.0793)	0.2997 (0.2887)	0.7059 (0.3337)
5)	Manures	0.7666 (0.4140)	–	–	–	-0.0532 (0.0393)
6)	Fertilizers	-0.0371 (0.6195)	0.2651 (0.3415)	-0.3827* (0.1271)	-0.0467 (0.2136)	0.0816 (0.1080)
7)	Plant protection chemicals	-0.1535 (0.4236)	–	2.6304 (1.2556)	0.3323 (0.1232)	0.4994* (0.1829)
8)	Labour	1.1088* (0.4389)	1.2043 (2.9374)	-0.9275 (0.6266)	-1.9753** (0.4725)	0.3808* (0.1372)
9)	R^2	0.94804	0.8693	0.9315	0.9460	0.9478

Note : 1) Figures in parentheses indicates standard errors.

2) *= Significant at 5% level, ** = Significant at 1% level

4.4.1.4 Paddy in AIAS, HIAS and SIAS

Table 4.18 gives regression coefficients of various inputs in paddy in selected agricultural systems namely AIAS, HIAS and SIAS both in *kharif* and *rabi*/summer. In *kharif*, regression coefficients of fertilizers (0.9375) was found to be statistically significant in AIAS as against seeds (0.0942) in HIAS and labour (1.1088) in SIAS. The regression coefficients in remaining inputs were positive and non-significant except fertilizers and plant protection chemicals in HIAS, seeds and labour in AIAS and seeds, fertilizers and plant protection chemicals in SIAS. In all the systems, the R^2 was found to be very high (>0.95).

In case of *rabi*/summer, the regression coefficients of land (0.5740) and labour (1.1067) were found statistically significant in AIAS. The regression coefficients of fertilizers (-0.3925) in AIAS and land (-0.6310) and labour (-0.8937) in HIAS were found to be negative. The coefficient of multiple determination (R^2) was very high in both HIAS (0.9673) and AIAS (0.9627).

4.4.2 Ratios of MVP to factor cost (FC)

The ratios of marginal value product to factor costs were computed for various inputs in different crops under selected agricultural systems.

4.4.2.1 AIAS

Table 4.19 gives the ratios of MVP to factor costs of various inputs in different crops in AIAS. In case of paddy in *kharif*, the ratios of MVP to factor costs were found to be less

Table 4.18 Regression coefficients of various inputs in paddy under selected agricultural systems

Sl. No.	Items	*Kharif*			*Rabi*/summer	
		AIAS	HIAS	SIAS	AIAS	HIAS
1)	n	25	30	14	25	30
2)	Intercept	2.0286	1.9605	5.9959	3.0614	4.0310
3)	Land	0.0923 (0.2471)	0.2085 (0.7831)	2.2210 (1.5719)	0.5740* (0.2326)	-0.6310 (0.8154)
4)	Seeds	-1.3629 (2.4230)	0.0942* (0.0407)	2.6952 (1.5140)	1.4107 (4.7963)	1.0713 (1.4690)
5)	Manures	0.0934 (0.1765)	0.0149 (0.1362)	0.7666 (0.4140)	–	–
6)	Fertilizers	0.9375* (0.4063)	-1.0627 (2.7192)	-0.0371 (0.6195)	-0.3925 (0.6145)	0.4372* (0.2017)
7)	Plant protection chemicals	0.4193 (1.3093)	-0.3740 (0.1372)	-0.1535 (0.4236)	1.0623 (2.2963)	0.1154 (0.2479)
8)	Labour	-1.3723 (0.8451)	1.2073 (2.5630)	1.1088* (0.4389)	1.1067* (0.4190)	-0.8937 (1.4965)
11)	R^2	0.9560	0.9520	0.9480	0.9627	0.9673

Note : 1) Figures in parentheses indicate respective standard errors.

2) *= Significant at 5% level, ** = Significant at 1% level

Table 4.19 Ratios of Marginal Value Product (MVP) to factor costs (FC) of different inputs in AIAS

Sl. No.	Items	*Kharif*	*Rabi*/summer	Bi-season	
		Paddy	Paddy	Banana	Sugarcane
1)	Land	2.1378	5.3087	3.1087	0.6498
2)	Seeds	-0.2458	1.0347	1.3497	-3.4093
3)	Manures	1.1054	--	-0.2840	2.1054
4)	Fertilizers	1.0245	-2.1097	0.0247	1.0245
5)	Plant protection chemicals	3.2165	1.1394	--	--
6)	Labour	-0.9458	3.0349	-2.1672	3.2165

than one in seeds (-0.2458) and labour (-0.9458) while it was greater than one for all other inputs. However, the ratios of MVP to factor costs (FC) were less than one for fertilizers (-2.1097) and greater than one in all other inputs in *rabi*/summer paddy..

In case of banana, the ratios of MVP to factor costs were greater than one for land (3.1087) and seeds (1.3497), while it was less than one for all other inputs. however, it was less than one for land (0.6498) and seeds (-3.4093) and greater than one for all other inputs.

4.4.2.2 HIAS

Table 4.20 gives the ratios of MVP to factor cost of various inputs in paddy. In case of *kharif*, the ratios of MVP to factor cost were less than one for fertilizers (-0.1295) and plant protection chemicals (-0.5920). The ratios were found to be greater than unity in all the inputs. In *rabi*/summer, the ratios were found to be less than unity in land (-1.4062) and labour (-2.0047) and greater than one in all the inputs.

4.4.2.3 SIAS

Under irrigated situation of the system,(Table 4.21) the ratios of MVP to factor costs were found to be less than one for seeds (-4.1289), fertilizers (-0.0461) and plant protection chemicals (-02018) in paddy; fertilizers (0.8945) in jowar; land (-13.0170), fertilizers (-0.4934) and labour (-1.0633) in sunflower and all inputs except land (18.7434) had less than unity in groundnut.. Whereas in the remaining inputs of all the crops, the ratios of MVP to factor cost was more than unity. In the bi-season crop of cotton under irrigation, the ratios of

Table 4.20 Ratio of marginal value product to factor costs of paddy in HIAS

Sl. No.	Items	Kharif	Rabi/summer
1)	Land	3.2079	-1.4062
2)	Seeds	1.9254	2.1960
3)	Manures	2.0976	–
4)	Fertilizers	-0.1295	3.6972
5)	Plant protection chemicals	-1.5970	1.1420
6)	Labour	4.7310	-2.0047

Table 4.21 Ratios of Marginal Value Product (MVP) to factor costs (FC) of different inputs irrigated crops of SIAS

Sl. No.	Items	*Kharif*	*Rabi*/summer			Bi-season
		Paddy	Jowar	Sunflower	Groundnur	Hybrid cotton
1)	Land	5.9083	5.4076	-13.0170	9.7434	-2.0873
2)	Seeds	4.1289	2.1942	7.0607	4.3958	1.0276
3)	Manures	1.3509	--	--	--	-0.1058
4)	Fertilizers	-0.0461	0.8945	-0.4934	1.0076	1.1007
5)	Plant protection chemicals	-0.2018	--	3.5202	0.4752	0.1203
6)	Labour	1.2947	1.6082	-1.0633	-2.2806	3.4823

MVP to factor cost was more than unity in seeds (1.0276), fertilizers (1.1007) and labour (3.4823), while it was less than one in rest of the inputs.

Under rainfed crops in *kharif*, (Table 4.22), the ratios of MVP to factor cost were less than unity in all the inputs except manures (1.2887) and fertilizers (1.7910) in bajra ; land (16.1391) in jowar; land (5.6385), manures (1.1844), fertilizers (1.2832) and labour (1.1136) in greengram ; seeds (1.6863), manures (1.2475) and plant protection chemicals (1.4145) in sunflower.

In *rabi* jowar, the ratio of MVP to factor cost was less than unity in land (-3.3565) while it was greater than one in the remaining inputs. In the case of bi-season crop of cotton under rainfed situation, the ratios of MVP to factor cost were less than unity in fertilizers (-0.4525) and plant protection chemicals (0.1094).

4.4.2.4 Paddy crop in AIAS, HIAS and SIAS

A perusal of Table 4.23 revealed that in *kharif*, the ratios of MVP to factor costs for all the inputs were greater than one for all the inputs in all the systems except seeds in both AIAS (-0.2458) and SIAS (-4.1289); labour in AIAS (-0.9458); fertilizers in both HIAS (-0.1295) and SIAS (-0.0461) and plant protection chemicals in both HIAS (-1.5970) and SIAS (-0.2081).

Table 4.22 Ratios of Marginal Value Product (MVP) to factor costs (FC) of different inputs in rainfed crops of SIAS

Sl. No.	Items	*Kharif*				*Rabi*	Bi-season
		Bajra	Jowar	Greengram	Sunflower	Jowar	Cotton
1)	Land	1.9883	16.1391	5.6385	2.4033	-3.3565	1.8403
2)	Seeds	0.0530	-0.1868	1.1708	1.6863	2.6390	6.0503
3)	Manures	1.2887	1.0730	1.1844	1.2475	--	12.4563
4)	Fertilizers	1.7910	2.0030	1.2832	0.0622	2.1100	-2.4507
5)	Plant protection chemicals	--	--	-0.1669	1.4145	--	1.6543
6)	Labour	2.1302	-0.8524	1.3136	-0.6628	1.5114	0.6541

Table 4.23 Ratios of Marginal Value Product (MVP) to factor costs (FC) of paddy in selected agricultural systems

Sl. No.	Items	*Kharif*			*Rabi*/summer	
		AIAS	HIAS	SIAS	AIAS	HIAS
1)	Land	2.1378	3.2079	5.9083	5.3087	-1.4062
2)	Seeds	-0.2458	1.9254	4.1289	1.0347	2.1960
3)	Manures	1.1054	2.0976	1.3509	--	--
4)	Fertilizers	1.0245	-0.1295	-0.0461	-2.1097	3.6972
5)	Plant protection chemicals	3.2165	-1.5970	-0.2081	1.1394	1.1420
6)	Labour	-0.9458	4.7310	1.2947	3.0349	-2.0047

In *rabi*/summer, the ratios of MVP to factor costs were less than unity for fertilizers (-2.1097) in AIAS; land (-1.4062) and labour (-2.0047) in HIAS. In remaining inputs, the ratios were greater than unity in all the systems.

4.5 Efficiency indicators of selected agricultural systems

The index values of different efficiency indicators as well as composite efficiency index in selected agricultural systems were worked out and presented in Tables 4.24.

It is evident from the Table 4.24 that the AIAS has got the highest index of cropping intensity (329.20), followed by HIAS (227.84) and SIAS (180.82). Index of cropping intensity in SIAS and HIAS were found to be less than average indices of cropping intensities in all the agricultural systems.

Similarly, HIAS had highest index of 1.9397 followed by AIAS (1.6778) in the case of irrigation intensity. The SIAS with an index of 0.4181 was found to be less than average index of irrigation intensity (1.3452) of all the systems.

In the case of plant protection chemicals use intensity, HIAS (2187.73) and higher index than AIAS (620.87) and SIAS (509.11). However, in both SIAS and AIAS, the indices were less than average index of all the systems (902.29).

Table 4.24 Index values of different efficiency indicators in selected agricultural systems

Sl. No.	Indicators	Agricultural systems AIAS	HIAS	SIAS	Average
1)	Cropping Intensity (CI)	329.20	227.84	180.82	245.95
2)	Irrigation Intensity (I I)	1.6778	1.9397	0.4181	1.3452
3)	PPC's Use Intensity (PPCUI)	620.87	2187.73	509.11	1105.90
4)	Organic Manures Use Intensity (OMUI)	567.68	101.07	37.92	233.55
5)	Fertilizer Use Intensity (FUI)	1601.18	2060.19	606.65	1422.67
6)	High Yielding Varity Seeds Use Intensity (HYVUI)	0.9349	1.00	0.5600	0.8310
7)	Machine Power Use Intensity (MPUI)	1175.13	1894.47	117.70	1062.43
8)	Commercial Crops Intensity (CCI)	0.0320	--	0.2529	0.1424
9)	Composite Yield Index (CYI)	92.28	86.36	84.57	87.73
10)	Labour Use Intensity (LUI)	2924.29	4180.49	1080.03	2728.27
	Composite Efficiency Index (CEI)	37.56	39.08	20.11	32.25

It is worth noting that organic manures use intensity was higher in AIAS (567.68) than HIAS (101.17) and SIAS (37.92). Similar trend was observed in the case of composite yield index.

With respect to fertilizer use intensity, the index was found to be substantially higher in HIAS (2060.19) as compared to AIAS (1601.18) and SIAS (606.65). The index in SIAS was found to be less than average index of all the systems (1422.67).

In the case of high yielding variety seeds use intensity, the average index of all the systems together was found to be 0.8310. Among the selected agricultural systems, index was marginally higher in HIAS (1.00) over AIAS (0.94). However, the HYV seeds use index being 0.56 in SIAS was not only lower than the average index of 0.8310 but also considerably lower than that of HIAS and AIAS. Similar trend was found with respect to mechanical power use intensity and labour use intensity.

In case of commercial crops intensity, index was higher in SIAS (0.2539), compared to AIAS (0.0320). The average index of all the systems was 0.1424.

The composite yield index was found to be relatively higher in AIAS (92.28) as compared to HIAS (86.36) and SIAS (84.57).

The efficiency of selected agricultural systems were examined by computing the CEI by considering all the indices of various efficiency indicators together. It is evident from the table that the CEI was found to be higher in HIAS (39.08), compared to AIAS (37.56) and SIAS (20.11). The CEI for SIAS was found below the average CEI of all the agricultural systems (32.25).

4.6 Socio-economic status of sample farmers

Socio- economic status of sample farmers in all the selected agricultural systems were computed by considering various socio-economic indicators/parameters to know the impact of different agricultural systems of the sample farmers. The results are presented in Table 4.25 through 4.28.

4.6.1 Social status of sample farmers

It is evident from Table 4.25 and Fig. 6 that the percentage of illiterates were found to be higher in SIAS (69.40%) followed by HIAS (37.63%) and AIAS (10.15%). On the contrary, extent of education at both school and college levels was higher in AIAS (62.49% and 27.36%), compared to HIAS (49.43% and 12.94%) and SIAS (27.69% and 3.17%). With respect to family structure, the percentage of nuclear family was found to be higher in AIAS (63.47%) as against joint family in SIAS (73.33%). The percentage of nuclear family was found lowest in SIAS (26.67%) whereas, joint family was found lowest in AIAS (36.53%).

In the case of migration, it was found that the percentage of migration was found to be higher in SIAS (58.46%) as compared to HIAS (19.70%) and AIAS (9.35%). In contrast, the percentage of immigration was found highest in AIAS (79.63%) and lowest in SIAS (12.11%).

Table 4.25 Social status of sample farmers in selected agricultural systems (percentages)

Sl. No.	Social parameters	AIAS	HIAS	SIAS
1)	Literacy			
	a) Illiterates	10.15	37.63	69.40
	i) Male	22.70	31.40	41.67
	ii) Female	77.30	68.60	58.33
	b) School	62.49	49.43	27.69
	i) Male	56.45	66.73	84.40
	ii) Female	43.55	33.27	15.60
	c) College	27.36	12.94	3.17
	i) Male	67.39	79.89	90.32
	ii) Female	32.61	20.11	9.68
2)	Family Structure			
	a) Nuclear	63.47	39.19	26.67
	b) Joint	36.53	60.81	73.33
3)	Migration	9.35	19.70	58.46
4)	Immigration	79.63	63.34	12.11

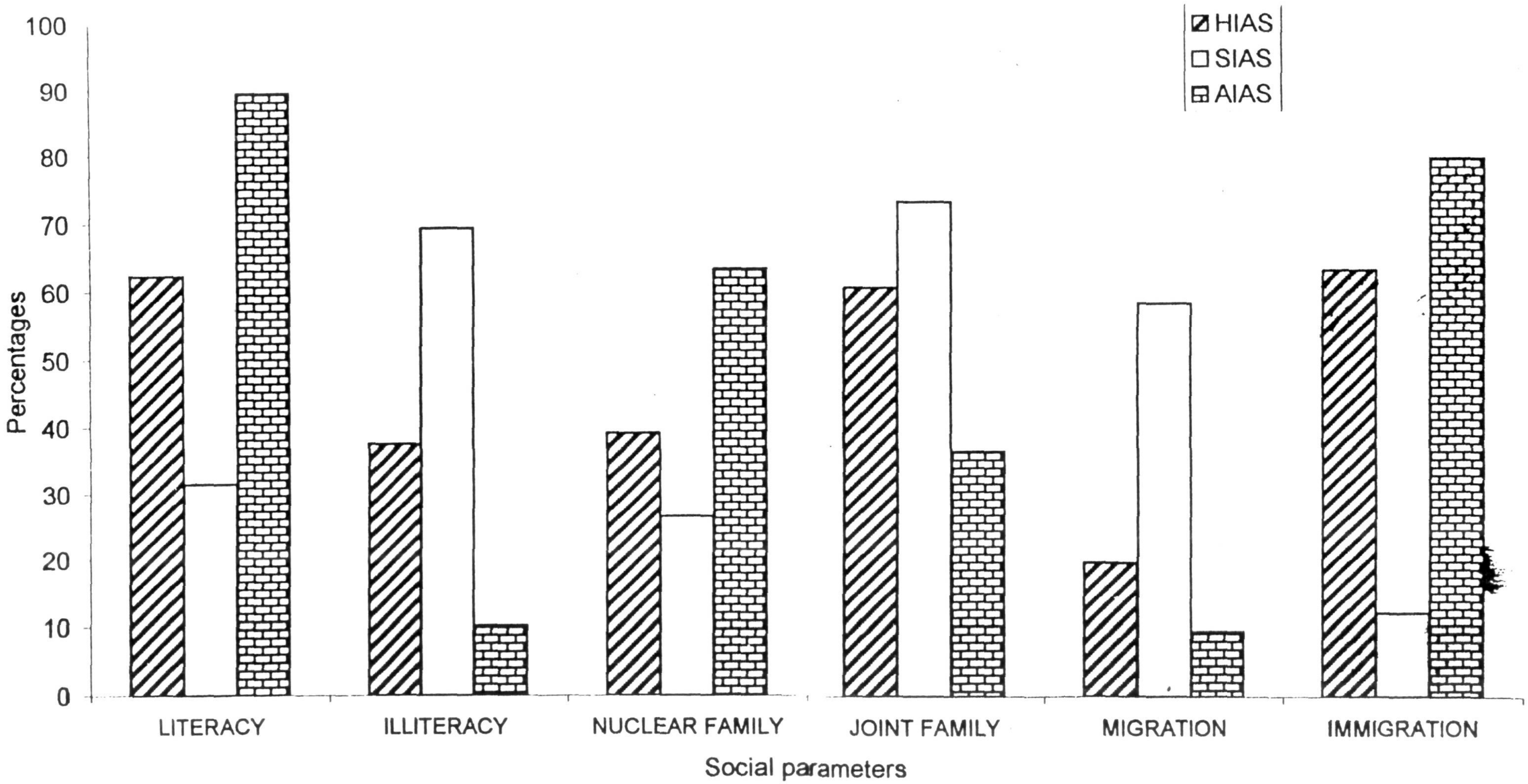


Fig. 6 Social status of sample farmers in selected agricultural systems

4.6.2 Capital farm assets position of sample farmers

It is evident from the Table 4.26 that the number of bullocks (0.76), farm implements and tools (3.56) kuccha house (0.77) per farmer were found to be highest in SIAS with lowest monetary values. However, these were found to be lowest in AIAS with relatively higher monetary values. On the contrary, the position of other assets namely, buffaloes (0.53), cows (0.29), tractor (0.26), animal shed (0.28) and pucca house (0.87) per farmer was highest in AIAS with highest monetary values as against their lowest number in SIAS.

4.6.3 Domestic capital assets of sample farmers

The results depicted in the Table 4.27 have clearly revealed that the number of domestic capital assets per farmer were found to be higher in AIAS with highest monetary values in all the assets except bicycles (0.28), motorcycles (0.73), four-wheelers (0.13) and furniture (1.80) wherein they were found highest in HIAS. In contrast, all the domestic capital assets per farmer except bicycle (0.74) were found lowest in SIAS with lower monetary values. In general, number of domestic capital assets per farmer was found to be relatively lower in HIAS compared to AIAS with high or low monetary value.

4.6.4 Income and Employment status of sample farmers

Income and employment status of sample farmers in selected agricultural systems were computed and results are presented in Table 4.28.

It is evident from the table that major source of annual income realized by the sample farmers was from agriculture in all the agricultural systems. However, it was found highest in

Table 4.26 Farm capital assets position of sample farmers in selected agricultural systems

(per farmer)

Sl. No.	Capital farm assets	AIAS	HIAS	SIAS
		No.	No.	No.
1)	Bullocks	0.73 (5619.25)	0.84 (5716.66)	1.53 (3641.66)
2)	Buffaloes	0.53 (2416.40)	0.33 (1870.70)	0.60 (1260.40)
3)	Cows	0.30 (2140.80)	0.27 (2227.50)	0.13 (967.15)
4)	Sheep and Goats	—	--	7.47 (2140.65)
5)	Tractor	0.23 (70000.00)	0.27 (85333.33)	0.07 (16500.00)
6)	Sprayers	0.80 (1280.00)	0.87 (1265.40)	0.37 (619.83)
7)	Farm implement and tools	2.17 (1739.68)	2.30 (1619.33)	3.57 (1065.40)
8)	Animal shed	0.27 (1684.65)	0.20 (1516.66)	---
9)	Domestic house			
	a) Kuccha house	0.13 (1755.00)	0.27 (3120.00)	0.77 (6197.50)
	b) Pucca house	0.87 (48415.00)	0.73 (56150.00)	0.33 (22550.00)

Note : Figures in parentheses indicates value of capital assets per sample farmer in rupees.

Table 4.27 Domestic capital assets position of sample farmers in selected agricultural systems

Sl. No.	Domestic capital assets	AIAS	HIAS	SIAS
		No./farmer	No./farmer	No. /farmer
1)	Radio	0.81 (895.40)	0.73 (861.65)	0.60 (636.80)
2)	Television	1.00 (6440.60)	0.93 (5850.00)	0.53 (3469.10)
3)	Telephone	0.33 (2170.00)	0.20 (1400.00)	0.06 (320.00)
4)	Bicycle	0.28 (340.17)	0.23 (297.00)	0.74 (796.95)
5)	Motor cycle	0.73 (17856.67)	0.83 (19505.00)	0.27 (8670.50)
6)	Four- wheelers	0.13 (11765.00)	0.20 (17630.00)	---
7)	Furniture	1.80 (2149.75)	1.87 (2340.50)	0.33 (1117.60)
8)	Refrigerators	0.30 (3920.00)	0.26 (4095.00)	----
9)	Pressure cooker	0.25 (212.50)	0.20 (196.75)	0.05 (39.75)
10)	L.P.G. Stove	0.30 (910.00)	0.23 (770.00)	0.03 (95.00)

Note : Figures in parentheses indicates the value of domestic assets per sample farmer in rupees.

Table 4.28 Income and employment status of sample farmers in selected agricultural systems

Sl. No.	Particulars	AIAS	HIAS	SIAS
1)	Agricultural income (Rs. /farmer)	130996.03 (85.70)	105098.44 (79.87)	20600.04 (71.34)
2)	Non-Agril. Income (Rs. /farmer)			
	a) Service	16224.00 (10.61)	19240.00 (14.62)	6840.00 (23.69)
	b) Trading	3890.80 (2.54)	4800.00 (3.64)	1436.67 (4.97)
	c) Others	1741.60 (1.13)	2440.00 (1.85)	----
	Sub-total	21856.40 (14.30)	26480.00 (20.13)	8276.67 (28.66)
3)	Annual total income (Rs. /farmer)	152852.43 (100.00)	131578.44 (100.00)	82088.55 (100.00)
4)	Annual total income (Rs./ha)	31565.30	18700.79	4963.86
5)	Average size of holdings (ha)	2.71	5.62	4.79
6)	Employment Pattern			
	a) Family labours (No.)	2.23	4.79	4.79
	b) Hired labours (No.	0.89	1.36	
7)	Wage structure			
	a) Male (Rs./person day)	40.50	42.50	28.36
	b) Female (Rs./person day)	20.50	21.76	15.75
	c) Bullock (Rs./bullock day)	140.00	165.00	110.00
	d) Tractor (Rs./hour)	225.00	245.00	185.00

Note : Figures in parentheses indicates percentage to total annual income

AIAS (Rs.130996.03) as compared to HIAS (Rs.105098.44) and SIAS (Rs.20600.04). Whereas, in the case of non-agricultural income it was found highest in HIAS (Rs.26480.00) followed by AIAS (Rs.21856.40) and SIAS (Rs.8276.67). In respect of employment pattern, it was found that family labour involvement in cultivation of crops was found higher in SIAS (4.79) as compared to AIAS (2.23) and HIAS (1.91). However, use of hired labour was found to be higher in HIAS (1.36), compared to AIAS (0.87). Wage structure for male (Rs.42.50), female (Rs.21.76), bullock labours (Rs.165.00) as well as hire charges of tractor (Rs.245.00) was found to be considerably higher in HIAS than those of SIAS. However, wage structure in AIAS was marginally lower than HIAS.

DISCUSSION

V DISCUSSION

The present chapter seeks to discuss the results of the investigation presented in the previous chapter. The main findings of the results are discussed under the following heads, for the purpose of analytical clarity.

5.1 Cropping and land use pattern

5.2 Input use pattern in different crops

5.3 Costs and returns of different crops

5.4 Resource use efficiency of various inputs in different crops

5.5 Efficiency indicators of selected agricultural systems

5.6 Socio-economic status of sample farmers

5.1 Cropping and land use pattern

The results depicted in Table 4.1 clearly reveled that the proportion of total cropped area devoted to *kharif* and *rabi*/summer crops was found to be highest in HIAS where monoculture of paddy was preferred by the sample farmers of this system mainly due to assured supply of irrigation water for both the seasons. Similar cropping pattern was noticed in AIAS, besides annual crops namely, sugarcane and banana. This system (AIAS) had an advantage of assured supply of irrigation water around the year and which was found to be the major factor in influencing the cultivation of annual crops besides seasonal crops (paddy-

paddy) regularly. The proportion of total cropped area devoted to *kharif* (78.93 ha), *rabi* (77.31ha) and bi-season (30.76 ha) was found to be relatively higher in SIAS than HIAS.

The cropping pattern in SIAS was highly diversified with different crops cultivated over seasons mainly due to cultivation of major crops under rainfed situations as well as inadequate supply of canal water with a view to the risk of production. Similar findings were observed by Jodha, 1977. On the contrary, monoculturing of paddy both in *kharif* and *rabi* / summer was noticed in HIAS in view of assured supply of canal water. Rajkumar and Panda, 1986 have also reported similar findings. In the case of AIAS, even though two crops of paddy was observed both in *kharif* (39.76%) and *rabi*/summer (32.64%) seasons, diversification with sugarcane (16.64%) and banana (10.96%) as bi-season crops was noticed. Thus, the nature of cropping pattern in HIAS was highly risk prone, compared to AIAS and SIAS.

The nature of cropping pattern prevailed in selected agricultural systems, influenced the extent of cropping intensity as well as land use intensity (CLUI). The cropping intensity was found to be higher in AIAS due to growing of two crops of paddy in a year besides to cultivation of annual crops like banana and sugarcane. However, in case of HIAS, though the water supply was more assured , the cropping intensity was found to be lower than HIAS in view of practice of monoculture of padddy around the year. Similarly, the cropping intensity was found to bc lower in SIAS due to cultivation of bi-seasonal crop of cotton. However, the cultivable land utilization index (CLUI) was higher in both SIAS and AIAS, compared to HIAS eventhough the cropping intensity was lower. This was mainly due to cultivation of bi-seasonal crops, which occupied the land longer period than seasonal crops in a year. Thus, it is clear that the land use efficiency was higher in AIAS and SIAS than HIAS due to diversified and long duration duration cropping pattern.

5.2 Input use pattern in different crops

5.2.1 AIAS

The input use pattern in this system clearly indicated (Table 4.4) that the expenditure on human labour formed the major component of total cost in all the crops and seasons. This shows that paddy, banana and sugarcane grown in this system were labour intensive in nature. In case of paddy, though the total cost in *kharif* paddy (Rs.12034.04/ha) was higher than *rabi*/summer paddy (Rs.9786.68/ha), the share of different inputs remained almost same in both seasons. It is worth noting that the use of manure input was considerably higher in all the crops in this system. The opinion survey indicated that the farmers in this system were practicing green manuring, incorporation of crop residues and other organic manures over the years. Therefore, soils of this system are not degraded inspite of irigation for the last three centuries unlike in HIAS. The cultivation of diversified cropping pattern, use of organic manure, etc., were the main reasons for lower incidence of pests and diseases and hence lower cost on plant protection chemicals and fertilizers in AIAS.

5.2.2 HIAS

The results depicted in Table 4.5 clearly indicated that, the per hectare expenditure on plant protection chemicals formed major component of total cost of cultivation of paddy in both *kharif* (30.37%) and *rabi*/summer (30.66%) seasons. The expenditure on chemical fertilizers formed second highest component in both seasons. This clearly indicated that due to highly intensive cultivation of paddy, the use of plant protection chemicals and fertilizers were also found to be higher.

5.2.3 SIAS

The results depicted in Table 4.6 have clearly revealed that per hectare expenditure on human labour formed the major component in all the rainfed crops except cotton in which plant protection chemicals was the major component of total expenditure. Under rainfed situations, farmers used more of family labour for different operations as it was non-cash input. In the case of cotton, due to severe incidence of pests and diseases, the costs on their control was found to be higher. This is followed by expenditure on bullock labour which formed the second highest component in all the crops except in sunflower in which fertilizer was found to be second major component. The variation in the use of human and bullock labour among the different crops under rainfed situation was mainly due to operational differences in the cultivation of these crops. The per hectare expenditure on all the inputs was found to be highest in cotton, compared to all other rainfed crops. Since cotton was more susceptible to pests, and diseases and labour intensive in nature, the total input cost was found to be higher than other crops.

The per hectare expenditure on human labour formed the major component in all the light irrigated crops (Table 4.7) except paddy and cotton wherein plant protection chemicals formed the major component of total expenditure. The cultivation of light irrigated crops with improved package might have resulted in higher use of human labour. Further, due to scarcity of human labour, the wage rates were also very high, resulting in higher cost on human labour. The expenditure on bullock labour formed the second major component of total expenditure in all the light irrigated crops except seeds in groundnut. In case of groundnut, quantity of seeds used and their market value was considerably higher than other light irrigated crops. The differences in the use of human and bullock labour among the irrigated crops were mainly due to differences in the cultivation of crops under irrigated situations. Therefore, use of machine power may be encouraged so that the expenditure on human labour could be reduced and thereby cost of cultivation also reduced.

5.2.4 Paddy in selected agricultural systems

Among the various inputs used in *kharif* season, plant protection chemicals formed the major component of total expenditure in both HIAS (30.20%) and SIAS (28.05%) while it was third major component in AIAS (14.32%). It is worth noting that the use of plant protection chemicals in HIAS and SIAS was significantly higher than that of AIAS by 193.48 and 116.12 per cents, respectively. This was mainly due to monoculturing of paddy over years, resulting in building of pests and diseases. However, due to use of relatively higher quantity of organic manures, crop rotation and lower levels of fertilizer use, the incidence of pests and diseases were found to be less and thereby less expenditure on plant protection chemicals in AIAS. The savings on plant protection chemicals alone formed about Rs.3336.09 per hectare in AIAS over HIAS. Similarly, the use of fertilizers in both SIAS and HIAS was considerably higher than that of AIAS by 13.13 and 54.09 per cents, respectively. The farmers in AIAS used more of organic manure while the SIAS and HIAS depended on the chemical other hand, the cultivation of paddy in HIAS and SIAS was found to be intensive with the higher levels of chemical fertilizers and plant protection chemicals. Thus, eventhough the cultivation of paddy in SIAS and HIAS was found to be intensive, its profits were lower than that of AIAS. Similar trend in costs and returns structure were noticed in *rabi*/ summer paddy between HIAS and AIAS.

5.3.2 Costs and returns structure of other crops in selected agricultural systems

A critical perusal of Table 4.11 revealed that the profits at Cost-C were found to be higher in paddy (Rs. 14402.95/ha) as compared to other single season crops under irrigated situations of SIAS eventhough its cost of cultivation was also higher mainly due to higher productivity and remunerative prices. However, due to limitation of canal water supply in SIAS, the farmers cannot venture into paddy cultivation in large areas. Therefore, under light irrigated situations, cultivation of groundnut (Rs.10833.25/ha) was found to be profitable than sunflower (Rs 8914.82/ha) and jowar (Rs.6816.40/ha). The findings of Hiremath *et al*, 1984 (a) also supported the results.

Under rainfed situations of SIAS, cultivation of sunflower (Rs.4114.36/ha) was found to be profitable over other crops (Table 4.12). In the case of bi-season crop of cotton, inspite of higher gross returns (Rs.21475.33/ha), its profit (Rs.3428.83/ha) was lower than sunflower mainly due to higher cost of cultivation including significant expenditure on plant protection chemicals.

fertilizers for nutrient management in paddy. The extent of use of organic manures in SIAS and HIAS were less than AIAS by 41.19 and 13.82 per cents, respectively. Similar findings were also observed during *rabi*/summer seasons between HIAS and AIAS wherein use of plant protection chemicals (226.08%) and fertilizer (71.96%) in HIAS were substantially higher than those of AIAS.

Therefore, it is clear that use of organic manure, diversification of crops, lower level of chemical fertilizers and plant protection chemicals could able to sustain AIAS over years.

5.3 Costs and returns of different crops

5.3.1 Costs and returns structure of paddy in selected agricultural systems

A critical analysis of costs and returns structure of different crops under selected agricultural systems revealed that under irrigated situations the profits at Cost-C in different crops were substantially higher in AIAS, compared to those in HIAS and SIAS.

In the case of paddy under *kharif* season, profit at Cost-C was found higher in AIAS (Rs.20002/ha) over SIAS (Rs.14402.95/ha) and HIAS (Rs.17408.49/ha) mainly due to lower cost of cultivation, since there was marginal difference in gross returns. The Cost-C incurred in paddy under *kharif* in AIAS was lower than that of SIAS and HIAS by 4.42 and 18.39 percents, respectively. As a result, the benefit cost ratio in AIAS (1.98) was also higher than that of SIAS (1.67) and HIAS (1.72). The chemical fertilizers and plant protection chemicals which formed major component of total cost of cultivation in paddy (Table 4.8) were used at lower levels in AIAS and thereby contributing towards decline in cost of cultivation. On the

In general, the profits from rainfed crops were found to be marginal with low benefit cost ratio in SIAS. Moreover, the profitability of rainfed crops, on an average, was considerably lower than those of irrigated crops in SIAS. Therefore, concerted efforts needs to be made to supply the canal water to all the farmers of this system to increase their income.

It is worth noting that profits from banana (Rs.36267.35/ha) and sugarcane (Rs.29401.04/ha) were higher than other crops under assured irrigated situations of AIAS as well as HIAS. In addition to higher profits, cultivation of banana and sugarcane helps in building / maintaining soil fertility and ecosystem due to incorporation of crop residues, less use of chemical fertilizers and plant protection chemicals. Thus, the AIAS was able to maintain stable production and income over HIAS and SIAS.

5.4 Resource use efficiency of various inputs

A perusal of Tables 4.14 to 4.17 clearly revealed that the selected variable inputs explained nearly 85 per cent of the variations in output of different crops in all the selected agricultural systems.

In the case of paddy under *kharif* season, fertilizers (0.9375) had significant influence on gross returns in AIAS as against seeds (0.0942) in HIAS fertilizers and labour (1.1088) in SIAS. It is worth noting both fertilizers and plant protection chemicals had negative influence on output of paddy in HIAS and SIAS indicating their excess use. This was further strengthened when the ratios of MVP to FC were considered. The ratios of MVP to FC in the case of fertilizers and plant protection chemicals were found to be less than unity, clearly indicating there over utilization both in HIAS and SIAS. This calls for educating the farmers for optimum use of plant protection chemicals and fertilizers especially in HIAS and SIAS. However, fertilizers which had significant influence on *rabi*/summer paddy in AIAS was found to be under used with MVP to FC being more than unity. The significant influence on fertilizers on paddy output in AIAS may be attributed to its optimum use as well as for higher use of organic manures.

In case of banana under AIAS, seeds had significant influence with the greater than unity of its ratios of MVP to FC. This shows that seedling material which were under used may be increased to obtain higher yields. It was observed that the number of plants per unit area varies considerably among the farmers. The farmers using less number of plants may be advised to increase their number in order to enhance the production. Labour had negative influence with less than unity of its ratios of MVP to FC indicating over use of input. This may be attributed to the labour intensive nature of the crop. These are contrary to the findings of the Patil and Acharya, 1974. Similar findings were found in sugarcane wherein seeds add negative influence with less than unity (-3.4093) of its ratios of MVP to FC. It is worth noting that manures and labour had significant influence with the greater than unity of its ratio of MVP to FC suggesting more and more use of organic manure and labour in the cultivating sugarcane in AIAS.

Under rainfed situations of SIAS, ratios of MVP to FC of all the inputs in different *kharif* crops were greater than unity except bullock labour in bajra, land in jowar, seeds and plant protection chemicals in greengram and human labour in sunflower. Similarly, seeds and human labour in *rabi* jowar and fertilizers and human labour in cotton had their ratios of MVP to FC less than one. The findings, in general, shows that most of the inputs were under utilized in rainfed situation and hence there is scope to increase their usage for higher returns. Similarly, most of the inputs had their ratios of MVP to FC greater than unity indicating scope to increase their usage except fertilizers in *kharif* paddy ; seeds in *rabi*/summer jowar ; fertilizers and machine power in sunflower ; seeds and human labour in groundnut and land, fertilizers, plant protection chemicals and labour in groundnut. Similar findings were reported by Khunt and Raju, 1984. Land, manures and plant protection chemicals in hybrid cotton. The plant protection chemicals were found to be excessive in most of the crops under irrigated situations of SIAS. It may be mainly due to the inadequate use of organic manures and decline in the fertility of soils which necessitated to use more and more of chemical fertilizers to obtain better output. The use of plant protection chemicals was also found to be excessive in hybrid cotton in view of severe incidence if pests and diseases. Therefore, in order to reduce the cost on chemical fertilizers and plant protection chemicals on one hand and to increase their output besides conserving the eco-system, use of organic manures, bio-fertilizers and practice of integrated pest management with the use of plant products, biological agents, etc., needs to be encouraged.

5.5 Efficiency indicators in selected agricultural systems

The efficiency indicators of selected agricultural systems which are depicted in Table 4.24 have clearly indicated the imbalances in index values of different indicators among selected agricultural systems. However, it is worth noting that the intensity of all selected indicators namely, cropping intensity, irrigation intensity, plant protection chemicals use intensity, fertilizers use intensity, High Yielding Variety use intensity, machine power use intensity, commercial crops intensity, and labour use intensity were higher. This clearly indicates that cultivation of crops in HIAS was highly intensive with higher use of most of the resources mainly due to assured supply of irrigation water. Under AIAS, eventhough the canal water supply was more assure, the intensity of most of the resources was found to be moderate mainly due to the experience of the farmers with irrigated agriculture over generations during last 3 centuries. However, intensities of all the selected indicators were found to be lower in SIAS in view of risk of irrregular and in-adequate supply of canal irrigation water. In general, composite efficiency index (CEI) was also found to be higher in HIAS, compared to AIAS and SIAS in view of higher intensities of various indicators selected as explained earlier.

However, it is interesting to note that inspite of the higher intensity in cultivation of crops in HIAS (86.36), its composite yield index was found to be lower than AIAS (92.28). This may be attributed to the indiscriminate and non-judicious use of resources as well as cultivation practices in HIAS. On the contrary, farmers with vast and long experience in irrigated agriculture in AIAS could able to obtain higher and sustainable production.

Thus, it can be inferred that eventhough agricultural practices in AIAS were moderately intensive, its returns were optimum. Therefore, the farmers in both HIAS and SIAS needs to be educated in rational and scientific cultivation practices.

5.6 Socio-economic status of sample farmers

A critical analysis of socio-economic parameters (Table 4.25 to 4.28) was carried out to know the position of sample farmers under selected agricultural systems.

The position of social parameters appears to be fairly better in AIAS than those of HIAS and SIAS. The extent of illiteracy was highest in SIAS (69.40%) followed by HIAS (37.63%) and AIAS (10.15%). On the contrary, literacy at both school and college levels were higher in AIAS than HIAS and SIAS. It is worth noting that the pattern of literacy position between male and female was also very wide in selected agricultural systems. About 15.60 and 9.68 percents of female were educated at school and college level in SIAS as against 43.55 and 32.61 percents respectively, in AIAS. As a result of better educational status of farmers in AIAS, the tendency to live independently increased with 63.47 per cent opting for nuclear family. On the contrary, the joint family system was more predominant in SIAS (73.33%) mainly due to illiteracy, higher dependence on agriculture, low-income levels, etc.

The migration of people from SIAS (58.46%) was found to be higher than those of HIAS (19.70%) and AIAS (9.35%) mainly due to inadequate employment opportunities in agriculture which is highly risky in view of its dependence on rainfall and irregular as well as inadequate supply of canal irrigation water. Moreover, the number of family members employed in agriculture (Table 4.28) in SIAS (4.79) was also higher than those involved in AIAS (2.23) and HIAS (1.91) indicating need of more employment opportunities. On the contrary, immigration of people to AIAS (79.63%) and HIAS (63.34%) was found substantial in view of regular and assured employment opportunities in agriculture due to supply of canal irrigation water round the year.

In the case of farm assets, the extent of animal and other capital assets position was found poor in SIAS as compared to both HIAS and AIAS, mainly due to lower intensity of farm practices. Similar pattern was noticed in the case of domestic capital assets. The extent of domestic capital assets (Table 4.26) was found to be either very poor or non-exisitng with farmers in SIAS. On the contrary, most of the every farmer owned domestic capital assets like radio, television, motorcycle and furnitures in both HIAS and AIAS. The other domestic capital goods such as four-wheelers, telephone, refrigerators, and LPG stove, hither to considered as luxury in rural areas, were also available with farmers in HIAS and AIAS mainly due to higher income levels of farmers in these systems. On an average, annual income from all sources was found to be Rs.20,600.04 in SIAS as against Rs.1,05,098.44 in HIAS and Rs.1,30,996.03 in AIAS.

Thus, it is concluded that the socio-economic position of sample farmers in both HIAS and AIAS was found better than those in SIAS.

SUMMARY AND POLICY IMPLICATIONS

VI SUMMARY AND POLICY IMPLICATIONS

6.1 Introduction

In India, where changes in agriculture practices are occurring rapidly, traditional and modern systems frequently co-exist in adjacent areas of the country. Prior to green revolution, Indian agriculture was in the form of traditional or subsistence farming which were characterized by use of local seeds or planting material, harnessing the rainfall water resources, use of locally available resources and practice of indigenous method of agricultural operations in the production of various crops. Modernization of agriculture has led to intensive cultivation practices with excessive use of chemical fertilizers, plant protection chemicals, and improved varieties/hybrids. Such areas are invariably seen in irrigated commands of the country. Because of intensive practice of agriculture system and non-judicious use of resources, several adverse effects on soil, environment and human health are noticed in recent years, besides increase in the cost of cultivation. Therefore, it is necessary to examine whether the irrigated commands which apparently looks to be progressed, are really progressed or not.

Tungabahadra project in Karnataka is one of the important major irrigation project commissioned during 1952. The agricultural system in the head region of the Tungabhadra project is highly intensive with excessive use of irrigation water coupled with chemical fertilizers and plant protection chemicals. Due to indiscriminate use of these inputs, this region is affected by salinity, water logging, increase in the incidence of pests and diseases, human health hazards etc., Added to all these, there is no increase in the yield of major crops eventhough the cost of cultivation is increasing. Such phenomena are low to moderate in tail region of the Tungabhadra project area. However, in the Vijayanagar canal irrigated systems within Tungabhadra project command area, such problems apparently looks to be minimum inspite of their irrigated agriculture for last 3 centuries.

Therefore, a critical examination of these distinct agricultural systems is essential to throw light on the future developmental strategies. In this regard, an attempt has been made in the present study to assess the performance of these three agricultural systems and to find out their socio-economic impact. More specifically, the objectives of the study are :

1) To identify cropping and land use pattern in selected agricultural systems
2) To find out input use pattern, costs and returns structure in different crops under selected agricultural systems
3) To estimate the resource use efficiency of various inputs in different crops
4) To find out the efficiency off selected agricultural systems
5) To determine the socio-economic impact of selected agricultural systems

6.2 Methodology

For the purpose of this study, three different agricultural systems prevailed in Tungabhadra project area was identified based on the period of practice of irrigated agriculture. A random sampling technique was used for the selection of villages and farmers for the study based on their homogenity with respect to water availability and cropping pattern. For evaluating the objectives of this study, necessary data were collected regarding socio-economic characteristics of sample farmers including size of holdings, family structure, educational level, their assets position, etc. The cropping pattern and cultivation practices of different crops were also collected by personal interview method with the help of well structured questionaire. The data pertained to the agricultural year 1998-99. In addition, secondary data were collected from the concerned authorities of the study area. The data so collected were analyzed using tabular presentation, production functional analysis and use of efficiency indicators.

6.3 Major findings of the study

The most important findings of the study are summarized below :

1) The cropping pattern in SIAS and AIAS was found to be diversified, compared to HIAS wherein monoculture of paddy was noticed both in *kharif* and *rabi* / summer.

2) The cropping intensity (329.20) as well as CLUI (1.7053) were higher in AIAS indicating efficient use of land, compared to other systems.

3) Under rainfed as well as light irrigated situations in SIAS, expenditure on human labour was found to major components of total cost on various inputs in all crops except cotton.

4) The expenditure on chemical fertilizers and plant protection chemicals were the major components of total cost of paddy cultivation in both SIAS and HIAS. However, expenditure on fertilizers and plant protection chemicals was lower in paddy under AIAS.

5) In AIAS, the expenditure on human labour formed the major components in all the crops including paddy.

6) The profitability of paddy cultivation under *kharif* season (profit at Cost-C) was found to be higher in AIAS (Rs.20002/ha) as compared to HIAS (Rs.17408/ha) and SIAS (Rs.14402.95/ha) due to lower cost of cultivation.

7) Among light irrigated crops in SIAS, cultivation of groundnut (Rs.10833.25/ha) was found to be profitable than sunflower (Rs.8914.82/ha) and jowar (Rs.6816.40/ha).

8) The use of chemical fertilizers and plant protection chemicals were found to be over used in *kharif* paddy under HIAS and SIAS.

9) Under AIAS, fertilizers had significant influence on paddy output in *rabi*/summer, however, it was under utilized.

10) Under AIAS, organic manures and labour had significant influence on sugarcane output, however they were under utilized.

11) In general, it was found that most of the inputs were under utilized and hence there is scope to increase their usage for higher returns in rainfed situations of SIAS.

12) The use of chemical fertilizers and plant protection chemicals were found excessive in most of the crops under irrigated situations of SIAS.

13) The practice of cultivation in HIAS was found to be highly intensive with higher intensity of most of the resources except organic manures. However, it was moderate in AIAS and very low in SIAS.

14) In general, eventhough composite efficiency index (CEI) of HIAS was higher than AIAS and SIAS, its composite yield index (CYI) was found to be lower than AIAS.

15) The composite efficiency index (CEI) as well as composite yield index (CYI) of AIAS was found to be higher, indicating its sustained efficiency, compared to other systems.

16) The position of socio-economic characteristics of sample farmers in both HIAS and AIAS appears to be better than those in SIAS.

Policy Implications

The implications that have emerged from this study are summarized below :

1) The monoculture of paddy after paddy in HIAS has resulted in adverse effects like increased use of chemical fertilizers, plant protection chemicals, degradation of soil health, etc.

2) The over use of chemical fertilizers and plant protection chemicals in HIAS and SIAS needs to be rationalized by educating the farmers so as to increase their returns.

3) The use of machine power needs to be encouraged to reduce the cost on human labour and thereby total cost of cultivation. Therefore, farm implements and machines suitable to various operations needs to be developed for large-scale adoption.

4) In general, most of the inputs under SIAS were under utilized. Therefore, for optimum use of resources, farmers need to be educated with suitable extension activities.

5) The practice of agriculture in AIAS with higher use of organic manures, appropriate crop rotations and plant protection chemicals used, etc., appears to be sustained over years in terms of higher composite yield index. Hence, farmers under HIAS and SIAS needs to be educated with such practices for sustainable agriculture system as well as to improve their socio-economic status.

6) The experiences of irrigated agricultural systems over centuries in AIAS may be extended to other irrigated commands in the country.

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APPENDIX

APPENDIX - I

Name of surveyor ---------------------
Date of Survey ---------------------

Part 1 INFORMATION REGARDING FARMER AND CROP PRODUCTION

Part A. General information about farmer and cropping patterns.

1) Name : ------------------------ 2) Village : ------------------------
3) No. of years family has been in the village : ------------------------------
4) Number of full time servants : -------- 5) Main occupation : -----------
6) Subsidary occupations : dairy/ poultry / agri-labour / non-agricultural activities (provision stores etc.) / others (specify) ----------------------
7) Social information
   a) Family type : Joint / Nuclear
   b) Family composition :

Name	Male / Female	Age	At Home	Educational level			Occupation	Relation with Family Head
				Illit	School	College		

8. Details of capital farm assets :

Item	No.	Current value (Rs.)
Bullocks		
Buffaloes		
Cows		
Sheep & Goat		
Domestic house		
Animal shed		
Tractor & implements		
Threshers		
Sprayers		
Dusters		
IP sets		
Farm implements		
Farm tools		

9. Details of domestic capital assets :

Sl. No.	Domestic capital assets	No.	Current value (Rs.)
1.	Radio		
2.	Television		
3.	Telephone		
4.	Bicycle		
5.	Motorcycle		
6.	Four wheelers		
7.	Furniture		
8.	Refrigerators		
9.	Pressure cooker		
10.	LPG stove		

10. The nature and particulars of land
   a) Size of total land holding :
   b) Details of land holding (Field wise) :

Sy.No./ Field Name	Area (ha)	Owned	Leased (ha)		Operated (ha)	Share Cropped (ha)	Fallow (ha)	Soil type	RF	Irri	Source of irrigation
			In	Out							

11. Cropping pattern

Field name / Survey No.	Kharif season (1998)				Rabi (1997-98)				Summer		
	Crop & Variety	Area	Irri /RF	Previous crop	Crop & Variety	Area	Irri /RF	Previous crop	Crop & Variety	Area	Irri/ RF

12. Liquid capital :
    a) Owned ------------------------ (Rs.)
    b) Out side ------------------------ (Rs.)
       i) Source ---------------------------- ii) Amount -------------------- iii). Interest rate ----------

13. output other than crop.

	Used by family	Sold
a) Milk (Liter / year)		
b) FYM (tones/year)		
c) Hiring		
i) Labour (person – days / year)		
ii) Bullocks (pair-days / year)		
iii) Tractor (no.of hrs./yr.)		
iv) Thresher (no. of hrs./yr)		

Part B: General crop production sheet

1. Field name : ------------------------ 2. Crop & variety : ----------------
3. Year & season : ---------------------- 4. Area (ha) : -------------------
5. Irrigated / RF : ---------------------- 6. Soil type : -------------------
7. Date of sowing : ---------------------- 8. Date of harvest : ----------------
9. Material inputs : Seeds & Manures

Input	Total quantity	Rate	Total cost
Seed			
FYM			
Green manure			
Sheep/ Goat herd			
Fertilizers			
Urea			
S/P			
M/P			
DAP			
Others (Specify)			

Gypsum			
Micronutrients			

14. Material inputs:

Product name	Form (Liquid, dust, WP)	No. of appins.	Total Quantity	Rate/ unit (Rs.)	Total cost (Rs.)

15. Labour Inputs

Operation	No. of Times	Total human labour-days		Total bullock pair-days	Machinery		contract cost
		Male	Female		Type & HP	Total hrs.	
Ploughing							
Clod crushing							
Harrowing							
Field cleaning							
FYM transport and Spreading							
Sowing							
Ferti. Applin.							
Hoeing							
Weedicide Applin							
Hand weeding							
Pesticide Application							
Watch & ward							
Irrigation							
Harvesting							
Threshing							
Winnowing							
Packing							
Transport							
Market							
Others (Specify)							

16. Returns

Yield	Qty. Produced	Qty. sold	Rate/ unit (Rs.)	Family use			
				Seed	Consumption	Soil amend-ments	Fuel
Grain							
Straw							

Reasons for growing the particular crop
(Higher yield, price, water availability, family consumption, animal consumption, contingent crop, sustainable yield, capital limitation, soil type etc.)

Additional comments :

AN ECONOMIC ANALYSIS OF SELECTED AGRICULTURAL SYSTEMS IN TUNGABHADRA PROJECT AREA, KARNATAKA.

YERRISWAMY. J 1999 L. B. HUGAR
(MAJOR ADVISOR)

ABSTRACT

The study was undertaken (1997-98) in Tungabhadra Project (TBP) area to assess the selected agricultural systems which were identified on the basis of adquacy of irrigation water and period of practice of irrigated agriculture namely (i) Ancient Irrigated Agricultural System (*AIAS*) which is under irrigation from the period of Vijaynagara empire (last 3-4 centuries) with assured supply of water (ii) Highly Intensive Agricultural System (HIAS) under irrigation for the last 4 decades with assured supply of water and (iii) Semi-Intensive Agricultural System (SIAS) under irrigation for the last 2-3 decades with inadequate water supply. The cropping pattern was found to be highly diversified in SIAS and AIAS whereas monoculture of paddy was noticed in HIAS. The cropping intensity as well as cultivable land use index were also higher in AIAS over HIAS indicating higher land use efficiency in AIAS. The input use pattern in paddy clearly revealed that the cost on plant protection chemicals and chemical fertilizers formed the major components of total cost in HIAS and SIAS while the cost on labour in AIAS. The net returns of *kharif* paddy was found to be higher in AIAS (Rs. 20,002/ha), compared to HIAS (Rs. 17,408/ha) and SIAS (Rs. 14,402/ha) mainly due to higher cost on plant protection chemicals and fertilizers in HIAS. The resource use efficiency of fertilizers and plant protection chemicals indicated their excess use in paddy cultivation under HIAS and SIAS.

It is worth noting that the intensity of all selected indicators namely, cropping intensity, irrigation intensity, plant protection chemicals use intensity, fertilizer use intensity, high yielding variety seeds use intensity, machine power use intensity, commercial crops intensity and labour use intensity were found to be higher in HIAS except organic manure use intensity which was found to be higher in AIAS. Intensity of other resources found to be moderate in AIAS. Intensity of all indicators were lower in SIAS in view of risk of irregular and inadequate supply of canal irrigation water. The Composite Efficiency Index (CEI) as well as Composite Yield Index (CYI) of AIAS was found to be higher indicating its efficiency as compared to other systems. The position of socio-economic status of sample farmers in both HIAS and AIAS appears to be better than those in SIAS.

The practice of agriculture in AIAS with higher use of organic manures, appropriate crop rotations and less use of plant protection chemicals appears to be sustained over years in terms of higher composite yield index. Hence, farmers under HIAS and SIAS needs to be educated with such practices of sustainable agricultural system as well as to improve their socio-economic status.