ECONOMICS OF IRRIGATION-
A CASE STUDY OF KUTTIADI IRRIGATION PROJECT

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CERTIFICATE

Certified that the thesis "Economics of Irrigation- A case study of Kuttiadi Irrigation Project" is the record of bonafide research carried out by Mr. K.S. Mony under my guidance. The thesis is worth submitting for the degree of Doctor of Philosophy in Economics under the faculty of social Sciences.

Prof. (Dr.) K.C. Sankaranarayanan.
Supervising guide

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CHAPTER I

INTRODUCTION

The evergrowing stock of foodgrains in the early 80s created a sense of complacency among the planners and the academicians alike in the country. But the successive droughts during the years 1984 through 1987 and the consequent fall in foodgrain production have made everyone to realise how dependent Indian agriculture still is on the vagaries of monsoon.

The drought in 1987-88, one of the worst on record in the country, resulted in a fall of about 7 to 10 per cent in foodgrains production in that year relative to the previous year which, by itself, was a bad agricultural year, notwithstanding the efforts made to offset the fall (Economic Survey, 1988). The rapid increase in population (which was 2.25 per cent during 1971-81) has the effect of pushing up the demand for food and, if this persists amidst little or no growth in foodgrains or agricultural production, it will lead to a terrible scarcity in the economy in the food front (Seventh Five Year Plan, 1985-90, p.11). This is increasingly being realised and therefore the ways and means of increasing the agricultural production to match with the targets set in the Seventh Plan and Eighth Plan are being developed by what agency?

One obvious means that is sought to be pursued to reduce the dependence of agriculture on monsoon is to strengthen the irrigation network in the country. Access to irrigation (surface or ground water) can act as a substitute for any deficiency in natural rainfall, besides being a must for crop husbandry in rain deficient trucks (Dhawan, 1988, p.13) and can result in adoption of profitable cropping pattern which cannot be taken up when there is uncertainty regarding water availability for cultivation. Implicit in the above two points is the fact that irrigation cannot only have a positive impact on agricultural production, but also in its stability. In fact, in the mid 60s when the country was badly looking for reducing its reliance on food imports especially from U.S.A. under P.L.480, it is the areas endowed with better irrigation facilities which encouraged the government to go in a big way for the high-yielding variety seeds.

Irrigation has also the effect of increasing the intensity of cropping by making it possible to cultivate lands which would otherwise have to be left uncultivated. The beneficial role of irrigation in curbing farm instability in area, yield and output is also clearly established (Dhawan, 1988, p.172). The crop-wise trends also reveal the importance of irrigation in stabilising production (Mahendradev, 1987, p.87).

Dhawan estimated that for the country as a whole yield on irrigated land was 22 quintals in foodgrains energy equivalents (FEES) per hectare of gross irrigated area in 1983-84 (Dhawan, 1988, p.87-89). His estimates also show that on lands not benefited by irrigation, the yield was not more than nine quintals per hectare. Thus the yield differential between irrigated and unirrigated agriculture worked out to be about 13 quintals per hectare. Of course, all this is not to be taken as the pure yield effect (that is rise in yields of crops without any change in the crop pattern following access to irrigation). A decomposition exercise shows that the pure yield effect was only 6.9 quintals out of the 13.3 quintals of yield differential observed during 1983-84 (Dhawan, 1988, p.85). Of the rest 2.6 quintals was the pure crop pattern effect. "A positive value of 3.8 quintals for the interaction term signifies that irrigation induces a change in the crop pattern away from low to higher yield in crops" (Dhawan, 1988, p.85). The beneficial effect of irrigation have prompted the government to expand irrigation facilities right from the beginning of the planning era. An enormous increase in investment in irrigation has the effect of contributing to irrigation development in the country. The expansion of irrigable area as such is an inadequate measure of irrigation development, because there is a divergence between irrigation potential created and utilised. Further, even the expansion of area actually irrigated cannot be a true measure of irrigation development, because it tells little about the quality of irrigation as reflected in the quantum of water available per unit of area, the assurance and timeliness of water supplies and the extent of flexibility in adjusting water supply to crop water needs.

In the agricultural sector there is not much scope to increase the net sown area and that it has been almost stagnant. Another discouraging factor is that, a significant proportion of the net sown area has been taken away for developmental activities. This has reduced the net area available for cultivation and it would continue even in future. Realisation of this fact has led to enhance agricultural production and employment opportunities within the rural sector itself, by strengthening the use of the new technology consisting of the water-seed-fertilizer-strategy. It means that water origination is realised as one of the very important and crucial factors in increasing agricultural production, employment generation and additional net return. Since about 50 per cent of the irrigation potential is yet to be utilised, there is still significant scope to irrigate a vast agricultural area to enhance agricultural production and absorb more additional labour within irrigated agriculture (Government of India, 1988).

Statement of the Problem

Increasing agricultural production is one of the important objectives of the five year plans in India. This objective can be achieved by increasing the net area for cultivation. But the present world faces the problems of inadequacy of land due to the diversion of land from cultivation to developmental activities. This has reduced the net area available for cultivation. This shortage of land poses the need for increasing production and productivity per unit of land with help of strengthening the use of the new technology consisting of irrigation-seed-fertilizer-strategy. This led to the emergence of a number of large scale irrigation projects in Kerala. Several economists have analysed the various aspects of development of irrigation in the agricultural sector. But hardly any systematic and exhaustive study covering cropping pattern, intensity of cropping, adoption of technology, production, employment, cost and yield structure per unit of land as a result of irrigation in the state has so far been conducted. The present study is directed to fill this gap in a small way.

The Kuttiadi irrigation project in Kerala has been selected for the present study. This is mainly because this project is one of the major irrigation projects in Kerala situated in Kozhikode district. The district is endowed with a high average rainfall (exceeds even 5000 mm per annum). The average rainfall in the state is roughly assessed as 3085 mm per annum.

Objectives of the Study

The present study is undertaken with the following objectives:

1. To assess the nature and direction of change in the cropping pattern due to irrigation.
2. To know the changes in intensity of cropping as a result of irrigation.
3. To understand the effects of irrigation on adoption of modern technology.
4. To estimate the extent of increase in crop production per acre of gross cropped area due to irrigation.
5. To understand the impact of irrigation on employment and on the changing composition of male and female labour.
6. To examine the cost and yield difference between irrigated and non-irrigated land.
7. To estimate the net return per acre in the command area and in the non-command area by different crops.

Methodology

The impact of irrigation is evaluated in this study on the basis of "with" and "without" principle. The study is both descriptive as well as analytical. It is descriptive as far as literature survey is concerned and analytical with regard to the primary and secondary data collected for analysis, interpretation and conclusion. Both primary and secondary data were used for this study.

The Kuttiadi irrigation project has two main canals namely, Left Bank and Right Bank main canals. Each main canal has six and four branch canals respectively. The Left Bank main canal was selected purposively for this study. The reason for selecting this is that it covers two third of the total ayacut areas of the study region. Three villages namely, Kuzhakkoth, Sivapuram and Unnikulam also were selected from outside the command area to make a comparison between command area and non-command area to find out the real impact of irrigation.

A three stage sampling procedure was adopted for the selection of the study locations. First, the total length of

45 km of the Left Bank main canal with three reaches representing head, middle and lower (tail) were identified. Then, based on the criterion of water allocation by the canal authorities the head reaches were identified. This covered a length of 15 km where the first two branch canals, namely, Kallur and Kakkadi are located (at point 11.400 km and 14.400 km). Thereafter, the middle reaches was identified. This again covered a length of 15 km. It is here that the third and fourth branch canals namely, Naduvathur and Ayanikad were designed (at point 20.200 and 26.300 km). Finally, the lower reaches were identified. This also covered a length of 15 km. It is here that the last two canals namely, Thiruvangur and Iringal are designed (at 45 km; one is on the right and the other on the left).

At the second stage, each branch canal was again subdivided into three portions, viz. upper, middle and lower on the basis of one third of the total length of the branch canal. Three distributaries - one each from the upper, middle and lower portions - were selected and 12 beneficiaries from the area served by each of these three distributaries were canvassed. These 12 beneficiaries were distributed among marginal, small, medium and large operators. Thus, 36 beneficiaries from each branch canal were surveyed. Altogether, 36x6=216 household schedules were used in the command area for collection of data. Further to understand the level of development and for comparison, three neighbouring villages from outside the command area were also selected. Thirtysix households from each village were selected at random. Altogether 108 households were selected from outside the command area. In total, 324 (216 + 108) sample household schedules were used to collect both from the command and from the non-command area.

A pilot survey was undertaken to pre-test the schedule. It was on the basis of the pilot survey that the questions were finalised. The finalised schedules were used to collect information from the respondents.

The schedules were administered during the seasons of Viruppu, Mundakan and Puncha, during the months from May 1992 to April 1993. The puncha crop mainly depends on irrigation.

The primary data collected from the command area were compared with the primary data collected from the non-command area. For the purpose of this study, command area is those that is endowed with assured water supply, while the non-command area is those which does not possess assured water supply under any major or minor irrigation works extended by the government. Here the area that is not covered by any major irrigation canal system is named as non-command area.

Data thus collected was tabulated with the help of statistical tools like arithmetic mean, percentage, t-test. etc. and the data collected were analysed. And on the basis of analysis and interpretation, conclusions were drawn.

Limitations

The study has the following limitations. In the first place, the revenue records in the study villages have not been updated. A few sample farm households selected on the basis of the revenue records could not be retained in that particular farm size group, as they actually owned either less or more land than what is given to the revenue records. Secondly, there was time and resource constraints. So an extensive survey could not be conducted. Thirdly, Right Bank branch canals were not selected. This was due to frequent siltage problem.

Organisation of the Study

The present study is organised under nine chapters. The first chapter, which is in the nature of introduction, states the problem of study and methodology adopted for the study. The second chapter presents a brief summary of the literature on the subject. The third chapter presents a brief history of the development of irrigation in the state. It also explains the profile of the study area. The fourth chapter deals with the socio-economic conditions of the sample households both in the command and in the non-command areas. The fifth chapter examines the impact of irrigation on cropping pattern, intensity of cropping and the adoption of modern technology. The sixth chapter discusses the impact of irrigation on production of paddy as well as in non-paddy crops. The seventh chapter examines the impact of irrigation on employment and on the composition of male and female labour. Chapter eight presents cost and yield structure of cultivation of crops in the command and in the non-command areas. Chapter nine presents the summary and conclusion of the study.

Definition of Concepts

1. Crop Intensity

Crop intensity is the ratio of gross sown area to net sown area.

$$\text{Crop Intensity} = \frac{\text{Gross Cropped area}}{\text{Net cropped area}} \times 100$$

It is normally expressed in terms of percentage and therefore, it has been multiplied by 100. Under the present study, the agricultural year has been divided into three seasons - (1) viruppu, (2) Mundakan and (3) Puncha (summer crop). If a piece of land is sown only once or in only one season, the crop intensity has been treated as 100 per cent. If the same plot is sown two or three times, the crop intensity has been considered as 200 or 300 per cent, as the case may be.

2. Command Area

Command area is those that is endowed with assured water supply through major irrigation canal system.

3. Non-Command Area

Non-command area is those which does not possess assured water supply under any major irrigation canal system.

CHAPTER II

REVIEW OF LITERATURE

The present chapter provides a brief account of the literature. An attempt is made to summarise the nature and extent of the impact of irrigation on production, intensity of crop, cropping pattern, employment and migration of labour, technological change and also studies on cost-benefit analysis.

Theoretical Background

One of the direct benefits of irrigation has been the increase in productivity per unit of irrigated farm, compared to unirrigated farm (Raj, 1960, Abdul Aziz, 1979, Adinarayana,1984, Jayant, 1984, Nadkarni, 1984, Pant, 1984, Patel and Patel, 1984, Patil, 1986, Chambers, 1988). Raj has argued that "the area of the land that can be provided with assured supply of water imposes a limit to the rate of growth there can be realising by technological changes" (Raj, 1960). According to Abdul Aziz, irrigation has by and large resulted in higher yield per acre, higher cropping intensity and also changes in cropping pattern (Abdul Aziz, 1979). According to

Patel and Patel and Adinarayana, irrigation enhances the scope for the adoption of modern technology, intensity of cultivation and better use of complementary inputs which results in positive impact on agricultural growth (Patel & Patel: 1984, Adinarayana, 1984).

Thus, provision of timely and adequate supply of irrigation ensures soil moisture over a long period of time and facilitates planned and intensive cultivation. Further, it leads to changes in the cropping pattern. It also enhances the scope for the adoption of modern technology, viz., High Yielding Varieties, application of more fertilizer and pesticides and mechanization. All these factors put together will have a positive impact on intensity of crop, production, employment, additional net revenue by additional increasing cost per unit of land in the irrigated farm than that of unirrigated farm.

Studies on Impact of Irrigation on Production, Employment, Cropping Pattern, Intensity of Crops and Technology

The studies of Rao, Raj, Stain, William J. and Melvin G. Blase etc. have revealed that growth in agricultural production and irrigation are highly correlated. Irrigation has been considered as the most important and proximate factor of agricultural growth.

Rao argued in his study that inter-state differences in crop output growth during 1952-53 and 1964-65 were due to the inter-state differences in the growth of irrigation. He showed that high rates of growth of agricultural production achieved in this period in respect of Punjab and Tamil Nadu were due to high rates of growth of irrigation in these states. In his opinion public investment played a major role in achieving the high rates of growth of irrigation.

Raj pointed out in his study that the period in which the growth rates of agricultural output were high in Mexico, Taiwan, Punjab and Madras (Tamil Nadu) also witnessed high growth in extension of irrigated area in those countries/states. According to Raj "the area of the land that can be provided with assured supply of water imposes a limit to the rates of growth that can be realised by technological change".

According to Staub, William J. and Melin, G. Flase the success of the wheat technology in Punjab is due to the good irrigation base created with substantial public and private investment in the development of surface and ground water irrigation sources.

Provision of irrigation leads to growth in agricultural production and generation of more employment opportunities. According to Chambers, provision of adequate, dependable and timely supply of irrigation enhances production and employment opportunities directly through agriculture and allied activities and indirectly through multiplier effects, and provide reliable and continuous production and employment (Chambers, 1988). However, the extent of production and employment generation per unit of irrigated farm in Indian agriculture has been significantly lower than compared to the situation in Japan and in other South-East Asian Countries (George, 1970). It is, therefore, important to identify the factors that promote both farm productivity and employment, while framing policies for the maximisation of agricultural production and productive employment in agriculture.

Majority of the studies have indicated that the irrigated farms enhanced more production and employment than the unirrigated farms (Patel and Patel, 1984, Adinaryana, 1984, Ghosh,1984, Mehra, 1976, Bothe, Anne and Sundaram R.M., 1984, Ramachandran, 1984). Provision of timely and adequate supply of irrigation ensures soil moisture over a long period of time and facilitates planned and intensive cultivation. Further , it will lead to changes in the cropping pattern from rainfed and semi-irrigated inferior food and commercial crops to superior food and commercial crops. It also enhances the scope for the adoption of modern technology and leads to higher crop intensity and better use of complementary inputs. Finally, it will have a positive impact on production and employment.

According to Milk, Small and Lesli, Pant, Patel and Walter the change in cropping pattern has a positive relationship with agricultural production and employment (Milk, 1978, Small and Lesli, 1983, Pant, 1985, Patil, 1986, Walter (ed): 1986).

Several studies have pointed out that the increased crop intensity leads to increase in production along with absorption of substantial additional labourers in irrigated agriculture (Vaidyanath and Jose, 1978, Patil, 1979, Satya Priya, 1981, Joshi et. al, 1981, Puttaswamaiah, 1989).

The studies sponsored by the Research Programme Committee of the Planning Commission in respect of Sarada Canal, Tribeni Canal, Damodar Canal, Cauvery-Mettur Project, and Nizam Sagar showed ample evidence that these projects have brought about agricultural development of the regions. The benefit accruing from these projects are noticed in terms of cropping intensity, diversification and high quality crops, higher productivity, gains in income and more employment of hired labour. Substantial increase in the use of input were also noticed in the command areas of these projects (Balgit Singh, 1965, Jha Divakar, 1967, Basu, 1963, Sonachalam,1963, Sassu Wale, 1967).

Studies by Gadgil on Pravara Canal, Sovani and Rath on Hirakud, Nagabhushanam and Sarveswara Rao on Nagarjunasagar, and Raj and Chopra on Bhakra Nangal have emphasized the importance of irrigation water in regional development (Gadgil, 1948, Sovani,1960, Nagabhushanam,1963, Raj,1960). The study by Narasimha Murthy on Nagarjunasagar brought out the potentialities of multipurpose river valley project (Nagabhushanam, 1978). The study on "Efficient water use and Farm Management study-India" was a bold attempt in drawing up an elaborate plan for optimal use of water at the district level (William,1969). This study focussed attention on the inter-disciplinary approach to irrigation problems and detailed statistical economic analysis of data on water sources for optimising returns from water use. Minhas and Vaidyanathan stressed the scope for optimal use of project water (Minhas and Vaidyanathan,1969).

The study by Sen pleaded for conjunctive use of surface and ground water to meet the growing demands for irrigation on water (Sen 1970).

Rao in his study (in a perspective of 2 to 3 decades) pleaded for

(i) Exploitation of all sources of irrigation that exist as long as they meet the test of social profitability.

(ii) Modernisation of old irrigation projects on considerations of high pay-of for investment and better response to new technology; and

(iii) Further investment in irrigation projects whether surface or ground water as they continue to contribute to higher production, more employment and equity in the distribution of gains (Rao, Hanumantha: 1976).

Studies on Effects of Irrigation

Three studies (Abdul Aziz, 1979, Hemlata Rao et.al., 1979, N.D. Kamble et.al., 1979) have examined the effects of well and tank irrigation, while others have dealt with the effects of canal irrigation. The studies on canal irrigation have compared situations in wet (irrigated) and dry (unirrigated) areas (T.S. Epstein, 1962, Divankar Jha, 1967, K.S. Srikantan, et.al., 1979, Kenzo Fuji wara, et.al., 1982, T.K. Roy, 1983) or according to the percentage of area/farms under canal irrigation (Gadgil 1948, G.P. Mishra and Vivekananda 1979). By and large, the selected villages/farms are reported to be comparable except with respect to the use of canal water for irrigation.

The findings of these studies indicate that irrigation has, by and large, resulted in higher yield per acre, higher cropping intensity and also changes in cropping pattern. Due to irrigation the area under crops like paddy, wheat, sugarcane, pulses and vegetables has increased when compared to the crops like maize, ragi, bajra etc. The crop intensity which range from 1.0 to 1.3 in dry villages has increased to about 1.7 to 2.4 in the wet villages (Divanskar Jha 1967, G.P. Misra and M.Vivekananda, 1979, T.K.Roy,1983). The yeild per acre for paddy increases from 2.5 to 3.5 quintals in dry areas to 5 to 20 quintals in wet areas. In the case of wheat the increase is from 1.5 to 2.5 quintals to 5 to 10 quintals. Irrigation has also increased the number of mandays of work among the landless agricultural labourers as well as cultivators. Among the landless labourers the number of mandays of work in the dry villages ranges from 130 - 150 mandays per annum and it increases to 200 - 300 mandays in wet villages. Among the cultivators the number of mandays has increased from 170 - 200 to 250 - 300 days. Irrigation has also led to an increase in the use of hired labour - casual and permanent -as compared to the use of family labour (G.P. Misra and M.Vivekananda, 1979). This increase in the use of hired labour has been observed irrespective of the size of the farms. G.P. Misra and M. Vevekananda, 1979 observed similar changes in the case of well and tank irrigated areas. However, the extent of such changes is relatively less as compared to the canal irrigated areas (Abdul Aziz, 1979, Hemlata Rao et.al., 1979 and N.D. Kamble et.al., 1979). Shift from non-agricultural activity to agricultural activity and also from agricultural labourer to owner cultivation as a result of well irrigation (Aziz, 1979) and canal irrigation (T.K. Roy, 1983) has been reported.

Generally, with the provision of irrigation, the farmers have a tendency to shift from inferior rainfed crops to superior food and commercial crops which are highly profitable and labour intensive. Most of the studies have indicated that the change in cropping pattern has a positive relationship in the change in production and the use of labour (Milk, 1978, Small and Lesli, 1983, Pant, 1984, Patil, 1986 and Walter (ed), 1980). Several studies have indicated that the crops like paddy and sugarcane absorb the highest extent of labour among the food and commercial crops (Gupta et.al., 1979, George and Raj, 1981, Sharma, 1985 and Pandey, 1985). This is due to the fact that these crops involve new operations which are labour intensive and the crop duration and the intensity of these operations are also more. Therefore, they absorb more labour. But some others have argued that these crops have not been labour intensive since they require more water and duration than the other crops (Dhawan, 1985, Parashivamoorthy, 1989). The mixed, inter,sequence and double cropping absorbed more labour than the sole cropping (Ghodke and Rojan, 1972, Kalra and Sangale, 1985 and Patel, 1986).

It has also been pointed out that the increased crop intensity leads to higher production and the absorption of substantial additional labour in irrigated agriculture (Vaidyanath and Jose, 1978, Patil, 1979, Satyapriya, 1981, Josh et.a., 1981 and Puttaswamaiah, 1981).

Some studies have shown a positive relationship between crop intensity and farm size. This means that the crop intensity has been less on small farms and more on big farms. This is due to the fact that the small farmers cultivate their farm land only for one or two seasons, as they cannot afford to have alternative source of irrigation to substantiate the scarcity of water during the off-seasons. That is why the crop intensity is less on small farms. On the contrary, the big farmers cultivate their land more intensively throughout the year, by using alternative sources of irrigation. Therefore the crop intensity is more on the big farms.

However, a few studies reveal a negative relationship between the farm size and the crop intensity. This has been due to the fact that the small farmers have tried all types of crops and cultivated their farm land more intensively in the planned cultivation and used short duration crops to maximise the benefits from irrigation. In spite of the scarcity of water during summer season, they will cultivate semi-irrigated crops and never leave their land fallow. Thus the crop intensity will be more on small farms. On the other hand, the rich farmers do not want to cultivate their land during the second season when there is scarcity of water and leave the land fallow. Even under alternative and assured supply of water, the big farmers have a tendency to leave the land as current fallow for one or more seasons. With this the productivity of land could be enhanced significantly. The crop intensity has been low on big farms under such situations, especially, under tank and canal irrigation.

Studies about Irrigation and Labour Force

In these study groups only one has examined in detail the differences in labour force participation rates in the wet and dry villages (K.S. Srikantan et.al. 1979). The other studies have not discussed labour force participation, though they have examined the extent and pattern of in-migration into the irrigated areas. Among these studies, four have surveyed all the households in the selected villages, while Gadgil's study is based on a sample. Jha and Gadgil express in-migration in terms of individual, while in the other three studies it is in terms of in-migrating households. These studies do not discuss the criteria used for distinguishing in-migrants from the residents. Presumably persons/household not belonging to the surveyed villages, but counted at the time of survey, were treated as in-migrants or in-migrating households.

In the Nandipahad study (AERC, Walter, 1970) only one wet village was surveyed and no control village was selected and the estimation of migration is not based on scientific procedures, but on discussion with the village officials and the knowledgeable persons of the village (AERC, Walter 1970, p.11). Hence this study is not reviewed here.

In Srikantan's study work participation rates (those engaged in productive work receiving remuneration in cash/kind, as well as unpaid family workers expressed as percentage of population), particularly those of female and children, vary according to the availability of irrigation facility. For example, the male work participation rates in 0-14 age group is 15.3 per cent in irrigated settlement as compared to 9.5 per cent in settlement to be irrigated and 14 per cent in rainfed settlements. The rainfed settlements are dry villages which are used as control areas and are located outside the command area. Similarly, the female work participation rates in 0-14 age group is the highest in irrigated areas, 11.7 per cent as compared to 5.0 and 9.8 per cent in the area to be irrigated and control areas respectively. In the 15-55 age group, the male work participation rate is 87 per cent, and does not change according to irrigation facilities. On the other hand, female work participation rates 15-55 age group is the highest in the irrigated tracts with about 66 per cent as compared to 32.44 per cent in the other areas (K.S. Srikantan's et.al., 1978).

Among those aged 56 and above the dry areas have the least male work participation rate and the highest female participation rate as compared to the other areas. The differentials in female work participation rates are attributed to "the type of cultivation (whether wet or dry), the crops grown and socially sanctioned productive roles of women, ~~and, on the other hand,~~ the income differentials and the need to supplement the family income by agricultural and non-agricultural labour" (K.S. Srikantan, et.al. 1979, p.28).

Information on the effects of irrigation on the process of migration are contained in the other studies (D.R. Gadgil, 1948, T.S. Epstein, 1962, Divankar Jha 1967, Kenzo Fujiwara et.al. 1982 and T.K. Roy, 1983).

In Gadgil's study no estimate on in-migration is given. However, it appears that there was certain amount of in-migration in the irrigated areas. According to the author, "there is no doubt that some measure of in-migration into the tract has taken place, especially of members of the community called Saswad Mali, well known for their proficiency in Irrigated farming. A measure of this in migration is, however, very difficult to obtain. Only small percentage (less than 10), of the farmers included in our sample were new migrants. This does not necessarily indicate the extent of in-migration" (Gadgil, 1948, p.115). In the case of farm servants, it is observed that the number of farm servants was longer in the irrigated tract than the dry areas, and nearly 53 per cent of the farm servants of the irrigated tracts are migrant, while in the case of dry villages all farm servants were locals or residents.

In Epstein's study it is found that irrigation attracted a significant amount of in-migration into the irrigated village. According to the author, there was labour migration from dry village to wet villages within the region and there was also large scale migration of labour from outside the regions to the wet village.

In Jha's study, there is surprisingly no mention of in-migration into the wet villages. It is not clear whether or not any information was collected on in-migration. On the other hand, it is reported that the number of persons who out-migrated from the surveyed villages on percentage of the total population was 7.2 in wet villages and 5.8 in the dry villages respectively.

In Roy's study, the proportion of in-migrating household to the total households in the irrigated and dry areas are 22.2 and 2.1 per cent respectively. Among the in-migrating households in the wet village, a majority are from the same district followed by from other states. Though the year in which the canal water was made available is not clearly mentioned, it is reported that 4.3 per cent of the in-migrating households in the wet village migrated before irrigation and the remaining 18 per cent are reported to have moved in during 1961-79 when the canal water was made available is not clearly mentioned. It is reported that 4.3 per cent of the in-migrating households in the wet village migrated before irrigation and the remaining 18 per cent are reported to have moved in during 1961-79. When the canal water was made available and the land allotment was being made. In the wet villages, among the migrant households, 39 per cent are engaged in agricultural labour, 37 per cent in service occupation and about 13 per cent in cultivation. In his study, out-migration has also been observed in both wet and dry villages.

Kenzo Fujiwara and others have observed in-migration into the wet village and not in the dry village. There has not been any out-migration either from wet or dry village. During the 10 years period, after the advent of irrigation

(1957-67) about 54 per cent of the in-migrant households movedin and the remaining 34 per cent moved in during the following 10 year period (1967-77). Among those in-migrant households, 76 per cent are from the same district, 18 per cent from other districts and 6 per cent from outside the state. Nearly 80 per cent of the in-migrant households are engaged in agricultural labour and the remaining 20 per cent in cultivation.

b) Irrigation and Composition of Male and Female Labour

A positive relationship between the use of male labour and a negative relationship between the use of female labour and farm size has been hypothesised (Ghodke and Dyan, 1972, George and Raj, 1981 and Rao and Mohan,1985). This is due to the fact that the small farmers grow more food crops and use less inputs. Besides, the family male labourer works on other farms and spends less time on his own farm, to enhance the family income. All these factors reduce the use of male labour on small farms. On the contrary, food crops like paddy and high yielding variety ragi induce new operations which require more of female labour. Besides, intensive cultivation of agricultural crops and cocoon rearing among the small farms require more female labour.

On the other hand, the big farmers use more of modern inputs. Besides, they cultivate more of commercial crops and paddy which need more male labour for a few operations and less of female labour. Besides, improved economic prosperity leads to the withdrawal of family female labour working on farm land and reduction of the area under food crops require less female labour. The process of profit maximisation by big farmers and the use of contract labour reduce the use of family labour on big farms.

Some Studies on Cost-Benefit Analysis

The Pilot Intensive Rural Development Project in Tirthala Block of Kerala (Gopinath and C. Mukunda Das, 1978).

This is a social benefit-cost analysis of selected works. This is an ex-post evaluation of rural road works, minor irrigation works and housing for harijans. Tangible benefits are estimated through the method of net present value. Benefit-cost Ratio, and Internal Rate of Return, Expected life, Salvage value and discount rate are assumed. An attempt is made to evaluate the intangible benefits by the use of dimensional analysis. This is done to estimate the social multiplier benefits. This study ~~makes a~~ point that the housing project for harijans should be considered as a social investment for uplifting the weaker sections of the community. Only then the investment on housing can be justified. It also insists that the employment intensity is a factor which cannot be ignored in rural development projects.

An Investigation into the Socio-Economic Conditions GHOD Command Area (Maharashtra) (Vidyapath, 1980)

This was undertaken by the Department of Economics, Mahatma Phulakrishi Vidyaputh. This study was sponsored by the Irrigation Department, Government of Maharashtra. The objectives of this survey were the following:

i) to analyse the pattern of land utilisation, cropping pattern and the use of farm inputs,

ii) to cost of cultivation and cost structure and

iii) to study the farm business income and household economy of the farmers.

~~Its~~ one major finding was underutilisation of irrigation due to inadequate distributaries, inadequate land levelling and land development, inadequate drainage programme for reclaiming water-logged areas, lack of infra-structure facilities, lack of capital, untimely supply of water and availability of well water.

Other findings were:

i) shift to food crops from non-food crops,

ii) improvement to the farm business income,

iii) input-output ratio increasing from 1:1-28 to 1:1.58,

iv) spread of improved agricultural practices,

v) introduction of non-traditional crops and

vi) absorption of more human labour in the Command Area.

Irrigation in Bhojpur District; Bihar: (Agricultural Finance and Development Corporation, 1982)

This ex-post evaluation was a study sponsored by the Agricultural Refinance and Development Corporation. The subject matter of this study is an evaluation of the benefits of irrigation through 467 tube wells provided at a capital outlay of Rs.40.48 lakhs. Conventional methods of evaluating the additional production, employment and income attributable to this tube irrigation have been adopted. Its major findings are the following:

This command area was flood-prone during kharif season and drought-prone during the robi and summer months. The flood control measures have not been undertaken against the floods in the Ganga and some rivers on the eastern and southern boundaries. Yet against a target of 10 acres per tube well, the achievement is an average of 7 acres. The crop intensity has risen from 100 per cent in the control area to 154 to 170 per cent. The estimated value of annual additional production was Rs.45 lakhs and additional on-farm employment 1,15,000 mandays in 1978-79. This survey has not applied the benefit-cost technique.

Minor Irrigation in Tamil Nadu (G. Venkataramani, 1974)

This was undertaken at the request of the state government by the Madras Institute of Development Studies. G. Venkataramani, the author, has computed the productivity of minor irrigation works by designing a regression model. Irrigation is the independent variable and productivity the dependent variable. It takes the form of Q= f(I), when Q is the physical productivity and I is the quantum of irrigation. The linear regression equation takes the form of Y=a+bx where 'a' and 'b' are the parameters. The period covered is 20 years ending 1970-71. The regression co-efficients of 1.33 and 2.33 show that a positive relationship exists between the two variables - productivity and minor irrigation.

A Critical Evaluation of the Review and Identification of Research Gaps

The majority of the studies have reflected the factors which create impact on agricultural sector under irrigated farming. A critical evolution and review of the available literature are highly essential in order to identify the research gaps.

By and large, most of the studies have analysed the impact of irrigation on production and employment per unit of land either for a season or for an agricultural gear. While doing so, change in the cropping pattern, crop intensity, adoption of modern technology, mechanisation etc., have been taken into account. In the process, the studies have suffered from several limitations which are mentioned below:

In the first place, majority of the studies are based on the data from Farm Management studies or secondary data, which have several limitations. In the case of studies based on primary data, the sample size, many a time, has been too small and the time gap too wide or too narrow.

Secondly, in estimating the impact on production and employment under irrigated farms, the majority of the studies have considered only major crops, and the subsidiary crops which occupy a significant proportion of the cropped area are dropped out. This may either lead to over estimation or under estimation of the impact of irrigation.

Thirdly, majority of the studies have estimated the impact of irrigation for only one season.

Fourthly, most of the studies have not made any attempt to understand how far the canal irrigation induced the farmers to adopt modern technology in the command areas.

Fifthly, majority of the studies have not made any attempt to estimate the real impact on production and employment and cropping pattern by various crops during different seasons and over a period of time. This is highly essential to formulate an appropriate and suitable labour intensive cropping pattern on irrigated farms.

Finally, majority of these studies have not made any attempt to find out the cost and yield structure of cultivation among different crops individually, between command area and non-command area.

CHAPTER III

DEVELOPMENT OF IRRIGATION AND PROFILE OF THE STUDY AREA

Importance of Irrigation

Irrigation in an agrarian economy assumes the same importance as blood in human body. Agriculture by irrigation antedates recorded history and is probably one of the oldest occupations of civilized man (Shahane, 1981). Irrigation is the obvious means of making the country's agriculture relatively independent of the vagaries of the monsoon and thereby putting the agricultural economy of the nation on a sound and secure footing. It is an established fact that the welfare and happiness of the largest section of the people in a predominantly agricultural country hinger on the strength of agriculture. The transition from primitive hunting and food collecting way of life to one based on agricultural production has far-reaching implications. It led to a cultural revolution, by which mankind was able to progress beyond the cruel ecological limitations set by nature to the foraging primitive man, establishing the foundations for the eventual development of civilisation, (Gulhati, 1967). No less significant than this was the early revolution in food production that followed an evolution in agriculture on account of the development of new technology. Irrigation has played a vital role in this continuous process of progress. In most of the early civilisations of both hemispheres, as in many nations today, irrigated agriculture provided, and continue to provide, the agrarian basis of society.

Economic and social development to a great extent depends upon the creation of surplus agricultural produce. This often requires extension of agriculture through new irrigation projects or the improvement of existing irrigation systems and practices to ensure optimum land utilization through efficient water use. Improved water management (including irrigation and drainage) can probably do more towards increasing agricultural production both of food and other crops in the irrigated areas of the world than any other agricultural practice (Rober M. Hayam: 1979). Application of Science and Technology in soils, utilisation of water, protection of plants, use of tools and implements are now sufficiently advanced, if applied properly, may transform agriculture from an age-old art into a modern science.

Water is essential for life on earth. The importance of water has been recognised from the primitive days. The largest use of water in the world is for irrigating cards, as an agricultural input, specially for the production of foodgrains. For the growth of plants water must be available in appropriate quantities and at the right time, depend on the species of plant, the soil and other climatic conditions (Rao, 1967). Crops like sugarcane and rice need larger quantities of water than wheat, maize, jawar and other cereals. Even dry farming technology depends upon the moisture retained in the soil by conserving the scantly rainfall through the construction of small funds. Efficient utilisation of water resources is essential for agricultural production for meeting the challenge of feeding the ever-increasing human population. Land and water being limited, their efficient use is the basis for the survival of an ever-increasing population with world (Dakshinamurti, 1973). The success of agriculture depends on conservation of moisture in soil needed for optimum crop production.

Water is an important prerequisite for agricultural development. An assured water supply spells prosperity, creates employment potential, increases income and increased capital formation (Kulkarni, 1973). Water is the primary requirement for the healthy growth of crop. The need for regulated supplies of water and manure at regular intervals and in requisite doses was long realised for the increase in the productivity of land. In fact, the production of a crop requires soil, water, seeds, labour implements, proper planning and management (Kulkarni,1976).

The Famine Enquiry Commission of 1946 has rightly emphasized that among all the measures that may be adopted to increase the area under cultivation and the yield per acre. The first place must be given to the works for the supply and conservation of water (Finance Enquiry Commission,1945).

Irrigation has proved beneficial to the agricultural development of a country. It alleviates suffering, preserves life, averts famines and advances the material prosperity of the country. In a country like India, its importance is all the more great. In fact, as pointed out by Sir Charles Trevelyan, "Irrigation is everything in India; water is more valuable than land, because when water is applied to the land atleast six fold and render great extent of land productive, which otherwise would produce nothing of next to nothing" (Mukherjee R.K, 1939). Knowles writes, "The Irrigation works have made security of life, they have increased the yields and the value of the land and the revenue derived from it. They have lessened the cost of famine relief and have helped to civilize the whole region. In addition, they yield grandsome profits in governments" (Knowles,1982).

Irrigation development in the past had mostly taken place as a measure of famine relief. In India, in fact, famine gave birth to the idea of artificial irrigation. Now, with the population multiplying rapidly, irrigation has assumed greater importance for augmenting agricultural production (Nath, 1965).

The importance of irrigation may be viewed from two aspects, viz., "Protective aspect' to make up the moisture deficiency in soils during the cropping season so as to ensure proper and sustained growth of crop grown. 'Additional land use aspect' to enable a second or third crop being raised on the lands provided with irrigation which could otherwise not be cultivated efficiently more particularly during the past or pre-monsoon period. While the protective aspect helps in stabilising agriculture against droughts, the second facility cannot be neglected by an alert agriculturist. Irrigation has also a third aspect. It helps in augmenting and preserving the properties of soil by application of adequate supply of water.

Irrigation is essential for the maximisation of production of most farm crops. According to the Indian Council for Agricultural Research (ICAR), the production of irrigated crops is on an average 50 to 100 per cent higher than that of the unirrigated crops in the same locality. According to a 'Note on the Rate of Growth' during the Fourth Plan, the average yields of irrigated fields, such as in case of rice, it has been of the order of 52.5 per cent, wheat 53.1 per cent, maize 53 per cent and total production 92.6 per cent during 1964-65. It has been estimated that if proper irrigation facilities are provided to rice and wheat producing areas, the additional production of the two crops may be increased by 10 and 6 million tonnes respectively.

Further, different crops require water in different quantities throughout their growing period. For example, grain crops require maximum supply only during the time of car heads are formed, while sugarcane, cotton and chillies require sufficient water for the entire duration. Most of the annual crops do not require water when they are maturing. The total water requirement of crops varies from 10.6 acre-inches for mustard, to 95.0 acre-inches for sugarcane. The water needs of other crops are linseed 12.7, barley 14.1, oats 14.4, wheat 14.8, maize 17.8, potato 26.7, chillies 38.8, tobacco 39.2, rice 41.7 and cotton 42.2 acre-inches (Arkari, 1962).

In addition to the above crops, the water requirements of deciduous fruit trees is about 30 inches, and of citrus and ever-green trees about 40 inches a year. Tough crops such as beans, lettuce and water melons require about 16 inches of water, common feeder grasses about 24 inches and perennial legumes such as lucerne and beseem clover about 36 inches of water per year (Arkari,1962).

The water requirements for given area vary greatly according to the nature of the soil and crop. Of all crops, rice is the most dependent upon irrigation, because the biology of the rice plant requires that whole field should be actually under water during the planting season. Only under very rare circumstances can this result be brought about by natural rainfall, and in almost every case irrigation from streams or wells is necessary (Clark, Colin, 1970).

Average water requirements for rice in tropical climate have been estimated by the international rice commission at Bangkok at 1.5mm in all. These are the combined requirements for flooding the field at planting for growing season, a small amount receivable from water previously stored in the soil, with the balance having to be met by irrigation (News Letter No.8:1953).

Water is a basic input influencing crop production. It is an important constituent of protoplasm and is present to an extent of 85 to 90 per cent in the flesh weight of actively growing plant parts. Generally, the physiological activity increases as the water extent decreases. Water is an essential reagent in the photosynthesis and in hydrolytic processes, such as indigestion of starch to sugar. All plants nutrients enter into the plants through water. Solutes move from cell to cell and tissue to tissue. In spite of its essentiality, it is interesting to note that the total quantity of water required for all these processes is less than 5 per cent of the water absorbed. Most of the water entering into plant is lost by evapo-transpiration, directly contributing little or nothing to the growth of the plants. It is, however, required to be supplied to maintain the turgidity for growth of cells, new shoots etc. (Kaskhina murti, 1973). Such water requirements of various crops cannot be met by rainfall which is scanty and erratic in India. Therefore, efforts should be made to supplement rainfall by supplying water artificially to parched lands.

In an agrarian economy irrigation may be a good source of employment as well. Irrigation raises both the employment and income content of land and adds to capital formation. The construction and maintenance of an irrigation project has far-reaching effects on the economic life of the community living within a region and also to some extent of the community living without it. Investment in an irrigation project leads to the creation of new or additional production activity and new or additional production. The utilisation of the opportunities created by such capital work needs further investment in order to launch new productive activities or for expanding old activities in the area affected by the project (Gadgil, 1948). This additional investment involves the employment of additional capital and labour resources which, in turn, will lead to an increase in production.

The continued maintenance of the new investment would depend upon supplies of a set of commodities and services and would result in creating a demand for them. The demand for these commodities and services may lead to the expansion of opportunities of employment for the diversion from old employment of certain resource of capital and labour (Gadgil, 1948). As a result of this expansion new production comes into being. A number of consequences may follow from the emergence of this new production. Firstly, increased production means additional produce which has to be processed, traded, transported, etc., and increased production also means increased incomes in the hands of producers which may be spent in various ways. If the new product is directly consumed, there will be no further impact on economic activities. If, on the other hand, it is kept as surplus, it would form a basis of a series of economic activities necessitating the employment of further capital and labour resources. Secondly, the additional incomes to various categories of persons. These persons may utilize this income in a number of ways. The outlays by income recipients would lead to the creation of a new demand for goods and services which would, in its turn, lead to the employment of other capital and labour resource (Gadgil,1948).

Irrigation generates employment and capital formation. It may supplement the slender income of poor farmers by providing side jobs. It encourages farmers to adopt more scientific techniques. It enables them to sow the right grains at the right time and realise higher profits. It also permits them to go in for more intensive cropping which creates new opportunities for gainful employment (Khusro, 1980).

A comprehensive idea of this importance of irrigation water and the linkages it has in the development of many other sectors of the economy have emerged from the vast literature on water resource development and management.

The important points that have emerged are:

i. Water is a basic input for agricultural production and is also an essential prerequisite for multiple cropping and intensive use of land (Khusro, 1980, Rao, 1966).

ii) Water, unlike many other natural resources, is a self-renewing resource. It needs to be collected and stored for use. It cannot be preserved and saved for future.

iii) Availability of irrigation water induces the cultivators to make an intensive application of other inputs contributing to further increase in productivity by eliminating the risk due to weather uncertainties (William, 1969).

iv) Productivity gains of irrigated crops are higher than those of unirrigated crops (Dasune, 1969, Raj, 1961)

v) Irrigation is the main stay of green revolution in the country. The use of high-yielding seeds and chemical fertilizers require assumed and timely water supply, which is not possible without the development of irrigation systems.

vi) Effective use of improved cultivation methods and other inputs depends on irrigation as it is a prerequisite infrastructure (Dantwala, 1971 and William, 1969).

vii) Full productivity potentialities of "technical changes" in agriculture could be realised only under irrigation (William, 1969, Dantwala, 1971).

viii) Irrigation brings about an increase in yield per hectare crop productivity not only per se as a plant nutrient, but also by increasing plant response to other inputs (Khusro, 1968 and William, 1969).

ix) At the present level and quality, irrigation encourages the growth of the most lucrative crops (Khusro, 1980).

x) Irrigation has high potential for the use of human and animal labour and for education of poverty of rural masses (Krishna Bharadwaj, 1974 and Rao, 1976).

xi) Irrigation, by reducing the adverse affects of weather failure and improving productivity of crops, has induced the growth of agro-industrial complexes for cotton and jute, sugar, rice, milking flour milling, oils and vanaspati and fruit industries. These have brought in much-needed employment and increased trade and commerce of the produce of these industries, and

xii) Irrigation has also induced the growth of industrial complexes for fertilizer, agricultural machinery, pesticides, etc.

Irrigation Development

Soon after Independence the concern of the Government of India was mainly to initiate rapid growth. Prior to Independence the rate of growth of the economy was so dismal that the government in democratic India was faced with the problem of initiating economic growth in a largely stagnant economy. It was felt that the struggle for long term economic development should start with attempts at revitalising the background agricultural sector which was the mainstay of a majority of the nation's population. Accordingly 42.20 per cent of the First Plan's outlay was spent on agriculture including irrigation and power (Gupta,1989). There was also the question of how to allocate the investments within the agricultural sector. During the first five year plan the options left to the planners in this regard were fairly obvious. The importance of irrigation as a means of stimulating economic growth was emphasised with the first five year plan and about 60 per cent of the expenditure for agricultural development was devoted to irrigation schemes.

In absolute terms an amount of Rs.446 crores was spent on major, medium and minor Irrigation works.(seventh five year plan 85-90) Great hopes were placed by planners on expanding farm production through irrigation. Of course, the second Famine commission set up after the drought of 1896-97 itself felt the need for assigning top priority to the works of irrigation for protecting the country from drought (Report of Irrigation Commission,Vol 1 (1972)). However it is the First Irrigation Commission whose report was submitted in 1903 that was responsible for initiating irrigation development in the country (Agricultural situation of India, April 1969). Yet by 1950-51 the irrigation potential in the country was no more than 22.6 million hectares (B.D.Dhawan, 1988) and it constituted only about 20 per cent of the ultimate potential. The matter becomes even less comforting when the water resources are viewed in relation to the resources of cultivable land (180 million hectares) when the huge steadily growing population is brought into the picture (population growth at a rate of 13.31 per cent between 1941-51). The low level of irrigation as was prevelent in 1950-51 made the planners think that a significant increase in agricultural productivity could be achieved through irrigation development, simply because a constant water supply not only reduces the frightening dependence on monsoon, but it could also permit the growing of more than one crop a year.

But irrigation development has different connotations in different regional contexts. If irrigation development merely implies newly irrigating the land which is hitherto unirrigated in one region, it may mean improving the qualities of irrigation in another region which already enjoys irrigation facilities. There may also be other dimensions to this quality aspect such as optimal use of the irrigation potential created. Heterogeneity among regions calls for different policy options. However, planners' concern to start with was mainly to bring in additional land under irrigation, and the option was only obvious, given the then existing scope for expanding area under irrigation. In the subsequent plans the emphasis has changed with the quality aspect of irrigation assuming increasing importance. This is an aspect which we will highlight below. We are concerned in this context with the development of irrigation in the country during the plan area, significance and quality of alternative source of irrigation, and the impact of irrigation on agricultural productivity and stability. Our primary aim is to emphasise the quality aspect of irrigation development and the advantages that are associated with quality irrigation. Further we will touch upon how a quantitative development of, for instance, surface irrigation system by the public authorities can lead to the development of quality irrigation with private enterprise, how an initial impetus to change can lead to further self perpetuating development.

Development of Irrigation Potential in India

With this investment tremendous improvements in irrigation facilities have taken place during the plans. Before 1951, the total irrigated area in India was only 22.6 million hectares, of which 9.7 million hectares was irrigated through major and medium irrigation projects and 12.9 million hectares was irrigated through minor irrigation schemes. By the end of the year 1984-85, area under irrigation increased to 67.53 million hectares, of which 30.01 million hectares were under minor schemes.

Table 3.1

Development of Irrigation Potential

(in million hecatres)

Year	Major and Medium Projects	Minor Schemes	Total Potential
Upto 1951	9.70	12.90	22.60
1960-61	14.30	14.79	29.09
1979-80	26.60	30.00	56.60
1980-81	27.30	31.40	58.70
1984-85	30.01	37.52	67.53
1989-90	32.91	46.83	79.74
1990-91	33.60	49.16	82.76
1992-93	--	--	85.00

Source : Bhargava, V.K. (1993). Indian Economics, Sudha Publication Pvt. Ltd.,New Delhi, P.76.

Eventhough the total irrigation potential created in the country has increased from 22.60 million hectares in 1951 to 85 million hectares till the end of 1992-93, this potential has not been fully utilised . The gap between the potential and its utilisation, which was less than two million hectares in 1960-61, had widened to over 4 million hectares by 1980-81.

In 1989-90, this gap was further heightened at over 8 million hectares. Medium and major projects account for a major part of the gap between irrigation potential and its utilisation, though the minor schemes too have substantial unutilised potential.

Table 3.2

Irrigation - cumulative Potential and Utilisation

(million hectares)

Years	Major and medium projects		Minor Schemes		Total	
	potential	utilisation	potential	utilisation	potential	utilisation
Upto 1950-51	9.70	9.70	12.90	12.90	22.60	22.60
1960-61	14.30	12.91	14.79	14.79	29.09	27.70
1980-81	27.30	22.70	31.40	31.40	58.70	54.10
1985-86	30.53	25.78	39.09	36.35	69.62	62.13
1989-90	32.91	27.89	46.83	43.53	79.74	71.42
1990-91	33.60	28.60	49.16	45.56	82.76	74.16
1992-93	--	--	--	--	--	85.00

Source : Bhargava, B.K. (1993), Indian Economics, Sudha Publication Pvt. Ltd.,New Delhi, p.78.

It is regrettable to note that in spite of the huge irrigational requirements of the country and its vast usefulness and indispensability, irrigation facilities have been allowed to go waste. Table 3.2 shows the extent of underutilisation of irrigation facilities. It is seen that though the percentage utilisation has been increasing, the gap between potential created and its utilisation has been widening. The main category of causes for this state of affairs appears to be the lack of co-ordination between general administrative and developmental activities and inefficiency resulting in unimaginative rules, procedures and delays. The distribution of water is not regulated in reverse proportion to rainfall in an area so that when it rains, and when water supply is not in demand, water is supplied; and when it does not rain, there is water scarcity. Further, it is to be noted that the farmer needs water not for its own sake, he needs it for irrigating fields and crops. So, he needs water at appropriate timings of sowing, and during crop growth. And he would be able to use water only if he is able to get seeds, manures and other necessary inputs in time and at reasonable rates. Administrative procedures are such that the former normally finds availability of loan etc. behind schedule. Again, the farmers are seldom told in advance about the coming facility and advised to dig the necessary field channels facility which are often long and cumbersome to dig. Quite often water reaches the small distributaries before this preparatory work of receiving water is completed. In still other cases the farmers have rightly or wrongly many misgivings about the water rates, which they resent.

Another aspect of underutilisation of irrigation facilities is the loss of water in conveyance and this loss may be due to 50 per cent of the total supply. This is injurious to the area through which canal passes, as the problems of water logging, salinity etc. cause damage to the crops. It is as important to save this wastage as it is to provide more water.

Investment in Irrigation

After partition in 1947 India had to live with the 83 per cent of the population of undivided India and 84 per cent of net land area, but only 69 per cent of irrigated area amounting to 19.4 million hectares. Over one-half of the irrigated area under government canals in undivided India was lost in partition along with many agriculturally surplus areas. Thus, the need to accelerate the rate of irrigation development was actually felt after independence (Leslie Abbie, Paper No.536). With the beginning of planning in 1950-51 the Central and State Governments have been devoting huge investments for irrigation development. The country has invested about Rs.45,000 crores on major, medium and minor irrigation projects during the past 40 years. Table 3.3 gives the plan-wise expenditure on alternative irrigation schemes.

From table 3.3 it may be seen that in normal terms the expenditure on irrigation works increased from Rs.446 crores during the first Plan to an estimated amount of Rs.14,360 crores during the Seventh plan. The Eighth plan outlay for irrigation and flood control is Rs.33,055.57 crores. For major and medium irrigation project the allocation is Rs.22836.64 crores. One may also have an idea bout the investment in irrigation development by considering the proportion of the total outlay devoted to irrigation in different plans.

Table 3.3

Plan-wise Outlay on Irrigation

(Value in Rs Crores)

Plans	Plan outlay/expenditure: Major and Medium Irrigation	Minor Irri-gation	Total	Percentage to the outlay
First Plan	380*	66	446	(22.8)
Second Plan	380	142	522	(11.9)
Third Plan	581	328	909	(10.9)
Annual Plan (1966-69)	434	326	760	(11.4)
Fourth Plan (1969-74)	1237(b)	513	1750	(13.0)
Fifth Plan (1974-78)	2442(a)	631	3073	(10.7)
Sixth Plan (1980-85)	7516	1802	9318	(8.5)
Seventh Plan (1985-90)	11556	2804	14360	(8.0)
Eighth Plan (1992-97)	22837	6084	28921	--

* Include Rs.80 crores incurred during the Pre-plan

(a) Excludes plan outlay of Rs.50.54 crores on unapproved Cauvery basis projects

(b) Excludes non plan outlay Rs.52.54 crores on unapproved Cauvery basis project

Source :(1) Seventh Five Year Plan 1985-90, Vol.II, p.73.

(2) J.C. Aggarwal, (1993), Eighth Five Year Plan-Planning and Development in India.

From table 3.3 it may be noted that only in the First Plan, this proportion was over 20 per cent and in the rest of the plans the proportion varied around 10 per cent. Additionally we have the study of N. Rath which closely analyses the real investment going to the agricultural sector in general and to irrigation sector during the 4th, 5th and 6th plan periods. He shows that during the last 15 years there has been no significant increase in the rate of fixed capital formation in agriculture, with the Sixth plan in fact recording an effective decline. The steady decline in public investment in agriculture has been noted in hard investments like irrigation (Rath,1987). It is no doubt true that there has been some compensatory increase in private investment in irrigation, but they do not obviate the need for a greater public sector investment in irrigation, especially in flow irrigation schemes.

The need for greater public investment in irrigation is also reflected by the data on investment per hectare of additional potential created in major and medium irrigation projects. The rise in real investment expenditure per hectare of irrigation potential created is the result of three forces:

a progressive increase in the number of projects under construction, meaning on increasing proportion of funds are spent in the early stages of projects, before they begin yielding benefits; a proportional shift to more difficult and higher cost projects as the easier and cheaper opportunities for irrigation development were used up; and improved standards of design and construction in order to capture greater agricultural benefits.

Development of Irrigation in Kerala

In Kerala, due to specific climatic conditions of the state, development of irrigation facilities is a necessity for increasing agricultural production and productivity. Hence a larger chunk of resources of the state has been earmarked for the development of irrigation facilities.

Rainfall

In the isohyetal map of India, Kerala can be seen as a place receiving fairly good annual rainfall. The South-West monsoon locally known as "Edavapathy" is the main rainy season in Kerala. This monsoon lasts from late June to end of August or sometimes upto early September. July and August are real rainy months. About 60 per cent of the annual rainfall is received during the South-West monsoon period. This monsoon is reliable also. In September, the North-East monsoon starts which last upto November. About 30 per cent of the annual rainfall is received during this monsoon. This is not much reliable as the fluctuation in the intensity, duration and timing of rainfall is too much. The North-East monsoon is more active in the southern part of Kerala and also in Palghat area, which may probably be due to the fact that the ghats lose their heights in the Southern regions and leave a wide gap known as gap in the Palghat area. From December to May there is very little rainfall, but the occasional rainfall during this period is a very critical requirement for the poor cultivator as he still depends on rainfall for raising his crops.

The annual intensity of rainfall varies from place to place. In Kozhikode and Idukki districts there are places where annual rainfall exceeds even 5,000 m.m. In Palghat and Trivandrum districts there are places where the annual rainfall is even lower than 1250 mm. Generally less rainfall is received in the coastal region and its intensity and frequency increase towards the east, i.e. towards the western ghats. The average annual rainfall in the state is roughly assessed as 3,085 mm.

The Rivers

There are 42 west flowing rivers and 3 east flowing rivers in the State. All the rivers are very small, their length and size being controlled by the peculiar topography of the state. There are four relatively major rivers in the state, viz., the Chaliyar, the Bharathapuzha, the Periyar and the Pumba. These are more than 160 km. long each. These four rivers together, drain about 35 per cent of the state's total area and carry about 45 per cent of the total surface water. There are 20 rivers which are more than 50 km. long and hence can be considered as medium rivers. There are several other small streams varying in length from 50 to 10 km.

Most of the rivers are perennial but after the monsoon months, the discharge decreases considerably. During monsoon months flashy flows are common. As the intensity of rainfall during July and August is very high, floods are common in most of the rivers in these months even though the duration may not be very much. More than 300mm. of rainfall have been recorded in a day in several stations.

The rivers are navigable in the coastal belt and in the mid-land region, during rainy months. Near the coast there are a number of back waters, to which most of the rivers drain. These lakes and the rivers are inter-connected by artificial canals for navigation. Thus there is a network of navigation routes, but during summer months with less depths of flow in the rivers, navigation becomes impossible in most of the rivers for considerable lengths. This state of affairs can be improved only by storing water in the upstream reaches of the rivers and then letting down regulated flows, so as to have a minimum draft of 1.5 to 2m.

Another effect of reduced discharge during the summer months is the incoming of salt water from the sea into the rivers and then to the neighbouring low areas. Salt water travels up the rivers for several kilometers, ranging from 5 to 30 km. To prevent this menace also, letting down fresh water in a controlled manner is essential.

The rivers and the topography of the land offer no scope for locating any storage reservoir in the coastal and midland regions. Hence storages are possible only in the hilly tract. In this reach, the river flows through rocky beds with high hills on the sides, thus offering good sites for storage reservoirs.

Development of Irrigation Potential

The irrigation potential of the state is estimated to be 16 lakh hectares (net) or 25 lakhs hectares (gross), of which the potential of major and medium irrigation schemes has been estimated to be six lakh hectares (net) - i.e. 37.5 per cent or 14 lakhs hectares (gross) is estimated to be brought under irrigation through minor irrigation schemes.

In 1952-53 there was an area of 418 thousand hectares under irrigation. This formed about 20 per cent of the gross cropped area. The gross irrigated area increased to

652 thousand hectares by 1974-75, forming only 21.52 per cent of gross cropped area. However, the reported gross area under irrigation in 1975-76 was only 327 thousand hectares. This decline in the reported is mostly due to the change in the reporting method of irrigated area. Thus, during the period from 1962-53 to 1974-75, the gross irrigated area is believed to have increased from 418 thousand hectares to 652 thousand hectares, an increase of 56 per cent. As per the new series of data on irrigation area, given in table 3.4 the gross irrigated area is reported to have increased from 326.85 thousand hectares in 1975-76 to 536 thousand hectares in 1989-90. In other wards, the gross irrigated area formed only 18.09 per cent of the total cropped area in 1989-90, which is less than the percentage of gross irrigated area in Kerala in 1952-53 as per the old series of irrigated area. It is extremely unfortunate that this data on irrigated area are most unreliable, particularly so, when we take into account the fact that irrigation has been attracting a considerable proportion of public investment in agriculture in Kerala during the plan periods. Any attempt, therefore, to discern the contribution of irrigation to productivity increase or growth of agriculture in Kerala from this data will remain open to criticism.

Table 3.4

Area Under Irrigation in Kerala
(1955-56 to 1992-93)

(Area in '000 hectares)

Year	Net area	Gross area	% of gross irrigated to crop area
1955-56	247.68	349.44	16.04
1965-66	361.83	508.96	19.95
1970-71	431.25	601.39	30.50
1974-75	N.A.	651.75	21.52
1975-76	228.22	326.85	10.96
1980-81	237.97	380.93	13.20
1985-86	296.34	399.45	13.92
1989-90	310.00	536.00	18.09
1992-93	121.38	181.73	-

Source : 1. Directorate of Economics & Statistics, Statistics for planning, 1977-86, p.8.

2. State Planning Board, Economic Review, 1990.

Note :For 1975-76 onwards, revised estimates of Irrigation Department.

Though there is a great deal of suspicion with regard to the correctness of the extent of area under irrigation, there is no difference of opinion or doubt about the fact that, irrigation in Kerala is mainly confined to rice, the most important and common food crop. More than 80 per cent of the irrigated area is under paddy and most of the irrigation projects are concentrated in the main paddy-growing districts, viz., Palghat, Trichur and Ernakulam. It was only logical and natural that paddy received the topmost priority not only in irrigation, but also in all other promotional activities in the programme of agricultural development in the state, use of fertilizers and pesticides, high-yielding varieties, and mechanisation, because this was the policy at the national level too.

From the beginning of plan period the state government of Kerala have been diverting huge investment for irrigation development. Table 3.5 gives the plan-wise expenditure on major, medium and minor irrigation schemes.

Since 1951 the total public sector investment on major, medium and minor irrigation schemes has increased enormously. The largest share of investment i.e. 729.1 crores out of Rs.889.35 crores or 81.99 per cent of the total capital investment in the irrigation sector at the end of March 1990 was concentrated in major and medium scale irrigation schemes, the share of minor irrigation schemes being only 18.01 per cent.

Table 3.5

Financial Achievement Under Major and Medium and Minor Irrigation Schemes

(Rs in Lakhs)

Plan Period	Expenditure on major and medium Irrigation schemes	Expenditure on minor Irrigation schemes
I Plan		
1951-56	511.00	104.47
II Plan		
1956-61	893.00	259.81
III Plan		
1961-66	1032.00	459.64
Annual Plan		
1966-69	1073.00	389.72
Fourth Plan		
1969-74	2891.00	880.97
Fifth Plan		
1974-78	7683.00	951.00
Annual Plan		
1978-80	7235.00	912.00
Sixth Plan		
1980-85	25952.00	2670.00
Seventh Plan		
1985-86	6724.00	458.89
1986.87	5275.00	917.16
1987-88	5300.00	750.00
1988-90	8331.00	
Eighth Plan (outlay)	37500.00	13000.00
1992-93	7355.00	1191.37

Source : State Planning Board, Kerala, Trivandrum.

The objective of the Eighth Plan is to bring an additional area of 89,500 ha. (net) or 1,14,500 ha (gross) under irrigation for food and cash crops. This involves a huge investment for the Eighth Plan. This full amount cannot be funded by the government. So part of the fund may be revised from the beneficiaries and part from financial institutions. Location wise economically viable schemes may be prepared and posed for financial assistance from financial institutions like NABARD and other agencies. These funds may be made available to the individual farmer or registered societies formed by the beneficiary farmers to take this schemes. The utilisation of water from these schemes and its maintenance may be vested with farmers/beneficiary societies. Such a system will reduce the cost of irrigation as it does not contain the overhead charge of the irrigation department. Strict monitoring and supervision may be done by the financing institutions for the proper implementation and working of the scheme. Panchayat level viable schemes may be prepared on the basis of demand and implemented availing of the maximum institutional financial assistance and with full co-operation and participation of the beneficiary farmers.

Strategy for Development of Irrigation

The recent change in land use pattern, cropping pattern and failure of monsoon raise certain problems and issues to be considered as regards the strategy for the development of irrigation in the state.

1) The feasibility of large surface - reservoir oriented irrigation systems from the point of view of land required for submergence and canal system.

2) The escalation in the capital cost of large irrigation systems has risen already to as high as Rs.60,000 to 2,25,000 per hectares of land irrigated.

3) The necessity for storage of water through systems other than large reservoirs.

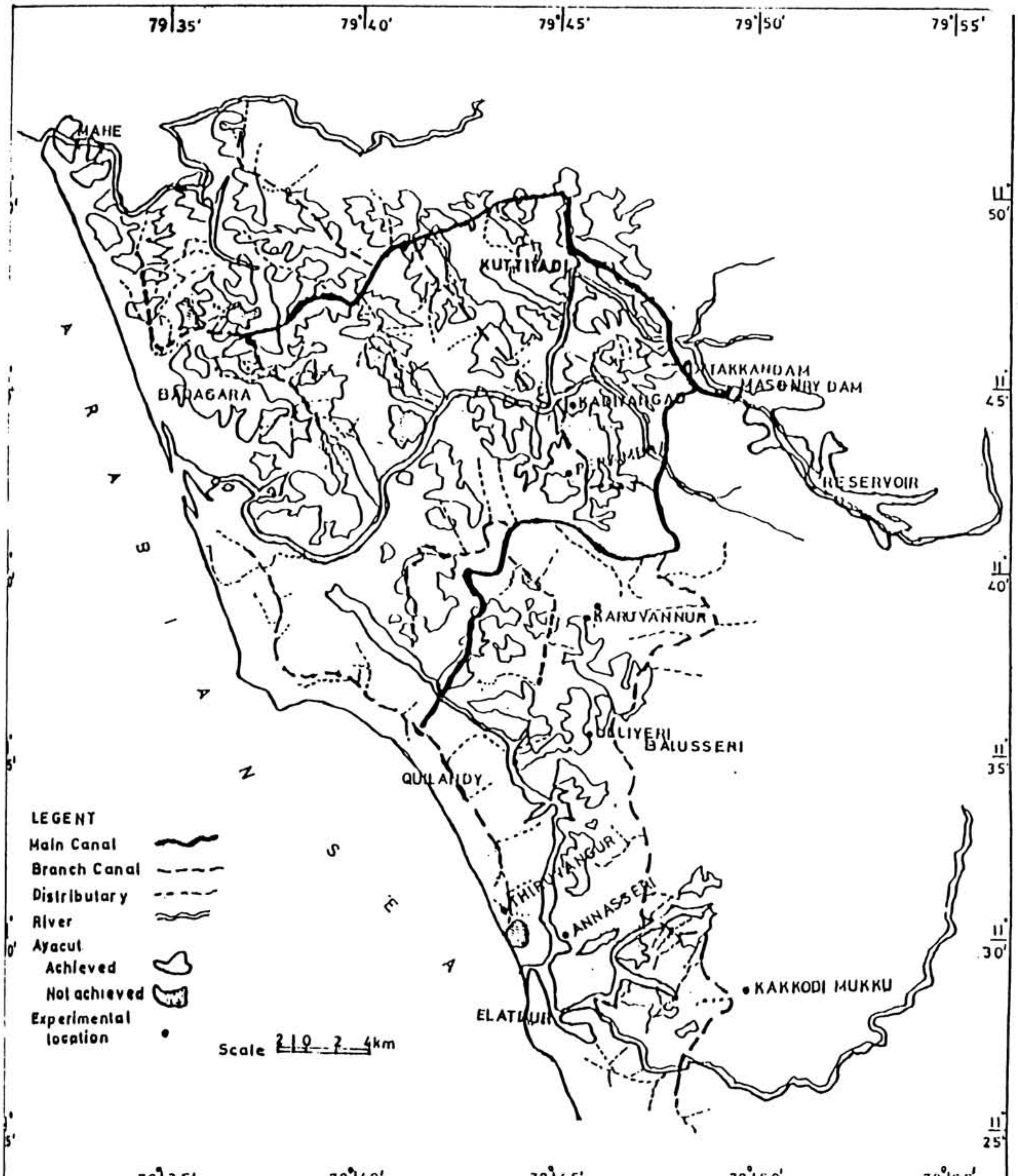
4) The emphasis ~~to be~~ given to localised irrigation system which can reduce the requirement of land for conveyance of water.

5) The necessity for linking the irrigation system to the cropping patterns in the up-coming plan periods.

PROFILE OF THE STUDY AREA

The Kuttiadi Irrigation Project, as its name implies, aims at the harnessing of the water of Kuttiadi river for irrigation purposes only. This project is the third major irrigation project in the Kerala State. It was taken up for execution in the year 1962. This project affords irrigation facilities for rice cultivation in 14,600 hectares of land in Kozhikode, Badagara and Quilandy taluks in Kozhikode district. The project envisaged the construction of a Masonry dam across the Kuttiadi river, 13 earth Saddle dams for the total length of 1844m and a canal system. The Ayacut and canal systems of Kuttiadi Irrigation project is given in Fig.1.

FIGURE 1



AYACUT AND CANAL SYSTEM OF KUTTIYADI IRRIGATION PROJECT.

History of the Project

The Malabar area of Kerala State comprising of the six districts of Palghat,Kozhikode, Kasargode, Wyanad, Malappuram and Cannanore is economically a very backward area. Till the reorganisation of states on 1-11-1956, this area was in Madras state. Except for a few irrigation schemes in Palghat district no development works of any magnitude were undertaken either in the I or II plan in the Kozhikode and Cannanore Districts. This area has abundant untapped water resources in numerous rivers originally from the Western Ghats.

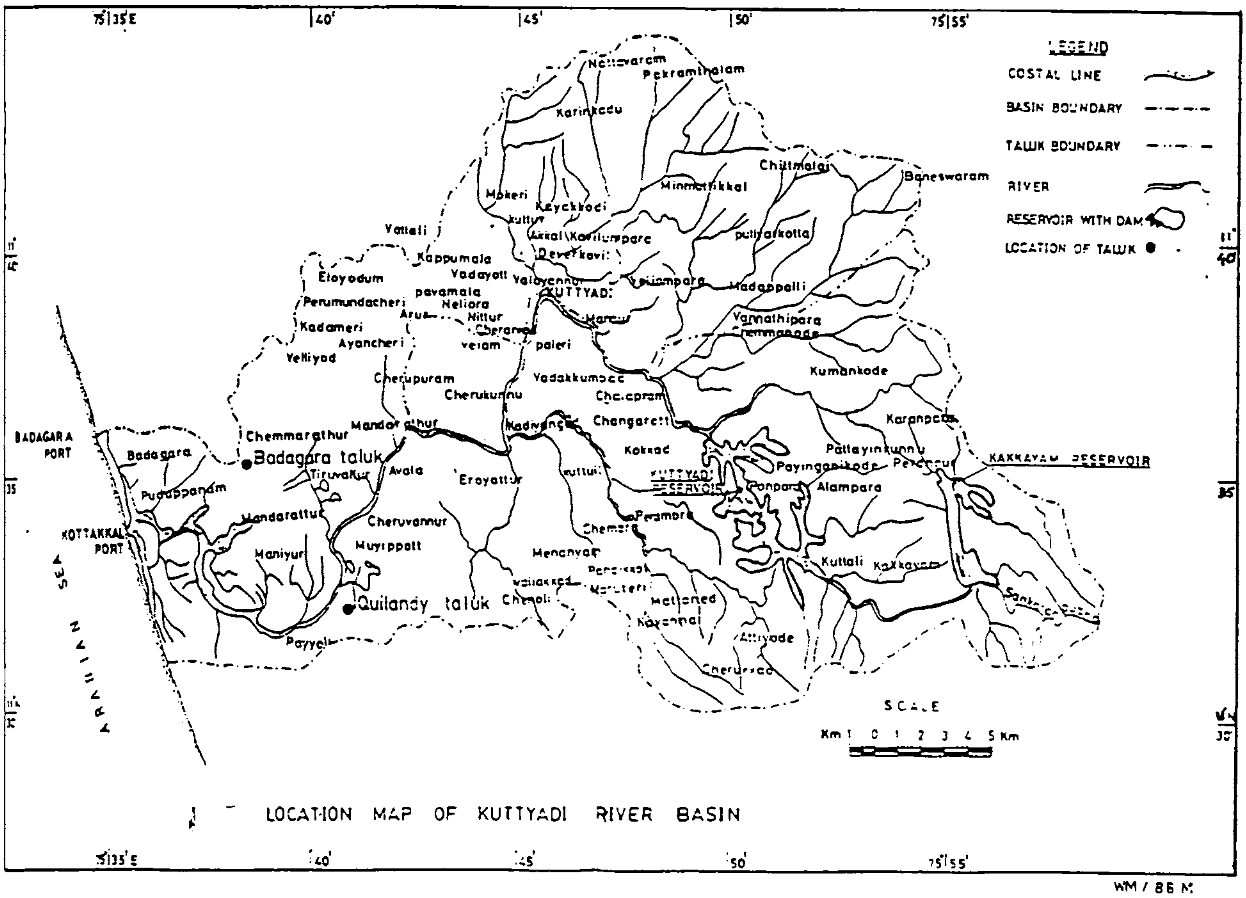
Preliminary appraisal of the water resources of all rivers in the state were carried out and the development possibilities of the various river basins are discussed in the publication, Advance Report on 'the water resources of Kerala'. It was found that due to the rapid slope in the upper reaches of the Kuttiyadi river and the large area of rice fields available in the lower reaches, a multipurpose project on this river is possible for generation of Hydro-Electricity power and Irrigation. From consideration of head available the power dam after detailed investigation was fixed at Oorakuzhi latitude 11° - 33' North Longitude 75° -

56' East. The storage capacity of this proposed dam is only 1800 Met. and height of dam is proposed to be 130 ft. The height of the dam was limited by the foundation condition existing and with this limited reservoir capacity in order to obtain the maximum power, it was proposed by the Kerala State Electricity Board to operate it for obtaining seasonal power only. The power draft varied from 300 cusecs in July to September and 40 cusecs in April to June. With this limited tailrace available it was not possible to give irrigation facilities to the 36,000 acres of land lying below. Hence investigations were carried out for a separate reservoir in this river for the purpose of irrigation.

Location and Extent

The location map of the Kuttiyadi river basis is given in figure 2. The command area spreads over 56 villages of Kozhikode, Quilandy and Badagara taluks of Kozhikode district. It is bounded on the north by Maha river, South by Korapuzha river, towards west by the Arabian sea and on the east by the Western ghats, with an ayacut area of 37933 ha. lying between 11° 18' 30 and 11° 43' North latitude, 75° 32' and 75° 49' East longitude (CWRDM. 1988).

FIGURE 2


LEGEND
COSTAL LINE
BASIN BOUNDARY
TALUK BOUNDARY
RIVER
RESERVOIR WITH DAM
LOCATION OF TALUK
BADAGARA PORT
KOTTAKKAL PORT
ARABIAN SEA
Badagara taluk
Quilandy taluk
KUTTYADI
KUTTYADI RESERVOIR
KAKKAYAM RESERVOIR
SCALE
Km 1 0 1 2 3 4 5 Km
LOCATION MAP OF KUTTYADI RIVER BASIN
WM / 86 M

Physiography, Relief and Drainage

The command area can be broadly grouped under two major natural divisions viz. the flat coastal strip which extends as a narrow belt all along the west coast and the gently sloping uplands of the eastern portion. The eastern region is interspersed by low lying paddy land.

The command area is drained by major rivers of Murat, Agalapuzha, Kuttiyadi and Mahe. Kuttiyadi river originates from Alanpara ranges of South Wynad and flows in a North-West direction. It joins Mural river at Kuttiadi. This river is the chief draining agent of the eastern portion, comprising of Perambra, Avalokko, Munnassery and Valayakumom.

Soils

A scientific grouping and classification of the command area soils (by Department of Soil Survey) shows the following: There are 15 recognised soil series as given in table 3.6. More than 50 per cent of the total command area have three soil series viz., Nenmanda, Kunnamangalam and Chalapuram.

Table 3.6

Soil Series Recognised and Mapped in the Command Area and their Extent of Occurrence*

Sl. No.	Name of the soil series	Area, ha.	Percentage of the total (%)
1.	Thikkodi	2547.7	6.7
2.	Elathur	2305.8	6.1
3.	Beypore	865.1	2.0
4.	Chaliyar	1181.7	3.1
5.	Nanmanda	11929.8	31.4
6.	Kunnamangalam	3820.8	10.1
7.	Moorikara	48.8	0.1
8.	Kalarikunnu	97.6	0.3
9.	Kizhakumuri	2240.7	5.9
10.	Kakkodi	1722.9	4.5
11.	Chalapuram	3880.4	10.3
12.	Ulleri	3495.6	9.5
13.	Mudodi	1114.1	2.9
14.	Purameri	1670.6	4.4
15.	Nadapuram	1040.9	2.7

Source: Pre-Irrigation Soil Survey Report (1970) Soil Survey Wing of the Department and Soil Conservation, Government of Kerala.

The soil of the low land representing the alluvial and colluvial deposits along with laterites in mid upland regions constitute nearly 82 per cent of the noted command area. The details are given in table 3.7.

Table 3.7

Summary of Soil Series in Different Regions of the Kuttiadi Command Area

	Command Area details	Soil series represented	Area (ha.)	Per cent total
1.	Soils of the Western portion along the cost	Thikkodi, Elathur Beypore	5718.6	14.8
2.	Soil along the river banks	Chaliyar	1181.7	3.1
3.	Soil of low lands	Chelapuram, Kakkodi, Kizhakkumuri Mudali, Nadapuram, Purameri and Ulleyeri	15165.5	40.2
4.	Soils of the mid upland region	Kalarikunnu, Kunnamangalam Movorikara and Nanmanda.	15893.0	41.9

Climate

The command area enjoys a humid tropical climate. The South-West monsoon begins during a second fortnight of May and lasts upto August. The North-East monsoon sets in September and continues upto the middle of November. Of the mean annual rainfall of 3060 mm. 75.8 per cent is received during June to August, 14.9 per cent during September to November and the remaining 9.3 per cent during dry period viz December to May. The details of the climate parameters are given in table 3.8.

Table 3.8

Climate at the Command Area of Kuttiadi Irrigation Project

Particulars	January	February	March	April	May	June	July	August	September	October	November	December	Total
Rain Fall (mm)	3.3	-	12.6	67.7	168.8	724.9	1026.5	569.6	223.7	145.9	85.5	33.4	3061.9
Air Temperature (0 c)												30.9	
Maximum	30.8	32.2	34.0	33.9	32.8	30.7	29.5	29.5	29.7	30.3	29.5	30.9	
Minimum	23.4	24.6	25.9	26.7	26.9	25.6	24.4	25.1	24.8	25.3	24.7	24.1	
Relative humidity (0 c)													
08.30 h.	74.0	76.0	74.0	75.0	81.0	90.0	92.0	92.0	88.0	85.0	80.0	75.0	
14.30 hrs.	64.0	66.0	69.0	71.0	76.0	85.0	89.0	86.0	82.0	78.0	72.0	64.0	
Mean	69.0	71.0	71.5	73.0	78.5	87.5	90.5	89.5	85.0	81.5	76.0	69.5	
Potential	138.9	141.8	170.2	153.8	139.2	99.2	92.9	102.3	111.2	113.2	115.0	127.5	1505.2

\+ Source: Badagara Taluk Office Mean for 7 years.
++ Source: Calicut IMD Observatory Mean for 30 years.

The irrigability classification of the command area under each class are given in table 3.9. The land under the command area comes under three irrigability classes viz. class 2,3 and 4, the percentage proportion under each class being 17.8, 34.7 and 47.4 respectively. They further subdivided depending on deficiencies with reference to soils, topography and drainage conditions.

Table 3.9

Irrigability Classification of the Command Area

Irrigability Class/subclass	Area (ha.)	Percentage of the total (%)
2 s	2325.9	6.1
2 d	4424.6	11.7
3 s	3991.3	10.5
3 d	2631.3	6.9
3 t	3450.3	9.1
3 st	2040.0	5.5
3 ts	371.8	1.0
3 sd	644.2	1.7
4 s	400.6	1.0
4 d	1114.1	2.9
4 t	12876.5	33.9
4 sd	3661.8	9.6

Source : Pre-irrigation Soil Survey Report of the Soil Survey Wing, Dept. of Soil Conservation, Govternment of Kerala (1970).

s - Soil, t - topography, d - drainage.

Land Use and Cropping Pattern

Before Irrigation

The major crop in the area were paddy and tapioca. Summer crops like balckgram, chumai, peas etc. are grown after the harvest. Coconut, Jack and Mango are the main fruit-bearingtrees grown in the area.

Due to the lake of irrigation facilities only one crop of paddy was cultivated in most of the lands. Second crop was attempted only in very low-lying areas and also in fields by the bank of rivers and streams where facilities exist for irrigation by diversion of water from these sources. No third crop was raised in any of the land.

The first crop of paddy extending from May to August and was attempted in the entire cultivable acreage. The first crop was mostly broadcast though transplanting was also done in some fields. Green manure and small quantities of cowdung were used as manure. No chemical manure was used as they were costly and often when the monsoon was excessive, the fields get flooded and the manure gets washed away. The yield per acre for the first crop was about 1/4 to 1/3 ton. The sowing was done usually in May. As the regular South-East monsoon starts only in June one or two wettings in May would be very essential and about 8" of irrigation would be required for the first crop.

The second crop was attempted in very low-lying lands where no first crop could be grown and also in lands lying along the banks of rivers and streams where facilities for irrigation exist. The second crop extended from September to December and was mostly transplanted. Intensive manuring using green manure, cowdung and chemical manure was practised. The average yield per acre is about 1/4 to 1/3 ton. Often when the monsoon fails the crops near the rivers and streams in tidal reaches were damaged due to saline.

The third crop was hardly over-attempted in this area as this crop has to depend entirely on irrigation and no source of irrigation existed during that period. The rivers and streams get dried up and in tidal reaches the water will be saline.

After Irrigation

After commissioning of the irrigation project in most of the command area there are three crops raised, namely Viruppu, Mundakan and Puncha as there is assured water supply. The present land use and crops grown are given in table 3.9.

Table 3.10

Land Use and Crops Grown

Sl. No.	Particulars	Area (ha.)	Percentage to total
1.	Gross Command Area	37930	--
2.	Roads, buildings and river etc.	10800	28.5
*2.	Wet land	14400	38.0
**4.	Dry land	10800	28.5
5.	Area under paddy	14400	38.0
6.	Area under coconut	8640	22.8
7.	Area under arecanut	1620	4.3
8.	Area under pepper	324	0.8
9.	Area under banana	108	0.3
10.	Area under other crops	108	0.3

* Area under paddy item (5)

** Area under upland crops (Item 6 to 10)

Problem Areas

Nearly 1678.8 ha. in Quilandy taluk and 822.8 ha. in Badagara taluk under the command area have been affected by saline conditions and hence needs reclamation. This area, in which represents nearly 6.6 per cent of the total command area and 9.9 per cent of the cultivated area, is mostly under paddy.

Kuttiyadi Irrigation project

Salient features:

The salient features of the works proposed are given below. The level noted are with reference to MSL taken as 0.00.

1. HYDROLOGY

a) Drainage area of the river above the dam site
671.95 sq.km. 42 sq.miles

b) Mean annual rainfall in the water shed
5173 mm 20366 sq.miles

c) Max. annual rainfall in the water shed

	7760 mm	305.5 sq.miles

d) Min. annual rainfall in the water shed

	3445mm	136.63 sq.miles

e) Estimated mean annual run off

	367.9 M. cum	13,000 Mc ft

f) Observed min: dry weather flow

	0.37 cumec	13 cusces

g) Observed max. flow at dam site

	881.5 cumec	31,150 cusces(1959)

h) Expected maximum flow	1434.8 cumec	50,700 cusces

2. RESERVOIR

a) Full reservoir level	+44.410 m	+145.71 'MSL
b) Top level of road way over dam	+46.240 m	+141.71 'MSL
c) Water Spread area	1052 ha.	2,600 acres
d) Storage capacity, total at FRL 145.71	120.4 M cum	4,256 Mc ft
e) Dead storage below RL	85.71 7.1 M cum	250 Mc ft
f) Live storage	113.3 M cum	4006 c ft

3. SPILL WAY DAM

a) Crest Level	+38.680 M	+126.91 'MSL
b) Width of still basin	56.08 m	184'

c) Average bed level of river at site
+41.540 m +47.71

d) Deepest bed level at site +13.930 m +45.71 MSL

e) Width of road way 6.71 m 22'

f) Top width of dam including operation platform
11.13 m 36' 6'

g) Size of vent way and No.4 nos
12.1 a x 40' x 18.'8
5.73 m from crest

h) Type of gates for crest opening
--- Radial shutter

i) Size of shutters 12.19 x 7.62 m 40' x 25'

j) Scour sluice shutter 1 no No. and size of vent way
1.22 m 4' dia

k) Sill level of scouring vent
+15.760 m +51.71' MSL

l) Top of floor of stilling basin
+13.325 m +43.71 MSL

m) Top of training wall +26.735 m +87.71 MSL

n) Top of crest Gates +44.410 m +145.71 MSL

4. BULK HEAD PORTION OF MASONRY DAM

a) Length of bulk head 114.60 m 376'

b) Length of top dam 170.69 m 560'

c) Maximum width of base at
+35.71 at 24.52 m 80.43'

d) Foundation level +10.88 m +35.71' MSL

e) Top of road level +46.240 m +151.71' MSL

f)	Top of parapet	+47.155 m	+154.71' MSL

5. EARTH DAM

a)	Total length of all earth dams	1844 m	6.050
b)	Top width	5.48 m	18'
c)	Full reservoir level	+44.410 m	+145.71
	Free board	2.44 m	+81
	Top level of bund	+46.850 m	+153.71'
	Side slopes adopted upstream portion		2 1/2 : 1
	Down stream portion		2 : 1
	Deepest foundation level	+23.075 m	+75.71' MSL
	Maximum Height	24.77 m	78'
	Cut of trench	6.10 m	20' bottom width
	Side slope	0.61 m	2' width 1 : 1

SALIENT FEATURES OF CANAL SYSTEM

a)	Gross command area (net)	36414 ha	90,000 acres
b)	Cultivable command area	25490 ha	63,000 acres
c)	Irrigation area	14566 ha	36,000 acres
d)	Designed discharge	18.4 cusces	650 cusecs
e)	Area irrigated for 1st crop	14566 ha	36,000 acres
f)	Area irrigated for 2nd crop	14566 ha	36,000 acres

g)	Area irrigated for 3rd crop	2023	5,000 acres
h)	Total area irrigated annually	31,154 ha	77,000 acres
i)	Length of main canal	3.42 km	1 M F, 20'
j)	Length of main branches	74.82 km	467 M
k)	Length of sub-branches	172.16 km	107 miles
l)	Full supply level during second crop	+27.650 m	90.71 MSL
m)	Full supply level during third crop	+26.735 m	+87.71 MSL
n)	Bed level of canal at take off	+25.735 m	+87.71 MSL
o)	Sill level of head sluice	+25.515 m	+83.71' MSL
p)	Bed with at head	3.81 m	12' 6'
q)	Full supply depth Ist and 2nd crop	2.44 m	8'
r)	Full supply depth, 3rd crop	1.52 m	5'

CHAPTER IV

SOCIO-ECONOMIC CONDITIONS OF THE SAMPLE HOUSEHOLDS

In this chapter the socio-economic background of the sample households in the command area and non-command area is analysed. This is done on the premise that the socio-economic background of a household determines to a larger extent the impact of irrigation on agriculture.

Family Composition - Age and Sex Group

The total population of the households surveyed was 1208 in the command area and 562 in the non-command area. The members of the surveyed households are classified on the basis of certain identified characteristics for the purpose of analysis. First we analyse the sample population on the basis of sex and age. This is presented in Table 4.1.

Table 4.1 reveals that there were 596 males and 612 females in the surveyed household's command area. The corresponding figures in the non-command area were 294 and 268. The average size of the households was 5.6 persons in the command area and 5.2 persons in the non-command area. The average number of children, adults and the old were 1.61, 3.23

and 0.76 respectively in the command area and 1.56, 3.05 and 0.6 respectively in the non-command area. The average number of males and females were 2.76 and 2.83 respectively in the command area and 2.72 and 2.48 respectively in the non-command area. The command area had a higher percentage of females to males compared with the non-command area.

Table 4.1

Family Composition - Age and Sex

Sl. No.	Categories	Command Area Nos	Command Area %	Non Command Area Nos	Non Command Area %
A	Non-Adults (less than 15 years)	347	28.73	168	29.89
	Males	183	--	82	
	Females	164	--	86	
B	Adults (15 to 60)	697	57.70	329	58.54
	Males	320	--	174	
	Females	377	--	155	
	Old People (60 +)	164	13.58	65	11.57
	Males	93	--	38	
	Females	71	--	27	
	Total Persons	1208	100	562	100

Source: Survey Data

Educational Status

The educational status to the sample population is analysed under the following heads: viz. illiterate, below fifth standard, fifth and below SSLC, SSLC and PDC, degree and above and technical and professionals. This information is presented in Table 4.2.

Table 4.2 reveals that majority of the sample population - both in the command area and in the non-command area (36.18% and 27.22%) - belongs to the fifth and below SSLC category. Educational status of the people in the command area in general is comparatively lower than in the non-command area. The only exception is that of the 5th and below SSLC category. But if we consider female literacy alone it can be seen that the percentage of female literacy at degree and above level and technical and professional level are lower in the command area as compared to the non-command area.

Table 4.2

Educational Status of the Respondents House holds - Sex wise

Sl. No.	Categories	Command Area				Non-Command Area			
		Male	Female	Total	%	Male	Female	Total	%
1.	Illiterate	13 (1.08)	17 (1.41)	30	2.48	5 (0.89)	13 (2.31)	18	3.20
2.	Below 5th Std.	81 (6.71)	112 (9.27)	193	15.98	61 (10.85)	59 (10.50)	120	21.35
3.	5th and below SSLC	231 (19.12)	206 (17.05)	437	36.18	88 (15.66)	65 (11.57)	153	27.22
4.	SSLC and P.D.C	129 (10.68)	170 (14.07)	299	24.75	69 (12.28)	73 (12.99)	142	25.27
5.	Degree and above	119 (9.85)	98 (8.11)	217	17.96	56 (9.96)	47 (8.36)	103	18.33
6.	Technical & Professional	23 (1.90)	9 (0.75)	32	2.65	15 (2.67)	11 (1.96)	26	4.63
	Total Persons	596 (49.34)	612 (50.66)	1208 (100)	100	294 (52.31)	268 (47.69)	562 (100)	100

Figures in Parenthesis indicates Percentage to total cost.

Source: Survey Data.

Usual Activity Status

It may be seen from table 4.3 that the employees form less than one per cent both in the command area (0.5%) and in the non-command area (0.53%), but the latter is more than the former. The employees form 23.68 per cent in the command area as against 24.02 per cent in the non-command area, of which the private sector employees account for 17.63 per cent and 18.33 per cent respectively in the command area and in the non-command area. The public sector employees form only 6.04 per cent in the command area and 5.69 per cent in the non-command area.

On account workers form 20.78 per cent and 19.04 per cent in the command area and in the non-command area respectively. The percentage of female on account workers in the command area is greater than on account workers in the non-command area.

Table 4.3

Details of Usual Activity Status - Sex wise

Sl. No.	Categories	Command Area				Non-Command Area			
		Male	Female	Total	%	Male	Female	Total	%
1.	Employers	11	0	11	0.91	3	0	3	0.53
2.	Employees	147	139	286	23.68	73	62	135	24.02
	Government	42	31	73	6.04	19	13	32	5.69
	Private	105	108	213	17.63	54	49	103	18.33
3.	Own account workers	114	137	251	20.78	59	48	107	19.04
4.	Not in the labour force	161	182	343	28.39	110	88	198	35.23
5.	Unemployed	163	154	317	26.24	49	70	119	21.17
	Total persons	596	612	1208	100	294	268	562	100

Source: Survey Data.

It is very important to notice that percentage of employment in the command area (26.24%) is higher than the percentage of unemployment in the non-command area (21.17%).

Religion - wise classification of sample households

From table 4.4 it can be seen that 127 out of 216 sample beneficiaries in the command area belong to Hindu religion, 21 to christian and 68 to muslim. Of the total of 108 sample households in the non-command area, 71 belong to Hindu, 6 to Christian and 31 to Muslim. If shows that majority of the sample households both in the command and in the non-command areas belongs to Hindu religion. This is followed by muslim and christian in that order. The SC/ST accounts for only 3.70 per cent in the command area and 5.56 in the non-command area.

Table 4.4

Religion wise Classification of Sample households (Samples in the Command Area 216 h.h and Non Command Area 108 h.h)

	Command Area							Non-Command Area						
	Hindu		Christian		Muslim		Total	Hindu		Christian		Muslim		Total
	Oth.	SC/ST	Oth.	SC/ST	Oth.	SC/ST		Oth.	SC/ST	Oth.	SC/ST	Oth.	SC/ST	
Nos.	119	8	21	-	68	-	216	65	6	6	0	31	-	108
%	55.09	3.7	9.72	–	30.48	–	100	60.19	5.56	5.56	–	28.7	–	100

(h.h. household)

Source: Survey Data.

Ownership of Landholdings

On the basis of ownership, landholdings are classified into owned and leased land. Table 4.5 indicates the ownership of landholdings of the sample population in the command area and in the non-command area. Out of 216 sample households, 205 (94.91%) cultivate in their own land in the command area as against 104 (96.30%) out of 108 sample households in the non command area.

Table 4.5

Details of Ownership of Land Holdings (Samples in the Command Area 216 h.h. and Non command Ara 108 h.h)

	Command Area			Non Command Area		
	Owned	Leased	Total	Owned	Leased	Total
Nos	205	11	216	104	4	108
%	94.91	5.09	100	96.30	3.70	100

Source: Survey Data.

Out of 108 in the non-command area leased land forms only 5.09 per cent in the command areas as against 3.70% in the non-command area. The percentage of leased land in the command area is greater than in the non-command area.

Since there is no reasonable net return from paddy cultivation, nobody is interested to take land on lease basis. This is the case even after the introduction of irrigation facility, which is the main cause for the lower percentage of leased land in paddy cultivation both in the command and non-command areas.

Details of Farm Size

The sample households are classified into four classes according to the size of landhold. This is presented in table 4.6.

The size of the households includes both owned and leased land. The small holdings of less than one acre form 51.39 per cent in the command area and 44.44 per cent in the non-command area. The small and medium farms form nearly 85 per cent both in the command and in the non-command areas. Large farms form only 1.39 per cent in the command area and 1.85 per cent in the non-command area. The percentage of large farms in the command area is less than that in the non-command area.

Table 4.6

Details of Farm size between Command area and Non-Command Area

		Command Area		Non- Command Area	
Sl. No.	Categories	Nos	%	Nos	%
1.	Small Farmers (less than 1 acre)	111	51.39	48	44.44
2.	Medium Farmers (1.01 to 2.47 acres)	72	33.33	45	41.67
3.	Big Farmers (2.48 to 4.96 acres)	30	13.89	13	12.04
4.	Large Farmers (4.97 and above area)	3	1.39	2	1.85
	Total	216	100	108	100

Source: Survey Data.

Details of Land Possession and Utilisation

A. Wet Land

Table 4.7 shows the details of wet land possession and its utilisation. The total area of wet land possessed in the command area is 310.66 acres as against 162.83 acres in the non-command area. The average wet landholding per household in the command area is 1.44 acres, as against 1.51 acres in the non-command area. Major portion of the wet land are used for paddy cultivation both in the command and in the non-command areas, which form 84.45 per cent and 73.75 per cent respectively. Land used for non-paddy crops accounts for 6.26 per cent in the command area and 14.11 per cent in the non-command area. Land used for non-agricultural purpose, fallow and waste forms 3.51 per cent, 1.27 per cent and 0.40 per cent respectively in the command area as against 11.40 per cent, 0.48 per cent and 0.26 per cent respectively in the non-command area.

Table 4.7

Details of Land Possession and Utilisation (Wet Land)
(area in acres)

Sl. No.	Categories	Command Area		Non-Command Area	
		area	%	area	%
1.	Paddy	262.36	84.45	120.08	73.75
2.	Non-paddy crops (excluding mixed crop)	19.44	6.26	22.98	14.11
3.	Non-agricultural uses	10.91	3.51	18.57	11.40
4.	Fallow	3.95	1.27	0.78	0.48
5.	Waste	1.24	0.40	0.42	0.26
6.	Water logging	12.76	4.11	--	--
	Total	310.66	100	162.83	100
	Average per h.h	1.44		1.51	

Source: Survey Data.

Area under fallow in the command area is greater than in the non-command area. The non-command area is free from water logging, whereas in the command area it accounts for 4.11 per cent.

Area under cultivation in the command and non-command areas account for 91.71 per cent and 87.86 per cent respectively. It should be noted that area under non-agricultural uses in the command area is less than in the non-command area due to irrigation.

B. Dry Land

Table 4.8 shows that details of dry land possession and its utilisation. The command area possessed nearly 145 acres of dry land, as against nearly 85 acres in the non-command area. The average dry landholding per household in the command and non-command areas is 0.67 and 0.79 acres respectively. There is no paddy crop raised in the dry land, both in the command and in the non-command areas.

Around 76 per cent of the total dry land is under non-paddy crops, both in the command and in the non-command areas. There is no dry land kept under fallow in the command area, whereas 2.21 acres are left fallow in the non-command area. Land in waste comes to 1.22 per cent and 3.52 per cent in the command area and non-command area respectively.

Table 4.8

Details of Land Possession and Utilisation (Dry land)

(Area in hectares)

Sl. No.	Categories	Command Area area	Command Area %	Non-Command Area area	Non-Command Area %
1.	Paddy	---	---	---	--
2.	Non-paddy crops (excluding mixed crop)	110.16	75.76	65.18	76.22
3.	Non-agricultural uses	33.48	23.02	15.44	18.05
4.	Fallow	--	--	1.89	2.21
5.	Waste	1.77	1.22	3.01	3.52
	Total	145.41	100	85.52	100
	Average per h.h	0.67	--	0.79	--

Source: Survey Data.

Physical and Financial Assets of the Sample Households

In any appraisal of the impact of irrigation on income and living standards and on the economy in general, an estimate of the wealth of the farmers in the command and non-command areas in the form of farm assets, livestock, non-farm buildings, agricultural implements including ploughs and tractors, pumpsets and carts, household durable consumer goods etc. constitute an important yardstick.

Table 4.9

Details of the Farm Assets Possession

(value in rupees)

Sl. No.	Categories	Command Area: Nos/Area in acres	Command Area: Command Total value	Command Area: Average Unit value	Non-Command Area: Nos/Area in acres	Non-Command Area: Total Value	Non-Command Area: Average unit Value
1.	Land						
	Wet	307.32	34358376	111800	162.83	15257171	93700
	Dry	145.41	56186424	386400	85.52	29393224	343700
2.	Agricultural building	69	565800	8200	28	207200	7400
3.	Tubewell/Pond/ well	254	1346200	5300	141	860100	6100
4.	Pump set	18	73800	9225	12	127800	10650
5.	Tractor	--	--	--	--	--	--
6.	Tiller	9	128520	14280	3	41400	13800
7.	Sprayer & Duster	31	25575	825	14	12880	920
8.	Other imple- ments	216	111888	518	108	47088	436
	Grand total		92796583			45946863	
	Average per h.h.		429614			425434	

Table 4.9 shows the details of the farm assets in the command and non-command areas.

The average value of farm works out to Rs.429,614 per household in the command area as against Rs.425,434 per household in the non-command area. The average value of farm assets per household in the command area is slightly higher than in the non-command area (Rs.4180). From this we can conclude that irrigation has made only very little positive impact on the farm assets in the command area.

Live Stock

Table 4.10 shows the details of livestock in the command and non-command areas. The average value of livestock per household in the command area is Rs.4471, as against Rs.3255 per household in the non-command area. Except drought animals and duck the average value of other categories in the livestock is greater in the non-command area compared to the command area.

Table 4.10

Details of Live Stocks between Command Area and Non-Command Area

(value in rupees)

		Command Area			Non Command Area		
Sl. No.	Categories	Nos	Total Value	Average unit value	Nos	Total value	Average unit value
1.	Drought Animals (pair)	34	102200	2800	13	38350	2850
2.	Milk Cattle/ buffaloe	204	652800	3200	84	235200	2800
3.	Goat/Sheep	196	114800	586	116	59160	510
4.	Pigs	61	22570	370	--	--	--
5.	Poultry	1286	33436	26	598	13754	23
6.	Duck	1663	39912	24	186	5022	27
	Grand Total		965718			351486	
	Average per h.h.		4471			3255	

Per household, the average number of draught animals, milch cattle, goat/sheep, pigs, poultry and ducks are 0.16, 0.94, 0.91, 0.28, 5.95 and 7.7 respectively in the command area. The corresponding figures in the non-command area are 0.12, 0.78, 1.07, 0.0, 5.54 and 1.72 respectively.

Both draught animals and milch cattles are used for ploughing both in the command and in the non-command areas. After starting irrigation the draught animals and milch cattles increased by 33.33 per cent and 20.51 per cent respectively in the command area.

When compared to the non-command area, the number of draught animal and milch cattle has increased in the command area due to the following three reasons. They are:

i) for ploughing purpose

ii) for making use of the subsidiary output of straws,

iii) for getting manure.

Non-Farm Assets

Non-farm assets include non-farm buildings, non-farm machinery like two wheelers, four wheelers, cycles, and bullock-carts etc. and other households items like TVs, VCP/VCR, fridges, vessels, jewels etc.

Table 4.11 indicates the value of non-farm assets of the households in the command and non-command areas.

The value of non-farm assets per household in the command area amounts to Rs.117,930, whereas in the non-command area it is Rs.92597. From table 4.11 we can understand that the average value of non-farm assets in the command area is greater than in the non-command area (27.36%).

Table 4.11

Details of Non Farm Assets of the households between

Command Area and Non Command Area

(value in Rupees)

Sl. No.	Categories	Command Area Nos	Command Area Total Value	Command Area Average unit value	Non-Command Area Nos	Non-Command Area Total value	Non-Command Area Average unit value
1.	Non-Farm buildings (houses)	227	19522000	86000	99	72270660	73000
2.	Non-Farm machinery						
	a) Two wheeler	34	275400	8100	12	134400	11200
	b) Car/Jeep/lorry	7	574000	82000	5	380000	76000
	c) Cycle	56	30240	540	38	23370	615
	d) Bullock cart	4	56800	14200	-	--	--
3.	Others (including T.V, V.C.P, Fridge, vessels, Jewels etc.)	--	5014440	23215	--	2235600	20700
	Grand total		25472880				10000430
	Average per h.h.		117930.00				92597

Financial Assets

The sample households were found to deposit their savings with various agencies such as commercial banks, co-operative societies, post office and other agencies. Statistics relating to these transactions are presented in table 4.12.

Table 4.12

Details of Financial Assets of the Sample households Between Command Area and Non Command Area

(value in rupees)

Sl. No.	Categories	Command Area			Non-Command Area		
		Number of h.h.	Total Amount	Average to the total h.h	No.of h.h.	Total Amount	Average to the total h.h.
1.	Commercial Banks	31	74400	344.44	23	32200	298.15
2.	Co-operative Societies	216	270216	1251.00	98	61740	571.60
3.	Post Office	102	278921	1291.30	38	63370	586.76
4.	Other Deposits	63	642000	2972.22	27	78300	725.00
	Grand Total		1265537			235610	
	Average per h.h.		5859			2182	

Source: Survey Data.

The total deposits amount to Rs.12,65,537 for 216 households in the command area as against Rs.2,35,610 for 108 households in the non-command area. The average deposits per household is Rs.5859 and Rs.2182 in the command and non-command areas respectively.

The percentage of households having deposits in the commercial banks are 14.35 per cent, co-operative societies 100 per cent, post office 47.32 per cent and other deposits 29.17 per cent in the command area, as against 21.30 per cent, 90.74 per cent, 35.19 per cent and 25.00 per cent in the commercial banks, co-operative banks, post office and other agencies respectively in the non-command area. From table 4.12 we can understand that majority of the sample households both in the command and in the non-command areas deposited in the co-operative societies followed by post office and other agencies.

It can be noticed that average deposits per households in the command area is much higher than that of non-command area and the difference between these two amounted to Rs.3777.

Debt Position

Table 4.13 indicates the debt position of the sample households in the command and in the non-command areas. The sample households were found to borrow from various agencies such as commercial banks, co-operative societies, money lenders, relatives and other agencies like chit fund and insurance corporation. According to table 4.13 majority of the sample households both in the command and non-command areas borrowed from co-operative societies than other agencies.

The total debt amounts to Rs.6,55,955 for 216 sample households in the command area, as against Rs.3,88,136 for 108 households in the non-command area. The average debt per household is Rs.3037 and Rs.3594 in the two areas respectively. The average debt position per household in the command area is less than that of the non-command area. Deducting the average loan per household in the command area, the real deposit amounts to Rs.2822. But in the case of non-command area the average debt amount per household is higher than its average deposit.

The percentage of households borrowing from commercial banks accounts for 12.03 per cent as against 12 per cent in the non-command area. However, percentage of households availing loans from co-operative societies is higher in the command area (27.31 per cent) as compared to the non-command area (22.22 per cent). Larger percentage of households borrow from money lenders and chit funds in the command area as compared to non-command area. Borrowings from relatives is higher in the non-command area as compared to the command area.

Table 4.13

Details of Debt Positions: (Borrowing From)

(value in rupees)

Sl. No.	Categories	Command Area			Non Command Area		
		Number of h.h.	Total Amount	Average to the to-tal h.h.	No.of h.h.	Total Amount	Average to the total h.h.
1.	Commercial Bank	26 (12.03)	74080	343	12(11.11)	32805	303
2.	Co-operative Societies	59 (27.31)	347600	1609	24(22.22)	180600	1672
3.	Money lender	14 (6.48)	11424	53	5(4.62)	2766	25
4.	Relatives	18 (8.33)	179645	832	13(12.04)	160720	1488
5.	Due Out sta-nding against chit fund & Insurance	41 (18.98)	43206	200	15(13.88)	11245	104
	Grand Total		655955			388136	
	Average Per h.h.		3037			3594	

Figures in Paranthesis indicates percentange to total households.

Details of remittances

Table 4.14 shows that the details of the sample households' remittances against different categories.

Table 4.14

Details Regarding Remittance of the Sample households between Command Area and Non Command Area

(value in rupees)

Sl. No.	Categories	Command Area No.of h.h.	Command Area Total Amount	Command Area Average to the total h.h	Non- Command Area Number of h.h.	Non- Command Area Total Amount	Non- Command Area Average to the total h.h.
1.	Insurance (per annuam)	194 (89.8)	358824	1661.22	101 (93.52)	216154	2001.42
2.	Chit fund	73 (33.8)	547500	2534.72	31 (28.7)	233000	2157.40
3.	Govt.bonds & Securities	13 (6.02)	265000	1226.85	17 (15.74)	185000	1712.96
4.	Balance Outstanding W.r.t loans given to others	9 (4.17)	414650	1919.67	13 (12.04)	326000	3018.52
	Grand total		1585974			960154	
	Average per h.h.		7342			8890	

Figures in Paranthesis indicates percentage to the total households.

The total remittance against insurance, chit fund govt. bonds and securities and balance outstanding with respect to loans given to others amount to Rs.15,85,974 in the command area and Rs.9,60,154 in the non-command area. The average remittance per household is Rs.7342 and Rs.8890 in the two areas respectively.

Table 4.14 also indicates that the number of households making India remittances in the command area are as follows:

Insurance	194
Chit funds	73
Govt. bond & securities	12
Loans	9

Corresponding figures are 101, 31, 17 and 13 in the non-command area.

Nearly 90 per cent of the households in the command area and 94 per cent in the non-command area hold insurance policy and remit premium regularly.

CHAPTER V

IMPACT OF IRRIGATION ON CROPPING PATTERN, INTENSITY OF CROPPING AND MODERN TECHNOLOGY

In the previous chapter the socio-economic conditions of the sample households in the command and non-command areas were analysed. The three sections in this chapter analyse the impact of irrigation on cropping pattern, intensity of cropping and adoption of modern technology respectively.

SECTION I

Impact of Irrigation on Cropping Pattern

The development of irrigation affects agriculture in several ways: They are:(1) It leads to a change in the cropping pattern (2) It makes the outcome of the crop more certain than before (3) It reduces instability of yields and (4) It facilitates adoption of HYV technology.

It is a fact that irrigation that leads to a more market-oriented cropping pattern. Though irrigation development is a crucial factor influencing cropping pattern, other factors like Government's water distribution policy, market prices, suitability of land etc. will also have a say on the cropping pattern. In the areas where irrigation is in the traditional manner like field-to-field irrigation, the farmers have no choice to change the cropping pattern to get higher returns. The field-to-field irrigation system of water distribution, in the absence of field channels, leaves no option for any farmer to grow any crop other than paddy. If farmers are given field channels that provide them individual access to the outlet point, a much more variegated crop pattern thus emerges under surface irrigation works [Dhawan: 1988].

But how do farmers behave in an economy which has had irrigation facilities for a long time ? In this context we want to analyse the irrigation development and its impact on cropping pattern in the study region. In the command area farmers adopt irrigation in the traditional manner like field-to-field irrigation.

Cropping Pattern

Distribution of gross cropped area among different crops between command and non-command areas is presented in table 5.1.

Table 5.1

Distribution of Gross Cropped Area of the Sample households between Command and Non- Command Area

(area in acres)

Crops	Command area			Non-Command area		
	Area	%	Mean Average per h.h.	Area	%	Mean Average per h.h.
Paddy	432.89	88.19	200.41	201.51	85.77	186.58
Non paddy						
a) Coconut	9.11	1.86	4.22	14.22	6.05	13.17
b) Arecanut	1.84	0.37	0.85	7.99	3.40	7.40
c) Banana	8.49	1.73	3.93	.77	0.33	0.71
d) Tapioca	32.21	6.56	14.91	7.63	3.25	7.06
e)Veg & Others	6.34	1.29	2.94	2.82	1.20	2.61
Total	490.88	100	2.27	234.94	100	2.18

h.h. house hold

Source: Survey Data.

The cropping pattern in the study area is influenced by the quantity of irrigation and also by location of land i.e. accessibility to get free flow of irrigation water to the field. Moreover it is also influenced by local turn policy of the Government.

From table 5.1 we can understand that the number of different crops raised by the farmers of the sample households are six each in both the command and the non-command areas. Among these, paddy is the most important crop in these two areas.

The total gross cropped area under cultivation of paddy and non-paddy (all crops) in these two areas is 490.88 acres and 234.94 acres respectively. The proportion of area under paddy is higher than non-paddy crops in the command and non-command areas forming about 88.19 per cent and 85.77 per cent respectively. As compared to non-command area, the percentage of area under paddy cultivation is 2.42 per cent higher in the command area due to irrigation.

This was tested statistically by using test of proportion. It was found that there was no significant difference in the proportion of gross cropped area under paddy crop in the command area as compared to non-command area.

i.e.

$H_0 : P_1 = P_2$

$H_1 : P_1 \neq P_2$, There is a significant difference.

$$Z_o = \frac{P_1 - P_2}{\sqrt{pq\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{|.88 - .85|}{\sqrt{.87\left(\frac{1}{490.88} + \frac{1}{294.94}\right)}}$$

$$= \frac{.03}{.06} = .5$$

where $p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2}$ $\qquad q = 1-p$

$Z_{0.5} = 1.96,$ $\qquad Z_o < Z_\alpha.$

Hence we accept the null hypothesis that there is no significant difference in the proportion of area under paddy cultivation in the command area as compared to non-command area.

In the command area, 11.81 per cent of the land of the households is allocated to grow non-paddy crops like coconut, arecanut, banana, tapioca, vegetables and others as against 14.23 per cent in the non-command area. As compared to non-command area, the percentage of area under cultivation of non-paddy crops is lower in the command area. This is largely because free flow of irrigation water encourages the farmer to raise only paddy crop in the command area.

Among the non-paddy crops, the percentage of area under cultivation of tapioca is the highest (6.56%) followed by coconut (1.86%), banana (1.73%), vegetable and others (1.29%) and arecanut (0.37%) in the command area. Whereas in the non-command area it is the highest in the case of coconut (6.05%), it is followed by arecanut (3.4%), tapioca (3.25%), vegetable and others (1.20%) and banana (0.33%).

The farmers in the non-command area depend on rainfed tanks. They cannot raise banana as it requires irrigation for 10 to 12 months continuously until it bears fruits. So the percentage of area under cultivation of banana crop in the non-command area is very insignificant as compared to command area.

Classification of area under cultivation of Paddy Crop - Season and Variety-wise

Table 5.2 indicates season-wise and variety-wise classification of paddy cultivation during a year in the command area and non-command area.

Number of paddy crop raised per annum in the command area is three against only two in the non-command area. No summer crop (puncha crop) was raised in the non-command area due to nonavailability of canal irrigation.

Total area under paddy cultivation by all seasons in the command and non-command areas is 432.89 acres and 201.51 acres respectively. Of the total area under paddy cultivation in the command area, viruppu, mundakan and puncha seasons account for 18.83, 46.81 and 34.36 per cent respectively. Corresponding figures in the non-command area are 43.52, 56.48 '0' per cent respectively. There is no puncha crop raised in the non-command area due to the absence of irrigation.

The percentage of area under paddy crop during mundakan season both in the command and non-command areas is greater than the other two seasons namely viruppu and puncha.

From table 5.2 we can easily understand that the number of farmers who have adopted high-yielding varieties in the command area is much greater than that of farmers in the non-command area. Nearly 50 per cent of the total paddy in the command area is under high-yielding variety as against only 16.5 per cent in the non-command area.

Table 5.2

Details of Cropping Pattern - Seasons and Varieties wise

between Command area and Non-Command area(Paddy only)

(area in acres)

	Command Area					Non-Command Area				
	Varieties					Varieties				
Seasons	HYV	%	Local	%	Total	HYV	%	Local	%	Total
Viruppu	27.45 (33.67)	12.89	54.07 (66.33)	24.58	81.52 (100)	16.18 (18.45)	48.68	71.51 (81.55)	42.50	87.69 (100)
Mundakan	36.70 (18.11)	17.24	165.92 (81.89)	75.42	202.62 (100)	17.06 (14.99)	51.32	96.76 (85.01)	57.50	113.82 (100)
Puncha	148.75 (100)	69.89	--	-0-	148.75 (100)	--	--	--	--	--
G. total	212.90	100	219.99	100	432.89	33.24	100	168.27	100	201.51
%	49.18	--	50.82	--	100	16.50	--	83.50	--	100

Figures in Parenthesis indicates percentage to total area.

Souce: Survey Data.

It is also interesting to note that all the farmers in the command area adopt only HYV during puncha season. This is because irrigation water will be available only for three months i.e. from the middle of January to middle of April every year. It forces the farmer to raise short term period HYV of paddy instead of long term period local variety of paddy.

Thus, irrigation provided chance for raising one more additional paddy crop called puncha and to adopt HYV of seeds during all seasons.

Cropping System

There are three types of cropping system, namely pure cropping, mixed cropping and inter-cropping. In practice both in the command and in the non-command areas these practices are followed. But the percentage of area under each cropping system is varying with quantity of irrigation.

Table 5.3 shows the area under each cropping system to net area and gross cropped area between command and non-command areas.

Table 5.3

Distribution of Cropping System of the Sample households Between Command Area and Non-command Area.

(area in acres)

	Command Area				Non-Cmmand Area			
	Cropping System				Cropping system			
	Pure Crop	Mixed Crop	Inter Crop	Total	Pure Cropping	Mixed Cropping	Inter cropping	Total
Net Area	223.81 (79.42)	38.55 (13.68)	19.44 (6.90)	281.80 (100)	109.63 (76.63)	10.45 (7.30)	22.98 (16.06)	143.06 (100)
Gross Cropped Area	432.89 (88.19)	38.55 (7.85)	19.44 (3.96)	490.99 (100)	201.51 (85.77)	10.45 (4.45)	22.98 (9.78)	234.94 (100)

Figures in Paranthesis indicates percentage to total area.

Source: Survey Data.

The total net area in the command area is 281.80 acres as against 143.06 acres in the non command area. The percentage of pure cropping forms the highest, (79.42%) followed by mixed cropping (13.68%) and inter cropping (6.9%) in the command area.

The percentage of pure cropping, mixed cropping and inter-cropping in the non-command area forms 76.63 per cent 7.30 per cent and 16.06 per cent respectively.

The proportion of area under pure cropping is the highest, forming 79.42 per cent and 76.69 per cent respectively in the command area and non-command area.

In the command area, the percentage of area under mixed cropping is greater than inter-cropping, whereas in the non-command area it is just reverse, that is the percentage of area under inter cropping is greater than mixed cropping.

The percentage of area under pure cropping, mixed cropping and inter-cropping to gross cropped area in the command area is 88.19 per cent, 7.85 per cent and 3.96 per cent respectively. In the non-command area, this is 85.77 per cent, 4.45 per cent and 9.78 per cent respectively.

Thus, the percentage of area under pure cropping and mixed cropping in the case of both net area and gross cropped area in the command area is greater than non-command area, as a result of irrigation.

Cropping Pattern of Non-paddy Crops by Reaches-wise

Table 5.4 shows the details of cropping pattern of non-paddy crops by reaches-wise in the command area after irrigation. This classification is more important to find out what type of crops are being raised among the reaches and its reasons.

According to table 5.4, among the three reaches, proportion of area under cultivation of non-paddy crops except banana, in the lower reaches is the highest (55.60%), followed by middle reaches (25.45%) and upper reaches (18.95%).

But in the case of individual crops it is true only in the case of tapioca. The proportion of area under cultivation of coconut and arecanut in the upper reaches is the highest (50.05%, 75.54%), followed by lower reaches (30.85%, 14.67%) and middle reaches (19.10%, 9.78%).

Table 5.4

Details of Cropping Pattern of Non-paddy crops

by Reaches-wise in the Command Area

(area in acres)

Crops	Upper reaches	%	Middle reaches	%	Lower reaches	%	Total	%
Coconut	2.81	30.85	1.74	19.10	4.56	50.05	9.11	100
Arecanut	0.27	14.67	0.18	9.78	1.39	75.54	1.84	100
Banana	2.84	33.45	4.39	51.71	1.26	14.84	8.49	100
Tapioca	3.24	10.06	5.81	18.04	23.16	32.21	32.21	100
Vegetable & Others	1.83	28.86	2.64	41.64	1.87	29.50	6.34	100
Total	10.09	--	14.76	--	32.24	--	57.99	--
Percentage	18.95		25.60		55.60		100	--

Source: Survey Data.

In the case of banana crop, it is the highest in the middle reaches (51.71%), followed by upper reaches (33.45%) and lower reaches (14.84%).

The proportion of area under vegetable in the middle reaches is the highest (41.64%), followed by lower reaches (29.50%) and upper reaches (28.86%).

On a whole, the proportion of area under cultivation of non-paddy crop in the lower reaches is the highest, followed by middle and upper reaches. It is mainly because, except banana, all other non-paddy crops are being raised more on the area which is suffering from inadequacy of water.

SECTION II

IMPACT OF IRRIGATION ON INTENSITY OF CROPPING

The ratio of gross cropped area to net sown area usually expressed in percentage terms, is defined generally as intensity of cropping in a year. It is a simple indicator of the extent of multiple cropping as under plough, that is, the number of crops being raised in a sequence (one after the other), with 100 per cent level standing for one crop per year, 200 per cent for double cropping and 300 per cent for triple i.e., year round cropping land. It is this measure of intensity of cropping that is discussed here.

One point needs to be emphasised here. It is obvious that, the longer the duration of crops grown, the lesser will be the area available for multiple cropping. Farmers essentially growing longer duration crops such as arecanut and coconut may have a lower intensity of cropping than those who devote most of their land for short duration crops.

Intensity of Crop

1. Paddy crop only

Reaches-wise classification of intensity of paddy crop among sample households is presented in table 5.5.

The total net area sown and gross cropped area in the command area are 262.36 acres and 432.89 respectively. In the non-command area it is 120.08 and 201.51 acres respectively.

Table 5.5

Reaches wise Classification of Intensity of Cropping (Paddy only)

(area in acres)

	Command Area				Non Command Area			
	Reaches				Reaches			
	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
Net Area	103.29	54.80	104.27	262.36	--	--	--	120.08
Gross Cropped area	169.86	119.19	143.84	432.89	--	--	--	201.51
Intensity of Cropping	164	218	138	165	--	--	--	168

Source: Survey Data.

In the command area the crop intensity has been 165 per cent among the sample households, as against 168 per cent in the non-command area.

Instead of increasing, the crop intensity has declined to 165 per cent from 168 per cent, after irrigation. The crop intensity and the farm size display a negative relationship in the command area.

Only a few small farmers have used their land more intensively compared to medium, big and large farmers. They used their farms during all the seasons. Those who do not have adequate supply of water in the command area are raising short term duration non-paddy crops during puncha season. The medium and big farmers leave a significant proportion of the land uncultivated during viruppu seasons in order to maintain the fertility of the soil and to enhance farm productivity during the mundakan season. Apart from this, shifting of paddy crop into long duration coconut crop and keeping level land as fallow due to high cost of production in the command area, are caused to reduce the number of crops being raised per year which causes for decreasing the intensity of crop in the command area as compared to non-command area.

2. Non-paddy crop only

Table 5.6 shows the reaches-wise classification of intensity of non-paddy crops among the sample households between command and non-command areas.

According to table 5.6 the intensity of non-paddy crop in the command area is 298 per cent, as against 145 per cent in the non-command area. The intensity of non-paddy crop in the command area is 153 per cent greater than non-command area.

Apart from this, among the three reaches in the command area, the percentage of intensity of non-paddy crop in the lower reaches is the highest (447%), followed by middle (234%) and upper reaches (186%).

Table 5.6

Reaches-Wise Classification Intensity of Cropping

for Non-Paddy Crops

(area in acres)

	Command Area				Non Command Area			
	Reaches				Reaches			
	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
Net Area	5.92	6.31	7.21	19.44	--	--	--	22.98
Gross Cropped area	10.99	14.76	32.24	57.99	--	--	--	33.43
Intensity of Cropping	186	234	447	298	--	--	--	145

Source: Survey Data.

The following are the reasons for the high intensity of non-paddy crop in the command area.

i) The farmers who are faced with inadequate supply of canal water at the tail end portion of the command area raise short term duration non-paddy crops like tapioca and vegetables in addition to viruppu and mundakan crops which increases the intensity of non-paddy crop in the lower reaches as compared to the other two reaches.

ii) In the case of non-command area, the major portion of area under non-paddy crops are covered by the long duration non-paddy crops like coconut, arecanut and banana, which reduces the intensity of non-paddy crop in the non-command area.

3. <u>All Crops (Paddy and Non-Paddy crops)</u>

Table 5.7 shows reaches-wise intensity of cropping to all crops (paddy and non-paddy) between command area and non-command area.

Table 5.7

Reaches wise Intensity of cropping in the Command Area and Non Command Area (Paddy and Non-paddy crops)

(area in acres)

	Command Area				Non Command Area			
	Reaches				Reaches			
	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
Net Area	109.21	61.11	111.48	281.80	--	--	--	143.06
Gross Cropped area	180.85	133.95	176.08	490.88	--	--	--	234.94
Intensity of Cropping	166	219	158	174	--	--	--	164

Source: Survey Data.

The crop intensity of all crops (paddy and non-paddy) in the command area is 174 per cent, as against 164 per cent in the non-command area. There is no significant difference in the crop intensity between command and non-command areas. Canal irrigation causes to increase the intensity of crop from 164 per to 174 per cent.

Intensity of crop before and after Irrigation (to all crops)

Table 5.8 indicates the intensity of cropping before and after irrigation in the command area.

Before irrigation, paddy alone was grown. But after canal irrigation, along with paddy, non-paddy crops are also raised.

According to sample households, the net and gross cropped area for all crops before irrigation are 307.32 and 455.80 acres respectively, as against 281.80 and 490.88 acres respectively, after irrigation.

Table 5.8

Details of Intensity of Cropping in the Command Area
After and Before Irrigation (all crops)

(area in acres)

	After			Before		
Categories	Paddy crop	Non-paddy crops	Total	Paddy crop	Non-paddy crops	Total
Net Area	262.36	19.44	281.80	307.32	--	307.32
Gross Cropped area	432.89	57.99	490.88	455.80	--	455.80
Intensity of Cropping	165	298	174	148	--	148

Source: Survey Data.

After irrigation the net area sown for paddy is decreased to 262.36 acres from 307.32 acres before irrigation. After irrigation the net area sown in the command area is 14.63 per cent less, compared to the net area sown before irrigation. It is mainly due to the following reasons:

i) Some parts of the wet land in the command area have been used for non-agricultural purposes like construction of houses, theaters, playgrounds etc.

ii) Water logging with upper reaches causes to keep their land as fallow.

On the whole, the intensity of crop to all crops before irrigation was 148 per cent as against 174 after irrigation.

SECTION III

Impact of Irrigation on Adoption of Modern Technology

Provision of irrigation generally induces the cultivators to adopt modern technologies like adoption of High Yielding Variety of improved seeds, application of fertilizer and introduction of mechanisation etc. to a large extent, which finally result in increasing agricultural production and employment in the rural economy.

The new strategy proposes to make a new technological breakthrough in India which comprises the introduction of new and HYV of improved seeds, increased application of the recommended doses of fertilizer and extension of the use of pesticides, so that the crop produced can be saved from destruction by insects. This technical breakthrough has brought about spectacular changes in the agricultural production of our economy. The large increase in the production of foodgrains recorded after 1966-67 is described as Green Revolution. The rapid introduction of high yielding wheat-varieties and paddy, and their multiplied effects in the other crops justifies the name of "Green Revolution". It has pushed into background the chronic food shortage. It has also provided an incentive for further development of agriculture. Modern science and technology can break through India's long closed circle of poverty to spearhead an agriculture take-off that will provide the missing momentum in rural resources and demand for rapid industrialisation (F.R. Frankel: 1971).

Application of modern Technology of HYV of seeds in paddy cultivation

In order to feed continuously the increasing population, there is a need to increase foodgrain production in general and agricultural production per unit of land in particular through irrigation. This increase in population relative to land should be viewed in the given circumstances (resources). Since India is a labour-abundant country one should prefer to use land-using inputs. HYV seeds are capable of increasing production and are land-using in character. Planners also feel that "Production of quality seeds will continue to be an important input for crop production strategy. The programme for production of certified seeds will, therefore, be pursued with added vigour" (Draft Five year Plan 1978-83).

Among the new agricultural strategies responsible for increasing productivity, adoption of resource input of HYV seed meets with ready response and adoption (Project Evaluation Organisation, Planning Commission, New Delhi, 1961). These seeds are considered to be neutral to scale and can be adopted by small farmers with meagre resources. Improved varieties of seeds is an essential ingredient of the recent Green Revolution and rightly named as "Miracles seed'.

The problems of HYV seeds technology are that it has a limited coverage and scope for adoption. This technology can successfully be implemented where water and chemical fertilizers are available. It is rightly called water - HYV seeds - fertilizer technology. This technology also requires heavy investment. Therefore, small farmers lagged behind large farmers in the adoption of new seed varieties. Moreover, the success in the sphere of HYV seeds has been limited to wheat and rice crops and a few commercial crops.

The adoption of high-yielding varieties in Kerala started only by 1968-69 and was mostly confined to paddy. In 1968-69 the area under HYV of paddy was 123 thousand hectares, forming 14 per cent of the total area under paddy. In between

1970-71 and 1980-81, the area under HYV increased from 159.20 thousand hectares to 279.3 thousand hectares, an increase of more than 75 per cent. However, the area declined since then to 155.63 thousand hectares by 1989-90. In other words, HYV of paddy accounted for 34.89 per cent in 1980-81, but declined to 26.68 per cent of the total area under paddy by 1989-90.

Adoption of Modern Technology of HYV of Seed

Table 5.9 presents the details of adoption of modern technology of HYV in paddy cultivation between command area and non-command area.

The provision of irrigation has enhanced the scope for the adoption of modern technology. The HYV technology accounts for 49.18 per cent of the gross cropped area (to all seasons) in the command area, as against only 16.5 per cent in the non-command area.

Of the gross cropped area of the HYV technology in the command area viruppu accounts for 12.89 per cent, mundakan 17.24 per cent and puncha 69.87 per cent. The area under HYV technology during puncha crop is the highest, followed by mundakan and viruppu.

Table 5.9

Detatails of Area under Adoption of HYV of Paddy Between the Command and Non-Command Area

(area in acre)

Varie-ties seed	Command Area					Non Command Area				
	Seasons					Seasons				
	Viruppu	Mundakan	Puncha	Total	%	Viruppu	Mundakan	Pun-cha	To-tal	%
HYV	27.45 (12.89)	36.70 (17.24)	148.75 (69.87)	212.90 (100)	49.18	16.18 (48.68)	17.06 (51.32)	- (0)	33.24 (100)	16.50
Local	54.07 (24.58)	165.92 (75.42)	- (0)	219.99 (100)	50.82	71.51 (42.50)	9676 (51.50)	- (0)	168.27 (100)	83.50
Total	81.52	202.62	148.75	432.89	100	87.69	113.82	-	20151	100

Note: Figures given in brackets indicate the percentage to the total.

Whereas in the non-command area the proportion of area under HYV technology during mundakan is the highest, it accounts for 51.32 per cent followed by viruppu 48.68% and there is no crop during puncha season.

Even after irrigation the percentage of area under HYV technology in the command area is not much. It is only less than 50 per cent. Most of the farmers in the command area are raising paddy crop only for self consumption and not for commercial purpose. They feel that quality of local variety of paddy is better than quality of HYV for consumption. This reduces the interest of the farmers to adopt HYV technology in the command area. Adoption of modern technology of HYV of seed for all crops is also analysed in table 5.10. Table 5.10 shows that area under HYV of seed for all crops in the command area is much higher than in the non-command area. The percentage of area under HYV of seed for all crops in the command area is 44.90 per cent, as against only 17.64 per cent in the non-command area.

Details of Adoption of HYV Technology of Seed for All Crops between Command and Non Command Area.

(area in acre)

Sl. No.	Crops	Command Area HYV	Command Area Local	Command Area Total	Non Command Area HYV	Non Command Area Local	Non Command Area Total
		Varieties					
1.	Paddy	212.90 (49.18%)	219.99 (50.82%)	432.89 (100%)	33.24 (16.50%)	168.27 (83.50%)	201.51 (100%)
2.	Non Paddy						
	a) Coconut	7.49 (82.22%)	1.62 (17.78%)	9.11 (100%)	8.21 (57.74%)	6.01 (42.26%)	14.22 (100%)
	b) Arecanut	-- (0%)	1.84 (100%)	1.84 (100%)	-- (0%)	7.99 (100%)	7.99 (100%)
	c) Banana	-- (0%)	8.49 (100%)	8.49 (100%)	-- (0%)	.77 (100%)	.77 (100%)
	d) Tapioca	-- (0%)	32.21 (100%)	32.21 (100%)	-- (0%)	7.63 (100%)	7.63 (100%)
	e) Vegetable & Others	-- (0%)	6.34 (100%)	6.34 (100%)	-- (0%)	2.82 (100%)	2.82 (100%)
Total Cropped area		220.39	270.49	490.88	41.45	193.49	234.94
	%	44.90	55.10	100	17.64	82.36	100

Of the total area under cultivation, area under HYV technology in coconut cultivation is the highest (82.22%). It is followed by paddy crop (49.18%) in the command area. In the case of non-command area also, adoption of HYV technology for coconut is the highest (57.74%). It is followed by paddy crop (16.50%). But it should be noted that no HYV technology is adopted in cultivation of other crops in both the areas.

Application of Fertilizer Technology

Application of fertilizer technology in paddy crop is analysed in table 5.11. From table 5.11 it can be understood that fertilizer applied per unit of land in the command area is higher, as compared to that of the non-command area. The average cost incurred for fertilizer per unit of land in the command area is Rs.230, as against Rs.152 in the non-command area. It forms 51.32 per cent higher in the command area. It is mainly due to the adoption of HYV technology as a result of irrigation in the command area.

Fertilizer application for all crops between command and non-command areas by variety-wise of seeds has also been analysed.

Table 5.11

Details of Fertilizer Application of the Sample house holds Between Command and Non-Command area by Variety of Seeds Wise (Paddy only)

(value in rupees)

	Common Area					Non Common Area				
	Seasons					Seasons				
Varieties seed	Viruppu	Mundakan	Puncha	Total	%	Viruppu	Mundakan	Puncha	Total	%
HyV	8965	10365	46740	66070	66.29	3493	3971	-	7464	24.39
Local	6975	26620	-	33595	33.71	9407	13724	-	23131	75.61
Total	15940	36985	46740	99665	(100%)	12900	17695	-	30595	
Cropped area in acre	81.52	202.62	148.75	432.89	--	87.69	113.82	-	201.51	
Average per acre	195	183	314	230	--	147	155	-	152	

Note: Figures given in brackets indicate percentage of fertilizer used to grand total of fertilizer used.

Details of Fertilizer Application of the Sample households Between

Command and Non-Command areas by Variety of Seeds Wise

(value in rupees)

		Command Area			Non Command Area		
		Varieties					
Sl. No.	Crops	HYV	Local	Total	HYV	Local	Total
1.	Paddy	66070	33595	99665	7464	23131	30595
2.	Non Paddy						
	a) Coconut	2279	383	2662	794	507	1301
	b) Arecanut	--	--	--	--	--	--
	c) Banana	--	5778	5778	--	416	416
	d) Tapioca	--	10912	10912	--	2258	2258
	e) Vegetable & Others	--	1599	1599	--	750	750
Total		68349	52267	115160	8258	27062	35320
Total cropped area		220.39	270.49	490.88	41.45	193.49	234.94
Average per acre		310	193	235	199	140	150

Table 5.12 shows that the cost incurred for fertilizer application per unit of land for all crops in the command area is higher than in the non-command area. The difference in cost per unit of land accounts for 64 per cent higher in the command area.

Table 5.12 clearly shows that the average cost per unit of land incurred for HYV and local variety in the command area is much higher than that in the non-command area. The additional cost incurred for HYV and local variety in the commad area is 55.58 and 37.86 per cent respectively.

Adoption of Mechanisation

Mechanisation adopted in the command area and non-command area is analysed here to know how far mechanisation introduced in agricultural operation in the command has resulted due to irrigation. This is analysed in table 5.13. From table 5.13 we can understand that area under application of mechanisation in both the areas is very limited. It accounts for only less than 8 per cent of the gross area under cultivation for all crops. Mechanisation in non-paddy crop is totally absent in the command area and non-command area.

Table 5.13

Detailsof Application of Mechanisation Between Command and Non-Command Areas and Variety of Seedwise (Paddy and Non Paddy)

(area in acre)

	Command Area				Non Command Area			
Crops	HYV	Local	Total	% of the total cro-pped area	HYV	Local	Total	% of the total cro-pped area
Paddy	24.06	10.58	34.64	7.06%	2.84	12.87	15.71	6.69%
Non-Paddy	--	--	--	--	--	--	--	--
Total	24.06	10.58	34.64	7.06%	2.84	12.87	15.71	6.69

In the command area, mechanisation used for HYV is greater than local variety, whereas as in the case of non-command area mechanisation used for HYV is less as compared to local variety.

CHAPTER VI

IMPACT OF IRRIGATION ON PRODUCTION

The cropping pattern, intensity of cropping and technological changes of the sample farmers in the command and non-command areas were discussed in chapter V. In this chapter an attempt is made to examine the impact of irrigation on production.

The area under cultivation in the command and non-command areas can be classified into two broad categories, viz.

i) area under paddy crop, and

ii) area under non-paddy crops

The former consists of paddy crop only while the latter includes commercial crops such as coconut, arecanut, tapioca, banana and vegetables. Of these, paddy is the principal crop grown in the command and non-command areas. However, of late, agricultural scene in Kerala has undergone a sea-change. Highly remunerative crops like coconut, arecanut, tapioca, banana and vegetables are being raised in the erstwhile paddy field.

The Economic Review (1979) of Kerala has also made mention of this trend. According to the Review "there was a gradual expansion of area in the non-foodgrain sector. This expansion is mainly at the cost of foodgrain sector".

Here an attempt is made to ascertain the impact of irrigation on production of the main crops in physical units during different seasons in the command and non-command areas on the basis of the "with and without principle"

1. Production of Paddy

(a) Viruppu Season

Table 6.1 indicates the impact of irrigation on paddy production during viruppu season variety-wise.

Table 6.1 shows that the gross cropped area under cultivation of paddy crop during viruppu season was 81.52 and 87.69 acres in the command area and non-command area respectively. Area under cultivation of paddy crop in the non-command area is 7.57 per cent higher than in the command

Table 6.1

Details of Variety-wise Paddy Production in Physical Units During Viruppu Season

	Command Area			Non-Command Area		
Varie-ties	Gross cropped area (in acres)	Quantity produc-tion in Kg.	Mean Aver-age	Gross cropped area (in acres)	Quantity Produc-tion in Kg.	Mean Average
HYV	27.45	21355	778	1618	11186	691
Local	54.07	28915	535	7151	36041	504
Total	81.52	50270	617	8769	47227	539

Source: Survey Data.

The average yield per acre in the command area and non-command area is 617 kg and 539 kg respectively. The yield is 14.47 per cent higher in the command area compared to that of the non-command area. This yield difference is largely due to the impact of irrigation. The data also indicate that the average yield per acre for HYV is higher than the local variety, both in the command and in the non-command areas.

The yield difference for HYV between the command and non-command areas is 87 kg per acre, while in the case of local variety the yield difference per acre is 31 kg. The yield is higher in the command area in both the cases.

(b) Mundakan Season

Table 6.2 shows the impact of irrigation on production of paddy (variety-wise) during mundakan season. Area under mundakan crop is larger than viruppu crop in the command and non-command sectors.

Table 6.2

Details of Variety-wise Paddy Production in Physical Units During Mundakan Season

Varieties	Command Area			Non Command Area		
	Gross cropped area (in acres)	Quantity production in K.g	Mean Average	Gross cropped area (in acres)	Quantity Production in Kg.	Mean Average
HYV	36.70	25400	692	17.06	12129	711
Local	165.92	88285	532	96.76	50124	518
Total	202.62	113685	561	113.82	62253	547

Source: Survey Data.

The average yield per acre during mundakan in the command and non-command areas is 561 kg and 547 kg respectively. The yield difference is only 14 kg per acre. But it is to be noted that the average yield per acre during mundakan season in the command area is lower than the viruppu season. In the case of non-command area the average yield per acre during mundakan is greater than during the viruppu season.

It may further be noted that in the command area, the average yield per acre for both the HYV and local varieties is lower during mundakan season when compared to the viruppu season.

But in the case of non-command area, the average yield for HY and local varieties is higher during mudakan season when compared to that of the viruppu season.

As a result of irrigation, paddy production per unit of land in the command area has increased 2.56 per cent during mundakan season.

(c) Puncha Season

The third crop of paddy is called puncha or summer crop. Puncha crop is raised only in the command area. Due to the availability of irrigation facility that it was possible to raise puncha crop.

Table 6.3

Details of Variety-wise Paddy Production in Physical Units During Puncha Season

Command Area

Varieties	Gross cropped area (in acres)	Quantity production- in Kg.	Mean Average
HYV	148.75	107975	726
Local	--	--	--
Total	148.75	107975	726

Source: Survey Data.

From the table 6.3 we can see that the total cropped area under puncha crop is 148.75 acres. The production amounts to about 107975 kg of paddy. The average yield per acre during puncha is 726 kg. The yield per acre during puncha season is higher than the other two seasons, viz. viruppu and mundakan.

It is interesting to note that farmers in the command area are using only HYV of seeds during the puncha season. It is mainly because canal irrigation is available in the command area only for three months i.e. from the middle of January to the middle of April every year.

(d) By All Seasons

The total paddy production of the sample households in all the seasons in the command and non-command areas are presented in table 6.4.

From table 6.4 it can be seen that only in the command area, paddy is raised in all the three seasons. In the non-command area it is raised only in two seasons. This is because of the nonavailability of irrigation.

Table 6.4

Details of Variety-wise Paddy Production in Physical Units by All Seasons

(Area in acres)

Season	Command Area: Gross Cropped Area	Command Area: Quantity of Prod. HYV	Command Area: Quantity of Prod. Local	Command Area: Quantity of Prod. Total	Command Area: Mean Average per acre	Non - Command Aread: Gross Cropp-ed area	Non - Command Aread: Quantity of Prod. HYV	Non - Command Aread: Quantity of Prod. Local	Non - Command Aread: Quantity of Prod. Total	Non - Command Aread: Mean Average per acre
Viruppu	81.52	21355	28915	50270	617	87.69	11186	36041	47227	539
Mundakan	202.62	25400	88285	113685	561	113.82	12129	50124	62253	547
Puncha	148.75	107975	--	107975	726	--	--	--	--	--
Total	432.89	154730	117200	271930	--	201.51	23315	86165	109480	--
Total Cropped Area	--	212.90	219.99	432.89	--	--	33.24	168.27	201.51	
Production										
Mean Average per Acre		727	533	628			701	512	543	

Source: Survey Data.

The total paddy production in the command and non-command areas amount to 271930 kg and 109480 kg respectively. The average yield per acre in these two areas is 628 kg and 543 kg respectively. The yield difference per acre between these two areas is 85 kg. This shows that the yield per acre is 15.65 per cent higher in the command area than in the non-command area.

It was tested statistically to find out if their is any significant difference in average yield per acre of paddy between the command area and non-command area.

$$H_0 : \bar{x}_1 = \bar{x}_2$$

$$H_1 : \bar{x}_1 \neq \bar{x}_2$$

$$Z_0 = \frac{|628.17 - 543.30|}{\sqrt{\frac{75.80^2}{432.89} + \frac{82.85^2}{201.51}}}$$

$$= \frac{84.87}{\sqrt{13.27 + 34.06}} = \frac{84.87}{6.88} = 12.33$$

$$Z_\alpha = 1.96$$

Since $Z_o > Z_\alpha$, we conclude that there is significant difference in average yield per acre between command area and non-command area.

In the command area, 56.90 per cent of the total paddy production comes from 49.18% of the gross cropped area through the use of HYV of seeds. The remaining 43.10 per cent of the paddy production comes from 51.82 per cent of the gross cropped area through the use of local variety of seeds. This shows that the average yield per acre for the HYV of seeds is higher than the local variety of seeds.

In the non-command area 21.30 per cent of the total production of paddy comes from 16.5 per cent of the gross cropped area through the use of HYV of seeds. The remaining 78.70 per cent of the paddy production is contributed by 83.50 per cent of the gross cropped area through the use of local variety of seeds.

The yield difference in the command and non-command areas in the case of HYV and local variety of seeds is 26 kg and 21 kg per acre respectively. Among the three seasons, the average yield per acre is higher for puncha than the other two, viz. viruppu and mundakan.

This was tested statistically to find out if there is any significant difference in average yield per acre for HYV of paddy in the command area as compared to non-command area.

$$H_o = \bar{x}_1 = \bar{x}_2$$
$$H_1 = \bar{x}_1 \neq \bar{x}_2$$

$$Z_o = \frac{|727 - 701|}{\sqrt{\frac{35.2^2}{212.90} + \frac{45.8^2}{33.24}}}$$

$$\frac{26}{\sqrt{5.82 + 63.10}} = \frac{26}{8.30} = 3.13$$

$Z_o > Z_\alpha$. Hence there is significant difference in average yield per acre for HYV of paddy in the command area as compared to non-command area.

It was also tested to find out if there is any significant difference between command area and non-command area in average yield per acre for local variety of seeds.

$$H_o : \bar{x}_1 = \bar{x}_2$$
$$H_1 : \bar{x}_1 \neq \bar{x}_2$$

$$Z_o = \frac{|533 - 512|}{\sqrt{\frac{259^2}{219.99} + \frac{36.8^2}{168.27}}} = \frac{21}{11.09} = 1.89$$

Hence there is no significant difference in average yield of paddy for local variety in the command area as compared to non-command area.

The overall increase in production in paddy due to irrigation is limited to 15.65 per cent. From this it can be stated that irrigation alone will not create any significant impact on paddy production. The lower impact of irrigation on paddy production in the study area is due to:

i) A major portion of the area under tail end portion in the command area was not cultivated during puncha season due to inadequate supply of irrigation water.

ii) The gross cropped area under paddy has not increased even after the provision of irrigation because of the unprofitable nature of paddy crop.

iii) Adoption of HYV of seeds is confined to 50 per cent of the area in the command area as against 33.24 per cent in the non-command area.

This shows that adoption of HYV of seeds has not increased even after the availability of irrigation facility. This is because of the farmers preference to the local variety for household consumption.

Impact of Irrigation on Paddy Production Reaches-wise

The uncertain water supply at farm level had a greater influence on cropping options of the farmers and the input use. This is true since fertilizer is a water dependent input and hence, greater the availability of dependable water supply, greater will be the input use which will have a direct impact on crop yield.

~~Another fact that is noticed~~ from the survey is ~~that~~ quantity of irrigation water is not uniform in all reaches under the canal irrigation system. It varies from reaches to reaches. In all canal irrigation systems the upper reaches get more water than the lower reaches.

All the unlined canal irrigation system are faced with the problems of water logging at the upper reaches and water shortage at the lower reaches. The Kuttiadi irrigation project is also not an exception to this. Reaches-wise impact of irrigation on paddy production is shown in table 6.5.

As per table 6.5 total production of paddy in all reaches in the command area comes to 271930 kg, as against 109480 kg in the non-command area. The average yield per acre in the command and non-command areas are 628 kg and 543 kg respectively.

Among the three reaches in the command area, the average yield per acre in the middle reaches is the highest (659 kg). It is followed by upper reaches (641 kg) and lower reaches (586 kg). The main reason for this is that the middle reaches are totally free from water logging and water shortage whereas the upper reaches and lower reaches face either water logging or water shortage.

Table 6.5

Details of Variety-wise Paddy Production in Physical Units

by Reaches-wise

Reaches	Command Area					Non - Command Area				
	Gross Cropped Area (in acres)	Quantity of prod.			Mean Average Per acre	Gross Cropped Area (in acres)	Quantity of Prod.			Mean Average Per Acre
		HYV	Local	Total			HYV	Local	Total	
Upper	194.58	83320	41335	124655	640.63	--	--	--	--	--
Middle	104.65	47265	21680	68945	658.81	--				
Lower	133.66	24145	54185	78330	586.04					
Total	432.89	154730	117200	271930	628	201.51	23315	86165	109480	543

Source: Survey Data.

It was tested statistically to find out if there is any significant difference in average yield per acre of paddy crop among the reaches in the command area.

Between Upper Reaches and Middle Reaches

H_0: There is no significant difference in yield per acre between upper and middle reaches

H_1: There is significant difference in yield per acre between upper and middle reaches

$$Z_0 = \frac{|640.63-658.84|}{\sqrt{\frac{15^2}{194.58}+\frac{25.32^2}{104.65}}} = \frac{18.21}{7.28} = 2.50$$

α- level ?

$Z_0 > Z_\alpha$. Hence there is significant difference in average yield per acre between upper and middle reaches.

Between Upper Reaches and Lower Reaches

H_0: There is no significant difference in yield per acre between upper and lower reaches

H_1: There is significant difference in yield per acre between upper and lower reaches

$$Z_o = \frac{|640.63-86.04|}{\sqrt{\frac{15^2}{194.58} + \frac{30^2}{133.66}}} = \frac{54.59}{3.89} = 14.033$$

$Z_o > Z_\alpha$. Hence there is significant difference in average yield per acre between upper and lower reaches.

In spite of these problems it is sure that irrigation has helped to increase paddy yield by 15.65 per cent.

From the analysis it may be stated that to increase total production and average yield per unit of land the following steps should be taken.

i) All unlined canals should be lined.

ii) Proper time should be followed to release and close down the shutter

iii) Shift irrigation system should be followed.

iv) Timely repairs should be done at water outlet points.

Production of Paddy before and after Irrigation

Table 6.6 presents the level of paddy production before and after the provision of irrigation. This analysis is done to find out the real impact of irrigation on production.

The very low profit nature of paddy prompted farmers to crop shifting and reduced the gross cropped area under paddy cultivation after provision of irrigation. However, the quantum of paddy production continued to be higher after the introduction of irrigation. This was made possible by the adoption of HYV of seeds and application of high doses of inputs like fertilizer and manure.

The total quantity of paddy production before and after irrigation is 241345 kg. and 271930 kg. respectively. The net difference in yield is 30585 kg. which accounts 18.75 per cent higher after irrigation.

The average yield per acre for paddy crop before and after irrigation is 529 kg and 628 kg respectively. The yield difference per acre is higher by 18.71 per cent after the introduction of irrigation.

Table 6.6

Details of Production of Paddy in Physical Units Before and After Commissioning the Project

Season	Before Irrigation					After Irrigation				
	Gross Cropped Area (in acres)	Quantity of prod.			Mean Average Per acre	Gross Cropped Area in (acres)	Quantity of Prod.			Mean Average Per Acre
		HYV	Local	Total			HYV	Local	Total	
Viruppu	231.65	--	118970	118970	514	81.20	21355	28915	50270	619
Mundakan	224.15	--	122375	122375	546	201.58	25400	88285	113685	564
Puncha	133.66	--	--	--	--	150.11	107975	--	107975	719
Total	455.80	--	241345	241345	529	432.89	154730	117200	271930	628

Source: Survey Data.

It was tested statistically to find out if there is any significant difference in average yield per acre of paddy before and after commissioning the project.

H_0: There is no significant difference in yield per acre before and after commissioning of the project

H_1: There is significant difference in yield per acre before and after commissioning of the project.

$$Z_0 = \frac{|628-529|}{\sqrt{\frac{75.80^2}{432.89} + \frac{68.35^2}{432.89}}} = \frac{99.00}{4.91} = 20.16$$

$Z_0 > Z_\alpha$. Hence we reject the null hypothesis and accept the alternative one that there is significant difference in average yield per acre of paddy before and after commissioning the project

Average yield per acre for paddy crop after the provision of irrigation, during viruppu and mundakan seasons were higher than the average yield per acre during viruppu and mundakan season before irrigation. The average yield difference per acre after irrigation during viruppu and mundakan seasons was 105 kg and 18 kg respectively. There was no puncha crop in the command area before commissioning of the irrigation project. But after provision of irrigation puncha crop is raised by all the farmers except those who are facing the problems of water logging and water shortage in the command area. All the farmers in the command area are adopting HYV of seeds during puncha season. The average yield per acre for puncha crop is 719 kg which is much higher than the average yield per acre during viruppu and mundakan.

As a whole, compared to the condition before irrigation, the production of paddy crop has increased by 18.71 per cent after the introduction of irrigation. Production per unit of land for paddy crop was increased by 18.71 per cent.

2.Production of Non-paddy Crops

Impact of irrigation on production of non-paddy crops is shown in table 6.7.

The area under cultivation of non-paddy crops in the command and non-command areas are 57.99 and 33.43 acres respectively. It forms around 13 and 14 per cent of the total gross cropped area of the command and non-command areas.

Table 6.7

Details of Production of Non-Paddy Crops in Physical Units

Crop	Command Area			Non-Command Area		
	Area in acres	Qty. of Prod. in Nos/Kg/year	Mean Average Nos/Kg/year	Area in acres	Qty. of Prod. in Nos/Kg/year	Mean Average Nos/Kg/year
Coconut						
HYV7	7.49	26476	3535	8.21	24462	2980
Local	1.62	4202	2594	6.01	12601	2097
Arecanut						
HYV	--	--	--	--	--	--
Loc	1.84	298	162	7.99	1024	128
Banana						
HYV	--	--	--	--	--	--
Local	8.49	24062	2834	.77	1779	2310
Tapioca						
HYV	--	--	--	--	--	--
Local	32.21	68910	2139	7.63	13426	1760
Vegeta-bles & Others						
HYV	--	--	--	--	--	--
Local	6.34	11372	1794	2.82	3158	1120
Total	57.99	--	--	33.43	--	--

Source: Survey Data.

HYV is adopted only in the case of coconut cultivation in the command and non-command areas. It accounts for 82.22 per cent in the command area and 57.74 per cent in the non-command area. Except coconut crop, all other non-paddy crops in the command and non-command areas belong to local variety of seeds only. Area under HYV coconut crop in the command area is more than in the non command area by 24.48 per cent.

The average yield per acre for coconut crop in the command and non-command areas is 3368 nuts and 2606 nuts per year respectively. The net yield difference per acre between these two areas is 762 nuts. As compared to non-command area the average yield per acre has increased by 29.24 per cent in the command area. The yield rate varies with variety of seeds. The yield per acre for HYV of seeds is 3535 nuts in the command area as against 2980 nuts in the non-command area. The yield difference is 555 nuts. It comes to 18.62 per cent. In the case of local variety of seeds, average yield per acre in these two areas is 2594 and 2097 nuts respectively. The difference in yield per acre is 497 nuts which comes to 23.70 per cent. Increase in yield per acre for HYV is less than proportionate to local variety in the command area after the provision of irrigation.

It was tested statistically to find out if there is any significant difference in average yield per acre of coconut between command and non-command areas for HYV and local variety

<u>High Yielding Variety</u>

H_0: There is no significant difference.

H_1: There is significant difference.

$$Z_0 = \frac{|3535-2980|}{\sqrt{\frac{85^2}{7.49} + \frac{72^2}{8.21}}} = \frac{555}{39.95} = 13.89$$

$Z_0 > Z_\alpha$. Hence there is significant difference in average yield per acre for high yielding variety of coconut between the command and non-command areas.

Local Variety

H_0: There is no significant difference.

H_1: There is significant difference.

$$Z_0 = \frac{|2594-2094|}{\sqrt{\frac{50.35^2}{1.62} + \frac{32.38^2}{6.01}}} = \frac{497}{41.71} = 11.91$$

$Z_0 > Z_\alpha$. Hence there is significant difference in average yield per acre for local variety of coconut between the command and non-command areas.

The average yield per acre for other crops like arecanut, banana, tapioca and vegetables and others is 162 kg 2834 kg, 2139 kg and 1794 kg respectively in the command area, as against 128 kg, 2310 kg, 1760 kg and 1120 kg respectively in the non-command area.

The yield difference per acre in the command area and in the non-command area for arecanut, banana, tapioca, vegetables and others is 34 kg, 524 kg, 379 kg and 674 kg respectively. The rate of increase in yield per acre for these crops due to irrigation is 26, 22.68, 21.53 and 60.18 per cent respectively.

Arecanut

H_0: There is no significant difference.

H_1: There is significant difference.

$$Z_0 = \frac{|162-128|}{\sqrt{\frac{25.38^2}{1.84} + \frac{12.35^2}{7.99}}} = \frac{34}{19.21} = 1.77$$

$Z_0 < Z_\alpha$. Hence there is no significant difference in average yield per acre for arecanut between the command and non-command areas.

Tapioca

H_0: There is no significant difference.

H_1: There is significant difference.

$$Z_o = \frac{|2139-1760|}{\sqrt{\frac{10.40^2}{32.21} + \frac{15^2}{7.63}}} = \frac{379}{5.73} = 66.143$$

$Z_o > Z_\alpha$. Hence there is significant difference in average yield per acre for tapioca between the command and non-command areas.

Vegetables and Others

H_0: There is no significant difference.

H_1: There is significant difference.

$$Z_o = \frac{|1794-1120|}{\sqrt{\frac{20^2}{6.34} + \frac{16^2}{2.84}}} = \frac{674}{11.49} = 61.27$$

$Z_o > Z_\alpha$. Hence there is significant difference in average yield per acre for vegetables and others between the command and non-command areas.

On the whole, irrigation has created a positive impact on yield rate of non-paddy crops also. Among the non-paddy crops, the percentage of increase in yield rate per unit of land is the highest for vegetables and others. It is followed by coconut, arecanut, banana and tapioca in that order.

Production of Non-Paddy Crops Reaches-wise

Reaches-wise classification of yield per unit of land for non-paddy crops is analysed here to find out the real impact of irrigation. It is mainly because, the quantity of irrigation varies with reaches to reaches within the command area. Generally the upper reaches in all canal irrigation systems get more quantity of water. It is followed by middle and lower reaches. This study region is also not an exception to this.

Reaches-wise classification of yield per unit of land on non-paddy crops is shown in tables 6.8, 6.9, 6.10.

Table 6.8

Details of Production of Non-Paddy Crops in the Upper Reaches Command Area

Crop	Area in acres	Qty. of Prod. in Nos/Kg/year	Mean Average Nos/Kg/year
Coconut			
HYV7	1.96	7831	3995
Local	0.85	2366	2784
Arecanut			
HYV	--	--	--
Loc	0.27	38	141
Banana			
HYV	--	--	--
Local	2.84	8506	2995
Tapioca			
HYV	--	--	--
Local	3.24	6301	1945
Vegetables & Others			
HYV	--	--	--
Local	1.83	3292	2181

Source: Survey Data.

Table 6.9

Details of production of Non-Paddy Crops in the Middle Reaches Command Area

Crop	Area in acres	Qty. of Prod. in Nos/Kg/year	Mean Average Nos/Kg/year
Coconut			
HYV7	1.28	4119	3218
Local	0.46	1149	2498
Arecanut			
HYV	--	--	--
Loc	0.18	22	122
Banana			
HYV	--	--	--
Local	4.39	12498	2847
Tapioca			
HYV	--	--	--
Local	5.81	11286	1943
Vegetables & Others			
HYV	--	--	--
Local	2.64	4578	1734

Source: Survey Data.

Table 6.10

Details of Production of Non-Paddy Crops in Lower-Reaches

Command Area

Crop	Area in acres	Qty. of Prod. in Nos/Kg/year	Mean Average Nos/Kg/year
Coconut			
HYV7	4.25	14526	3418
Local	0.31	687	1762
Arecanut			
HYV	--	--	--
Loc	1.39	138	99
Banana			
HYV	--	--	--
Local	1.26	3058	2427
Tapioca			
HYV	--	--	--
Local	23.16	52323	2216
Vegetables & Others			
HYV	--	--	--
Local	1.87	2802	1498

Source: Survey Data.

The total area under non-paddy crops in the upper, middle and lower reaches is 10.99, 14.76 and 32.24 acres respectively. The area under lower reaches is the highest followed by middle and upper reaches. The average yield per acre for coconut in the upper reaches is higher (3629 nuts) followed by lower (3336 nuts) and middle reaches (3028 nuts). When compared to middle reaches, the average yield per acre in the lower reaches is higher. It is mainly because, the area under HYV of seeds in the lower reaches is much higher as compared to the middle reaches which increases the average yield of coconut crop per acre in the lower reaches.

Area under cultivation of arecanut crop in the upper, middle and lower reaches is 0.27, 0.18, and 1.39 acres respectively. Its average yield per acre is 141 kg, 122 kg and 99 kg respectively in the upper, middle and lower reaches. Average yield per acre for arecanut in the upper reaches is the highest. It is followed by middle and lower reaches.

The average yield per acre for banana crop in the upper, middle and lower reaches is 2995 kg, 2847 kg and 2427 kg respectively. Like arecanut, banana crop's average yield per acre in the upper reaches is the highest, followed by middle and lower reaches.

The average yield per acre for tapioca is 1945 kg in the upper, 1943 kg in the middle and 2216 kg in the lower reaches. The average yield per acre in the lower reaches is the highest. It is followed by upper and middle reaches.

In the case of vegetables and others, the average yield per acre in the upper reaches is the highest (2181 kg), followed by middle (1734 kg) and lower reaches (1498 kg).

The average yield per acre for non-paddy crops, except coconut and tapioca, is the highest in the upper reaches. It is followed by middle and lower reaches. The average yield per acre for coconut and tapioca crops in the lower reaches is higher as compared to the other two reaches. It is mainly because of the following reasons: (i) The area of coconut under HYV of seeds in the lower reaches is much higher than the other two reaches. (ii) Tapioca crop requires only less quantity of water as compared to other non-paddy crops. So tapioca is raised in the lower reaches, where the problem of lack of irrigation exists.

CHAPTER VII

IMPACT OF IRRIGATION ON EMPLOYMENT

In this chapter the impact of irrigation on employment is examined. Agricultural operation generally increases with the introduction of irrigation facility. Studies show that mandays per acre on irrigated land over unirrigated land for certain crops is higher than increase in output per acre. For all crops combined in Amritsar and Ferojpur, Beldev Singh observed that both output and employment per acre of irrigated land have nearly doubled to that of unirrigated land. To that extent irrigation investment can generate adequate perennial supply of irrigation input. It is likely to be primarily used in its productive rather than protective role and is expected to be markedly improving the cropping intensity of land (Baldev Singh, 1978). Irrigation also plays the role of making possible the increased application of fertilizer, use of better seeds and introduction of improved farming techniques, which finally increase the demand for labour per unit of land. Labour absorption per unit of land in the command and non-command areas based on the sample study is analysed here. In this study the emphasis is more on the number of labour mandays generated per unit of land than the number of days of employment per household.

Here the impact of irrigation on employment with reference to paddy crop and non-paddy crops is analysed separately taking into account gross cropped area and net area.

Impact of Irrigation on Employment-Paddy Crop

Impact of irrigation on employment with reference to paddy crop cultivation is analysed under three headings, namely,

i) employment during viruppu season

ii) employment during mundakan season and

iii) employment during puncha season

1. Employment during viruppu Season

The number of mandays absorbed by paddy crop per unit of land during viruppu season in the command and non-command areas is indicated in table 7.1.

Table 7.1

Details of Sex Wise labour Absorption Per Acre by Paddy Crop During Viruppu Season

Between Command Area and Non Command Area

	Command Area						Non Command Area							
	Labour No. of mandays						Labour No.of mandays							
Variety	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Cropped Area	C.A	Male	Mean Average	Female	Mean Average	Total	Mean Average
HYV	27.45	354	12.9	1357	49.44	1711	62.33	16.18	156	9.64	822	5.8	978	60.44
Local	54.07	466	8.62	2499	46.22	2965	54.83	71.51	582	8.14	3316	46.37	3898	54.51
Total	81.52	820	10.06	3856	47.3	4676	57.36	87.69	738	8.42	4138	47.19	4876	55.6

From table 7.1 one can understand that the number of mandays absorbed by paddy crop per unit of land in the two areas is 57.36 and 55.60 respectively.

Labour absorption per unit of land in the command area is higher than in the non-command area. The difference per acre between these two areas is 1.76 in favour of the command area. It accounts for 3.17 per cent higher per acre (in the command area).

Of the total labour absorption per unit of land in the command area, male and female labour numbered 10.06 (17.54%) and 47.30 (82.46%) respectively. This comes to 8.42 (15.14%) and 47.19 (84.87%) respectively in the non-command area. From table 7.1 we can also note that the absorption of female labour per unit of land both in the command and in the non-command areas is high, as compared to male labour in paddy cultivation.

The percentage of absorption of male and female labour per unit of land in both the areas is more or less the same in the study region.

It is also interesting to note that quantity of labour absorption per unit of land for paddy cultivation varies with the nature of seeds adopted.

Adoption of HYV seeds absorbed more labour than local seeds. But the ratio of the male to female labour absorption varies slightly.

Adoption of HYV of seeds caused to absorb additional male mandays mainly for the purpose of applying fertilizer and spraying of pesticides. According to the sample survey, average mandays per unit of land for HYV and local varieties of seeds is 62.33 and 54.83 respectively. As compared to local variety seeds, the HYV seeds absorbed 7.5 mandays more per unit of land in the command area. But in the non-command area the average mandays per acre for HYV and local varieties of seeds were 60.44 and 54.51 respectively. The additional labour absorption by HYV seeds in the command area is 5.93 per acre.

The labour absorption difference per unit of land between HYV and local variety of seeds in the command area is higher (7.5) than that of non-command area (5.93).

The number of male and female mandays absorption per unit of land under HYV seeds in the command area is 12.9 (20.69%) and 49.44 (79.32%) respectively, whereas in the non-command area it is 9.64 (15.95%) and 50.80 (84.05%) respectively.

Lack of irrigation in the non-command area caused more growth of weeds which require more quantity of female labour for weeding. This increases the female labour absorption per unit of land in the non-command area as compared to female labour absorption in the command area.

Employment during Mundakan Season

Demand for labour mandays during mundakan season is presented in table 7.2. It can be seen from table 7.2 that average mandays absorption per unit of land in the command area is less than that in the non-command area.

Table 7.2

Details of Sex Wise Labour Absorption Per Acre by Paddy Crop During Mundakan Season

Between Command and Non-Command Areas

	Command Area							Non Command Area						
		Labour No. of mandays							Labour No.of mandays					
Variety	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Mean Average	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Mean Average
HYV	36.7	419	11.42	1603	43.68	2022	55.1	17.06	159	9.32	853	50	1012	59.32
Local	165.92	1258	7.58	7595	45.78	8853	53.36	96.76	779	8.05	4487	46.37	5266	54.42
Total	202.62	1677	8.21	9198	45.4	10875	53.67	113.82	938	8.24	5340	46.92	6278	55.16

The average mandays absorbed per unit of land in the command and non-command areas was 53.67 and 55.16 respectively. The latter is higher than the former. This is mainly because of the fact that the second crop called mundakan crop in the non-command area is always facing the problem of lack of irrigation at the final stage of the crop production. At that time, labour is required for wetting the land many times, which causes to increase the number of labour mandays per unit of land in the non-command area as compared to the command area.

The number of male mandays required per unit of land during mundakan is 8.28 in the command area as against 8.24 in the non-command area. It is more or less the same both in the command and in the non-command areas.

Female mandays required per unit of land in the command area and non-command area is also more or less the same which is 45.4 and 46.92 respectively. The latter is 1.52 higher than the former.

The difference in mandays used per unit of land for HYV and local variety of seeds in the command area is not much compared to non-command area. This is mainly because of the fact that after the introduction of irrigation, number of labour required for wetting of cropping land and weeding during mandakan in the command area is lower as compared to the non-command area.

As a whole, the number of mandays required for mundakan crop in the command area is 53.67 per unit of land as against 55.16 in the non-command area.

Employment during Puncha

Table 7.3 shows the demand for labour during puncha season. From table 7.3 it can be seen that puncha crop was raised only in the command area due to provision of canal irrigation.

Table 7.3

Details of Sex Wise labour Absorption Per Acre by Paddy Crop

During Puncha Between Command and Non-Command Areas

Command Area

Variety	Cropped Area	Labour No. of mandays					
		Male	Mean Average	Female	Mean Average	Total	Mean Average
HYV	148.75	1921	12.91	6880	46.25	8801	59.16
Local	-	-	-	-	-	-	-
Total	148.75	1921	12.91	6880	46.25	88.01	59.16

Nobody in the non-command area raised paddy crop during puncha season due to nonavailability of canal irrigation.

Since canal water is available only for three months for puncha crop, all the farmers are forced to adopt short term HYV seeds in the command area.

The average mandays per unit of land required during puncha crop was 59.16. Of this, 12.91 was male and 46.25 females. The average mandays per unit of land required for the puncha crop is higher than the other two seasons.

Employment to All Seasons (paddy crop)

The overall labour absorption by paddy crop per unit of land to gross cropped area is shown in table 7.4.

Table 7.4 shows that average mandays absorption per unit of land in the command and non-command areas are 56.26 and 54.96 respectively. Of these, the percentage of male and female labour absorption is 18.15 and 81.85 respectively in the command area, whereas in the non-command area they are 15.13 per cent and 84.87 per cent respectively.

Table 7.4

Details of Labour Absorption by Paddy Crop to All Seasons

	Command Area							Non Command Area						
		Labour No. of mandays							Labour No.of mandays					
Variety	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Mean Average	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Mean Average
HYV	212.9	2694	12659	840	46.22	12534	58.87	33.24	315	9.48	1601	48.16	1916	57.64
Local	219.99	1724	7.84	10094	45.88	11818	53.72	168.27	1361	8.09	863	46.73	9164	54.46
Total	432.89	4418	10.21	19934	46.05	24352	56.26	201.51	1676	8.32	9404	46.67	11080	54.98

It was tested statistically to find out whether there is any significant increase in labour absorption per unit of land in paddy crop cultivation in the command area as compared to the non-command area.

H_0 : There is no significant difference.

H_1 : There is significant difference.

$$Z_0 = \frac{|56.26 - 54.96|}{\sqrt{\frac{8.36^2}{432.89} + \frac{10.35^2}{201.51}}}$$

$$= \frac{1.3}{\sqrt{0.16 + 0.53}} = \frac{1.3}{.83} = 1.56$$

$$Z_0 < Z_\alpha$$

This shows that there is no significant increase in labour absorption per unit of land in paddy cultivation in the command area as compared to non-command area.

The male and female labour absorption ratios in the command and non-command areas are 1:4.51 and 1:5.61 respectively. As a result of irrigation, the number of mandays per unit of land increased from 54.98 to 56.26. The additional labour absorption per unit of land is 1.28, which forms 2.33 per cent higher in the command area.

Impact of Irrigation on Employment- Non-Paddy crops

The extent of sex-wise labour absorption per unit of land to gross cropped area for various non-paddy crops in the command and non-command areas is presented in table 7.5.

As per table 7.5, 57.99 acres of land under non-paddy crops in the command area absorbed 1893 mandays in which male mandays were 1394 and female mandays 499. It forms 73.64 per cent and 26.36 per cent respectively.

In the case of non-command area, 33.43 acres of land absorbed 884 labour mandays in which males and females were 697 and 187 respectively. It forms 78.85 per cent and 21.15 per cent respectively.

Table 7.5

Impact of Irrigation of Employed Non-Paddy Only Sex Wise

Crop	Command Area						Non Command Area			
	Cropped Area	Labour Mandays			Mean Average per acre	Cropped area	Labour Mandays			Mean ~~average~~ per acre
		Male	Female	Total			Male	Female	Total	
Coconut										
(HYV)	7.49	282 (82.46%)	60 (17.54%)	342 (100%)	46	8.21	261 (85.29%)	45 (14.71%)	306 (100%)	37
(local)	1.69	47 (78.33%)	13 (21.67%)	60 (100)	37	6.01	153 (81.82%)	34 (18.18%)	187 (100%)	31
Arecanut										
(HYV)	--	--	--	--	--	--	--	--	--	--
(Local)	1.84	21 (100%)	--	21 (100%)	11.41	7.99	83 (100%)	--	83 (100%)	10
Banana										
(HYV)	--	--	--	--	--	--	--	--	--	--
(Local)	8.49	575 (100%)	--	575 (100%)	67.73	0.77	51 (100%)	--	51 (100%)	66
Tapioca										
(HYV)	--	--	--	--	--	--	--	--	--	--
(Local)	32.21	442 (56.52%)	340 (43.48%)	782 (100%)	24.28	7.63	114 (57.58%)	84 (42.42%)	198 (100%)	26
Veget.&Oth.										
(HYV)	--	--	--	--	--	--	--	--	--	--
(Local)	6.34	27 (23.89%)	86 (76.11%)	113 (100%)	17.82	2.82	35 (59.32%)	24 (40.68%)	59 (100%)	21
Total	57.99	1394	499	1893	32.64	33.43	697	187	884	26.44

When compared to other crops, banana crop absorbed the maximum extent of labour per unit of land i.e. 67.73. It is followed by coconut 46.0 for HYV seeds and 37 for local variety seeds, tapioca 24.28, vegetable and others 17.82 and arecanut 11.41 in the command area. In the non-command area also, labour absorption for banana was the highest i.e. 66 per unit of land. It is followed by coconut 37 for HYV seeds and 31 for local variety seeds, tapioca 26, vegetable and other 21 and arecanut 10.

It was tested statistically by using the test of average whether there is any significant increase in labour absorption per unit of land for all individual non paddy crops in the command area as compared to the non-command area.

For coconut

H_o : There is no significant difference.

H_1 : There is significant difference.

$$Z_o = \frac{\left| \frac{402}{9.11} - \frac{493}{14.22} \right|}{\sqrt{\frac{5.85^2}{9.11} + \frac{6.05^2}{14.22}}}$$

$$= \frac{| 44.12 - 34.67 |}{\sqrt{6.25}} = \frac{9.45}{2.5} = 3.78$$

$Z_0 > Z_\alpha$

It shows that there is significant difference in labour absorption.

<u>For Arecanut</u>

H_0 : There is no significant difference.

H_1 : There is significant difference.

$$Z_0 = \frac{|11.41 - 10|}{\sqrt{\frac{3.5^2}{1.8} + \frac{2.3^2}{7.9}}}$$

$$= \frac{1.41}{3.7} = 0.38$$

$Z_0 < Z_\alpha$

From this we can understand that there is no significant difference in labour absorption.

<u>For Banana</u>

H_0 : There is no significant difference.

H_1 : There is significant difference.

$$Z_o = \frac{|67.73 - 66|}{\sqrt{\frac{6.25^2}{8.49} + \frac{6.65^2}{.77}}}$$

$$= \frac{1.73}{6.78} = 0.25$$

$Z_o < Z_\alpha$

0.25 < 1.96. Hence there is no significant difference in labour absorption.

<u>For Tapioca</u>

H_o : There is no significant difference.

H_1 : There is significant difference.

$$Z_o = \frac{|24.28 - 26|}{\sqrt{\frac{3.56^2}{32.21} + \frac{4.32^2}{7.63}}}$$

$$= \frac{1.72}{1.68} = 1.02$$

$Z_o < Z_\alpha$

Hence there is no significant difference in labour absorption.

For Vegetables and Others

H_0 : There is no significant difference.

H_1 : There is significant difference.

$$Z_0 = \frac{|17.82 - 21|}{\sqrt{\frac{5.32^2}{6.34} + \frac{3.56^2}{2.82}}}$$

$$= \frac{3.18}{2.99} = 1.063$$

$Z_0 < Z_\alpha$

Hence there is no significant difference in labour absorption.

Labour absorption per unit of land for non-paddy crops in the command area was 32.64 as against 26.44 in the non-command area. The former was 23.45 per cent higher than the latter.

For all Non-Paddy Crops

H_0 : There is no significant difference.

H_1 : There is significant difference.

$$Z_o = \frac{|97.37 - 38.47|}{\sqrt{\frac{6.32^2}{19.44} + \frac{5.56^2}{22.98}}}$$

$$= \frac{58.9}{\sqrt{2.05 + 1.34}} = 32.01$$

$$Z_o > Z_\alpha$$

Hence there is significant difference in labour absorption for non-paddy crops as a whole.

As compared to non-paddy crops labour absorption per unit of land for paddy crop is 72.37 per cent more in the command area. Male labour absorption per unit of land for non-paddy crops is much higher than female labour absorption. It is true both in the case of command area and in the non-command area. Male and female ratios per unit of land for non-paddy crops in the command area and non-command area are 2.79:1 and 3.73:1 respectively.

As a result of irrigation, the agricultural activity in the command area has increased through application of more quantity of fertilizer and manure for non-paddy crops like coconut, banana etc. Finally it increased the demand for labour in the command area as compared to the non-command area. As a whole, irrigation has absorbed additional labour for non-paddy crops per unit of land by 23.45 per cent. This is mainly because the area under highly labour-oriented banana crop in the command area is 11 times more than the non-command area, which increases the percentage of average labour mandays per unit of land for non-paddy crops in the command area as compared to the non-command area.

Impact of Irrigation on Employment for All Crops (Paddy & Non-Paddy)

Details of labour absorption by all crops to gross cropped area is analysed in table 7.6.

As per table 7.6 labour absorption per unit of land for all crops in the command and non-command areas are 53.47 and 50.92 respectively. Of this, male and female mandays absorption in the command area forms 22.14 and 77.86 per cent respectively, as against 19.84 per cent and 80.16 per cent in the non-command area.

Table 7.6

Details of Sex Wise Labour Obsorption by all Crops to Gross Cropped Area

	Command Area							Non Command Area						
crop	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Mean Average	Cropped Area	Male	Mean Average	Female	Mean Average	Total	Mean Average
Paddy	432.89	4418	10.21	19934	46.05	24352	56.25	201.51	1676	8.32	9404	46.67	11080	54.98
Non Paddy														
Coconut	9.11	329	36.11	73	8.01	402	44.13	14.22	414	29.11	79	5.56	493	34.67
Areanut	1.84	21	11.41	-	-	21	11.41	7.99	83	10.39	-	-	83	10.39
Banana	8.49	575	67.73	-	-	575	67.73	0.77	51	66.23	-	-	51	66.23
Tapioca	32.21	442	13.72	340	10.56	782	24.28	7.63	114	14.94	84	11.01	198	25.95
Vegetable & Others	6.34	27	4.26	86	13.56	113	17.82	2.82	35	12.41	24	8.51	59	20.92
Total	490.88	5812	11.84	20433	41.63	26245	53.47	234.94	2373	10.01	9591	40.82	11964	50.92

Among all the crops in command area labour manday absorption per unit of land for banana is higher (67.73) compared to paddy (56.25), coconut (44.13), tapioca (24.28), vegetable and others (17.82) and arecanut (11.41).

In the non-command area also, the banana crop absorbed higher (66.23) mandays compared to paddy (54.98), coconut (34.67), tapioca (25.95), vegetables and others (20.98) and arecanut (10.39).

Crops like coconut, arecanut and banana absorb more labour per unit of land in the command area as compared to the non-command area. But tapioca and vegetables and others absorb less labourers per unit of land as compared to the non-command area. It is mainly due to the fact that the number of wetting for these two crops in the non-command area is greater than in the command area, which increases average number of mandays per unit of land.

Additional labour absorption per unit of land for paddy, coconut, arecanut and banana are 1.27, 9.46, 1.02 and 1.5 respectively. The net difference in mandays absorption per unit of land for coconut is higher than banana, paddy and arecanut.

On the whole, provision of irrigation absorbed 2.55 additional labour mandays per unit of land for all crops. This accounts for an increase of 5 per cent only.

Impact of Irrigation on Employment for All Crops to Net Area

An analysis of the impact of irrigation on employment by net area sown is more important than by gross cropped area. Table 7.7 indicates labour manday's absorption per unit of land for all crops between command and non-command areas.

From table 7.7, we note that the labour absorption per unit of land by all crops in the command and non-command areas are 93.13 and 83.63 respectively. The net difference in labour absorption per unit of land between these two areas is 9.5. Thus canal irrigation helped to absorb additional labour mandays by 11.36 per cent in all crops.

Table 7.7

Details Labour Absorption by All Crops to Net Area Sown (Sex wise)

Crop	Command Area					Non- Command Area				
	Net area	Labour mandays			M.A Per acre	Net Area	Labour mandays			M.A per acre
		Male	Female	Total			Male	Female	Total	
Paddy	262.36	4418	19934	24352	92.82	120.08	1676	9404	11080	92.27
Non-Paddy	19.44	1394	499	1893	97.37	22.98	697	187	884	38.47
Total	281.80	5812	20433	26245	93.13	143.06	2373	9591	11964	83.63

Table 7.7 also shows that labour absorption per unit of land for paddy crop is 92.82 in the command area, as against 92.27 in the non-command area. Labour absorption per unit of land for paddy crop in the command and non-command areas is more or less equal i.e. 92.82 in the command area and 92.27 in the non-command area. The net difference is only 0.55 higher on command area. It accounts only for less than one per cent i.e. around 0.6 per cent per unit of land.

In the case of non-paddy crops, the labour absorption per unit of land in the command area (97.37) is higher than in the non-command area (38.47). The net difference per unit of land between these two areas is 58.9, which forms 253.11 per cent. Thus, irrigation helped to absorb additional labour per unit of land for non-paddy crops by 153 per cent. From this one can understand that the effect of irrigation on employment for non-paddy crops is greater than the paddy crop.

The impact of irrigation on employment sex-wise shows that in the command area, of the total labour absorption per unit of land for all crops, male and female labour absorption account for 22.15 per cent and 77.85 per cent respectively. It is 18.14 per cent and 81.86 per cent respectively to male and female for paddy crop, as against 73.64 per cent and 26.36 per cent to male and female respectively for non-paddy crops. In the non-command area the percentage of male and female labour absorption per unit of land for all crops is 19.83 and 80.17 respectively. The percentage of male and female labour absorption per unit of land for paddy crop is 15.13 and 84.87 respectively, as against non-paddy crops 78.85 per cent and 21.15 per cent respectively to male and female labour absorption.

Proportion of males to total labour force for paddy crop was statistically tested.

H_0 : There is no significant difference in the proportion of males before and after irrigation.

H_1 : There is significant difference.

$$Z_0 = \frac{|.15 - .18|}{\sqrt{\frac{6088}{35432}\left(\frac{1}{24352} + \frac{1}{11080}\right)}}$$

$$= \frac{.03}{.0047} = 6.38$$

$$Z_0 > Z_\alpha$$

Hence there is significant difference in the proportion of males in paddy cultivation.

Proportion of Males to Total Labour Force for Non-Paddy Crops

$$Z_o = \frac{\left| \frac{697}{884} - \frac{1394}{1893} \right|}{\sqrt{\frac{2091}{2777} \left(\frac{1}{1893} + \frac{1}{884} \right)}}$$

$= 1.7364$

$Z_o < Z_\alpha$

Hence there is no significant difference in the proportion of males in non-paddy crops cultivation.

After the introduction of irrigation, paddy crop per unit of land absorbed additional 2.88 male mandays of labour by reducing female labour by 2.33. But in the case of non-paddy crops it absorbed additional labour per unit of land for male and female to 41.38 and 17.53 respectively. Even though irrigation has positive impact on employment on both paddy crop and non-paddy crops, impact on the former is insignificant. On the whole, irrigation created only very limited impact on employment in the study region since major portion of the study area is under paddy cultivation.

CHAPTER VIII

ANALYSIS OF COST OF INPUTS AND YIELD STRUCTURE

In the previous chapter the impact of irrigation on mployment has been examined. In this chapter an attempt is ade to examine the differences in the input use as reflected n the cost and also yields, in the command area and in the on-command area. For convenience sake this chapter is ivided into three sections. Section I presents a brief iscussion on input use and cost structure in the command and on-command areas. In section II yield revenue structure is iscussed and the section III discusses net income, rate of hange in yield and output-input ratio.

ECTION I

nput Use and Cost Structure

The provision of irrigation invariably induces rmers to use more inputs on their land. The input use is rther strengthened by the adoption of HYV technology under e assured canal irrigated farms. Finally it increases the st per unit of land.

The absence of quality of land under modern agricultural practices may lead to improper utilisation of modern inputs like chemical fertilizers and pesticides. Sometimes inadequate water supply leads to underutilisation of these inputs. In such cases input may not lead to any increase in yield. Sometimes the already applied inputs may be washed due to excess irrigation. So also irrigation will lead to higher returns only if it is timely and adequate.

In the following paragraphs an attempt is made to compare the differences in the cost of inputs in the command and non-command areas. Here we compare input use in monetary terms.

Cost of Inputs of All Crops

Table 8.1 gives information regarding the cost difference per unit of land among the crops in the command and non-command areas.

Details of Cost Structure of Various Crops in the

Command and Non-Command Areas

(Cost in Rupees)

Sl. No.	Crop	Cropped area	Total Cost	Cost Mean Average per acre	Cropped area	Total cost	Cost Mean Average per acre
1.	Paddy	432.89	1733689	4005	201.51	735851	3652
2.	Coconut	9.11	28631	3143	14.22	39304	2764
3.	Arecanut	1.84	1301	707	7.99	5337	668
4.	Banana	8.49	42890	5052	0.77	3550	4610
5.	Tapioca	32.21	53130	1649	7.63	13916	1824
6.	Vegetables & Others	6.34	9414	1469	2.82	4523	1604
	Total	490.88	1868955	3907	234.94	802481	3416

From table 8.1 it can be seen that, average cost per unit of land in the command area is higher than the non-command area. The average cost difference per unit of land for all crops in the command and non-command areas is Rs.391, which is 11.45 per cent higher in the command area, compared to the non-command area. The average cost per unit of land for HYV is greater than the local variety. It is true both for the command and non-command areas.

The cost difference between HYV and local variety for all crops in the command and non-command areas is Rs.861 and Rs.386 which form 25.17 per cent and 11.53 per cent respectively.

The cost difference per unit of land due to irrigation for individual crops like paddy, coconut, arecanut, banana, tapioca and vegetables are Rs.355, Rs.378, Rs.39, Rs.442, Rs.175 and Rs.135 respectively.

Except tapioca and vegetables average cost per unit of land for other crops is higher in the command area, compared to the non-command area. Of these the average cost per unit of land for banana is the highest followed by coconut, paddy, vegetables and others and arecanut.

Cost Structure of Individual Crops

Paddy Crops

Table 8.2 gives information relating to cost of cultivation of paddy crop and its distribution among different inputs in the command and non-command areas. A perusal of table 8.2 reveals that there are some differences in cost on various inputs between these two categories of areas.

The average cost on material inputs like seed, fertilizer, pesticides, human labour, animal labour and irrigation is high in the command area than in the non-command area.

Table 8.2

Details of Cost of Cultivation and Its Distribution Among Various Inputs in the Command and Non-Command Area

(Paddy by all Seasons)

		Command Area											Non-Command Area			
Sl. No.	Input item	HYV	%	Local	%	Total Cost	%	Mean average/acre	HYV	%	Local	%	Total Cost	%	Mean average/acre
1	Seed	89829	9.77	94299	11.58	184128	10.62	425.35	13008	9.88	69917	11.57	82925	11.27	411.52
2	Soil condition	21456	2.33	18750	2.30	40206	2.32	92.88	4322	3.28	17203	2.85	21525	2.93	106.82
3	Fertilizer	66070	7.19	33595	4.13	99665	5.75	230.23	7464	5.67	23131	3.83	30595	4.16	151.83
4	Manure	103515	11.26	106735	13.11	210250	12.13	485.69	17216	13.07	91598	15.16	108814	14.79	539.99
5	Pesticides	25090	2.73	-	-	25090	1.45	57.96	3671	2.79	-	-	3671	0.50	18.22
6	Male	128457	13.97	80620	9.90	209057	12.06	482.93	13434	10.20	60717	10.05	74151	10.08	367.98
7	Female	314228	34.18	315845	38.79	630073	36.34	1455.50	47744	36.25	222393	36.81	270137	36.71	1340.56
8	Animal Labour	141335	15.37	146230	17.96	287585	16.59	664.34	21651	16.44	105549	17.47	127200	17.29	631.23
															83.53
9	Machine Labour	21840	2.38	10560	1.30	32400	1.87	74.85	3193	2.42	13640	2.26	16833	2.29	83.53
10	Water Tax	7566	0.82	7669	0.94	15235	0.88	35.19	-	-	-	-	-	-	-
Total		919386	100	814303	100	1733689	100	4005	131703	100	604148	100	735851	100	3652

In both the areas, labour accounts for the highest cost. It accounts for 48.40 per cent and 46.79 per cent respectively in the command and non-command areas. This is followed by animal labour, manure, seeds, fertilizer, machine and water tax.

Input cost on fertilizers, human labour, pesticides and water tax is higher in the command area as compared to the non-command area. Cost on seeds, manure, soil conditions, etc. is higher in the non-command area as compared to command area. On the whole, the difference in the total cost in the two areas is Rs.353, which accounts for 9.67 per cent higher in the command area.

(i) Paddy- Viruppu Season

Cost of cultivation of paddy crop during viruppu is analysed in Table 8.3. In the case of viruppu crop, the total cost difference on various inputs is about Rs.327, which shows that the cost is 8.9 per cent higher in the command area than in the non-command area. Among the difference, inputs cost is high in the case of human labour, animal labour, fertilizer and seed. This is followed by manure, soil conditioner, machinery pesticides and water tax.

Details of Cost of Cultivation and its Distribution Among Various Inputs in the Command and Non-Command Areas

(Paddy Crop during Viruppu)

Command Area

(Cost in Rupees)

M.A per

Sl. No.	Input Items	HYV	%	Local	%	Total Cost	%	Acre
1.	Seed	11912	9.46	23805	11.87	35717	10.94	438.14
2.	Soil conditioner	3297	2.62	5805	2.90	9102	2.79	111.65
3.	Manure	8965	7.12	6975	3.48	15940	4.88	195.53
4.	Fertilizer	17350	13.78	28445	14.19	45795	14.03	561.76
5.	Pesticides	3700	2.94	--	--	3700	1.13	45.39
6.	Male	16479	13.09	21165	10.56	37644	11.53	461.78
7.	Female	41158	32.70	75450	37.63	116608	35.73	1430.42
8.	Animal labour	22040	17.51	29990	14.96	52030	15.94	638.25
9.	Machine Labour	--	--	6960	3.47	6960	2.13	85.38
10.	Water Tax	961	0.76	1903	0.95	2864	0.88	35.13
	Total	125862	100	200498	100	326360	100	4003

(Cost in Rupees)

Sl. No.	Input Items	HYV	%	Local	%	Total cost	%	M.A per Acre
1.	Seed	6483	10.09	30623	11.86	37106	11.51	423.15
2.	Soil conditioner	1962	3.05	7635	2.96	9597	2.98	109.44
3.	Manure	3493	5.44	9407	3.64	12900	4.00	147.11
4.	Fertilizer	8362	13.02	39322	15.23	47684	14.79	543.78
5.	Pesticides	1917	2.98	--	--	1917	0.59	21.86
6.	Male	6484	10.10	26006	10.08	32490	10.08	370.51
7.	Female	23440	36.49	94513	36.62	117953	36.59	1345.11
8.	Animal labour	10534	16.40	44403	17.20	54937	17.04	626.49
9.	Machine Labour	1554	2.42	6202	2.40	7756	2.41	88.45
10.	Water Tax	--	--	--	--	--	--	--
	Total	64229	100	258111	100	322340	100	3676

Source ?

In the case of non-command area the cost pattern i.e. the proportion of sharing of the total cost is the same as in the command area except for fertilizer and manure. Average cost per unit of land for fertilizer accounts for 14.03 per cent of the total in the command area as against 4.0 per cent in the non-command area. In the case of manure input forms 4.88 per cent in the command area as against 14.79 per cent in the non-command area.

While considering the cost in absolute terms on individual inputs we notice certain differences. The cost is seen high in the case of all inputs except manure, in the command area.

The cost difference between HYV local variety in the command area and non-command area is 23.65 per cent and 10 per cent respectively. The cost is higher in the command area.

ii) Paddy - Mundakan Season

Under Mundakan season the total cost difference per unit of land comes to about Rs.126. This means that cost is higher by 3.47 per cent in the command area (Table 8.4).

Inputs in the Command area and Non-Command Area

(Paddy Crop During Mundakan)

Command Area

(Cost in Rupees)

Sl. No.	Input Items	HYV	%	Local	%	Total cost	%	M.A per Acre
1.	Seed	14661	9.92	70494	11.48	85155	11.18	420.25
2.	Soil conditioner	4397	2.98	12945	2.11	17342	2.28	85.58
3.	Manure	10365	7.01	26620	4.34	36985	4.86	182.53
4.	Fertilizer	16455	11.14	78290	12.75	94755	12.44	467.64
5.	Pesticides	4230	2.66	--	--	4230	0.55	20.87
6.	Male	19714	13.34	59455	9.69	79169	10.40	390.72
7.	Female	49800	33.70	240395	39.16	290195	38.10	1432.21
8.	Animal labour	21830	14.77	116240	18.94	138070	18.13	681.42
9.	Machine Labour	5040	3.41	3600	0.59	6640	1.13	42.64
10.	Water Tax	1291	0.87	5766	0.94	7057	0.93	34.82
	Total	147793	100	613805	100	761598	100	3759

(Cost in Rupees)

Sl. No.	Input Items	HYV	%	Local	%	Total cost	%	M.A per Acre
1.	Seed	6525	9.67	39294	11.36	45819	11.08	402.56
2.	Soil conditioner	2360	3.50	9568	2.77	11928	2.88	104.80
3.	Manure	3971	5.89	13724	3.97	17695	4.28	155.46
4.	Fertilizer	8854	13.12	52276	15.11	61130	14.78	537.08
5.	Pesticides	1754	2.60	--	--	1754	0.42	15.41
6.	Male	6950	10.30	34711	10.03	41661	10.07	366.03
7.	Female	24304	36.02	127880	36.96	152184	36.80	1337.06
8.	Animal labour	11117	16.48	61146	17.67	72263	17.48	634.89
9.	Machine Labour	1639	2.43	7438	2.15	9077	2.20	79.75
10.	Water Tax	--	--	--	--	--.	--	--
	Total	67474	100	346037	100	413511	100	3633

When we consider the distribution of cost on individual inputs, the cost on human labour is found to be the highest. This is followed by animal labour, manure, fertilizer, soil conditioner, machine labour, irrigation (water tax) and pesticide in that order.

(iii) <u>Paddy- Puncha Season</u>

Table 8.5 indicates cost of cultivation of puncha crop per unit to land in the command and non-command areas. During puncha season only HYV is cultivated in the command area. Nobody in the command area cultivates local varieties. It is mainly because the canal irrigation water is available only for three months. It forces the farmers in the command area to adopt HYV short term duration crops.

In the case of paddy crop during puncha season the cost of human labour is found to be the highest. This is followed by animal labour, manure and seed. Human labour accounts for 49 per cent of the total cost.

In the non-command area there is no cultivation of paddy during puncha season due to nonavailability of irrigation water.

Table 8.5

Cost of Cultivation of Paddy per Acre during Puncha Season
(Command Area)

(Cost in Rupees)

Sl. No.	Input Items	HYV	%	Local	%	Total cost	%	M.A per Acre
1.	Seed	63256	9.80	--	--	63256	9.80	425.25
2.	Soil conditioner	13762	2.13	--	--	13762	2.13	92.52
3.	Manure	46740	7.24	--	--	46740	7.24	314.22
4.	Fertilizer	69700	10.79	--	--	69700	10.79	468.57
5.	Pesticides	17160	2.66	--	--	17160	2.66	115.36
6.	Male	92264	14.29	--	--	92264	14.29	620.26
7.	Female	223270	34.58	--	--	223270	34.58	1500.97
8.	Animal labour	97465	15.09	--	--	97465	15.09	655.23
9.	Machine Labour	16800	2.60	--	--	16800	2.60	112.94
10.	Water Tax	5314	0.82	--	--	5314.	0.84	35.72
[illegible]		[illegible]	[illegible]			[illegible]	[illegible]	[illegible]

Cost of Cultivation of Paddy Crop Reaches-wise

The cost of cultivation of paddy crop reaches-wise is analysed in table 8.6. There is no reaches-wise classification made for paddy crop in the non-command area, as no paddy is cultivated during puncha in this area.

The cost of cultivation of paddy crop per unit of land in the upper, middle and lower reaches is Rs.4009, Rs.4138 and Rs.3894 respectively. Among these three reaches, cost per unit of land for middle reaches is the highest. It is followed by upper reaches and lower reaches. The cost incurred for HYV is higher than local variety in all the three reaches.

As compared to lower reaches, the percentages of cost incurred for the other two reaches, namely upper and middle reaches, are higher by 2.95 per cent and 6.27 per cent respectively.

Table 8.6

Details of Cost of Cultivation and its Distribution Among Various Inputs

in the Command Area and Non-Command Area (Paddy Crop only)

Command Area

Input Items	Upper reaches				Middle reaches				Lower reaches					
	HYV	Local	Total	M.A	HYV	Local	Total	M.A	HYV	Local	Total	M.A	Grand Total	M.A
1. Seed	49724	33648	83372	426	26533	16959	43492	416	13646	43618	57264	428	184128	425.34 (10.62%)
2. Soil Condi-tioner	11365	6200	17565	90	6970	4735	11705	112	3121	7815	10936	82	40206	92.87 (2.32%)
3. Fertilizer	36015	11225	47240	243	20095	7120	27215	260	9960	15250	25210	189	99665	230.23 (5.75%)
4. Manure	55065	43125	98190	504	34410	8130	42540	406	14040	55480	69520	520	210250	485 (12.13%)
5. Pesticides	12788	-	12788	66	8782	-	8782	84	3520	-	3520	26	25090	57.95 (1.45%)
6. Male	64092	26085	90177	463	45757	17550	63307	605	18588	36985	55573	416	209057	482.93 (12.06%)
7. Female	168543	111205	279748	1438	93730	58625	152355	1455	51955	146015	197970	1481	630073	1455.5 (36.34%)
8. Animal labour	74635	54155	128790	662	46450	31695	78145	746	20270	60380	80650	603	287585	664.33 (16.58%)
9. Machine labour	15360	-	15360	79	1920	-	1920	18	4560	10560	15120	113	32400	74.84 (1.87%)
10. Water tax	4148	2778	6926	36	2212	1401	3613	35	1132	3564	4696	35	15235	35.19 (0.88%)
Total	491735	288421	780156		286859	146215	433074		140792	379667	520459		1733689	4005 (100%)
Mean Average	4158	3779	4009		4437	3655	4138		4694	3662	3894		4005	

	Upper reaches				Middle reaches				Lower reaches					
Input Items	HYV	Local	Total	M.A	HYV	Local	Total	M.A	HYV	Local	Total	M.A	Grand Total	M.A
1. Seed													82925	411.51 (11.25%)
2. Soil Condi- tioner													21525	106.82 (2.92%)
3. Fertilizer													30595	151.83 (4.16%)
4. Manure													108814	540 (14.79%)
5. Pesticides													3671	18.22 (0.5%)
6. Male													74151	367.98 (10.03%)
7. Female													270137	1340.56 (36.71%)
8. Animal labour													127200	631.23 (17.28%)
9. Machine labour													16833	83.53 (2.29%)
10. Water tax													-	
Total													735851	3652 (100%)
Mean Average													3652	

Note: No reaches wise classificatin in the non-command area

From this we can understand that variation in the quantity of irrigation varies the quantity of input use and input cost for the same crop. From table 8.6 we can understand that the percentage of input cost incurred for human labour is the highest. It is followed by animal labour and manure in the command and non-command areas.

Cost of Cultivation of Non-Paddy Crops

The cost on various inputs and cost of production for coconut, arecanut, banana, tapioca, vegetables and others are presented in table 8.7.

Coconut

The average cost per acre for coconut in the command and non-command areas is Rs.3143 and Rs.2764 respectively. The cost difference per acre between these two areas is Rs.379, which is 13.71 per cent higher on command area. The cost difference for HYV between command area and non-command area is 17.20 per cent, which is higher on command area.

Details of Cost of Cultivation and its Distribution Among Various
Inputs in the Command and Non command Areas
(Non-Paddy Crops)

Command Area

(Cost in Rupees)

Sl. No.	Crop	C.A in acres	Fert-ilizer	Manure	Male	Female	Other Cost (Incl. Seed)	Total Cost	M. A per Acre
1.	Coconut								
	(HYV)	7.49	2279	5610	13347	2040	1021	24297	3273
			(9.3)	(23.09)	(54.93)	(8.40)	(4.20)	(100)	
	(Local)	1.62	383	901	2143	442	465	4334	2675
			(3.84)	(20.79)	(49.45)	(10.20)	(10.73)	(100)	
2.	Arecanut								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	1.84	--	--	960	--	341	1301	707
					(13.79)		(26.21)	(100)	
3.	Banana								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	8.49	5778	5244	25900	--	5068	42890	5052
			(13.47)	(12.23)	(60.39)		(13.91)	(100)	
4.	Tapioca								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	32.21	10912	5946	19010	10870	6392	53130	1649
			(20.54)	(11.19)	(35.78)	(20.46)	(12.03)	(100)	
5.	Vegetable & Other								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	6.34	1599	1667	1350	3014	1684	9314	1469
			(17.17)	(17.90)	(14.49)	(32.36)	(18.08)	(100)	
	Total	57.99	20951	19368	62710	16366	15871	135266	2333
			(15.49)	(14.32)	(46.36)	(12.10)	(11.73)	(100%)	

Figures in Parenthesis Percentage to Total Cost of Individual Crop.

Non-command Area

(Cost in Rupees)

Sl. No.	Crop	C.A in acres	Fert-ilizer	Manure	Male	Female	Other Cost (Incl. Seed)	Total Cost	M. A per Acre
1.	Coconut								
	(HYV)	8.21	7949	7461	11264	1629	1921	23069	2808
			(3.44)	(32.34)	(48.83)	(7.06)	(8.33)	(100)	
	(Local)	6.01	507	5416	7815	1130	1367	16235	2704
			(3.12)	(33.36)	(48.14)	(6.96)	(8.42)	(100)	
2.	Arecanut								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	7.99	--	--	3798	--	1539	5337	668
					(71.16)		(28.84)	(100)	
3.	Banana								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	0.77	416	520	2262	--	352	3550	4610
			(11.71)	(14.64)	(63.73)		(9.92)	(100)	
4.	Tapioca								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	7.63	2258	1916	5384	2972	1386	13916	1824
			(16.23)	(13.76)	(38.69)	(21.36)	(9.96)	(100)	
5.	Vegetable & Other								
	(HYV)	--	--	--	--	--	--	--	--
	(Local)	2.82	750	681	1561	870	661	4523	1604
			(16.58)	(15.05)	(34.51)	(19.24)	(14.62)	(100)	
	Total	33.43	4725	15994	32084	6601	7226	66630	1993
			(7.09)	(24.00)	(48.15)	(9.91)	(10.84)	(100%)	

Figures in Parenthesis Percentage to Total Cost of Individual Crops

The proportion of cost of human labour and manure are higher compared to the other inputs in the command area. This is true in the case of non-command area also.

From table 8.7 it can seen that fertilizer applied in the command area is much higher than in the non-command area. In the case of manure it is higher in the non-command area than in the command area.

Arecanut

The average cost for arecanut per acre in the command area is Rs.707, as against Rs.668 in the non-command area. The cost difference per acre between command area and non-command area is Rs.39. This means that cost is 5.84 per cent higher in the command area compared to the non-command area. The proportion of cost on human labour is the highest, which constitutes 73.79 per cent. This is followed by other costs which accounts for 26.21 per cent. The cost incurred for manure and fertilizer is totally 'zero' in both the areas.

Banana

The average cost per acre for banana is Rs.5052 and Rs.4610 respectively in the command and non-command areas. The cost difference is Rs.442. This shows that cost is 9.59 per cent higher in the command area compared to the non-command area.

The proportion of cost on human labour in the command area is the highest. This is followed by other cost, fertilizer and manure. In the non-command area also the cost on human labour is the highest. This is followed by manure, fertilizer and other costs.

Tapiocca

The average cost per acre for tapioca in the command and non-command areas is Rs.1644 and Rs. 1824 respectively. The cost difference per acre between these two areas is Rs.180, which forms 9.87 per cent lesser in the command area.

In the command area, among the various inputs, human labour shares the highest proportion to the total cost. Of the total human labour, the share of male and female labour come to 35.78 percent and 20.46 per cent respectively. Next to human labour fertilizer contributes the major share of total cost i.e. 20.54 per cent. The share of manure cost constitutes only 11 per cent which is the lowest among the different inputs.

In the case of non-command area also the human labour shares the highest proportion among the various input costs. Next to human labour fertilizer shares higher proportion of the total cost. This is followed by manure and other costs.

Vegetables and Others

The cost of cultivation of vegetables and others depends upon the variety of seeds used. It is practically difficult to compare the cost of production of different varieties of vegetables grown. However, one common feature is that the cost of production by and large is similar. The average cost per acre for vegetables in the command area is Rs.1469, as against Rs.1604 in the non-command area. The cost difference per acre is Rs.135. Cost is higher in the non-command area. It is due to the fact that human labour input required for wetting the land in the non-command area is much higher than in the command area. The cost on human labour constitutes a significant proportion in both the areas.

The cost on fertilizer, manure and other cost constitutes more or less the same proportion i.e. around 17 per cent each in the command area. In the non-command area the next higher cost is accounted for by fertilizer. This is followed by manure and other costs.

On the whole, the average cost per acre for non-paddy crops in the command and non-command areas is Rs.2333 and Rs.1993 respectively. The cost difference per acre is Rs.340. This means that the cost is higher in the command area by 17.06 per cent.

The proportion of cost shared by fertilizer, manure, human labour and other costs constitutes 15.49, 14.32, 58.46 and 11.73 per cent respectively in the command area.

In the non-command area the share of fertilizer, manure, human labour and other cost to the total cost constitute 7.09, 24.0, 58.06 and 10.84 per cent respectively.

Of the total cost, share on human labour is the highest. This comes to about 58 per cent in both the areas. Next higher cost in the command area is accounted for by fertilizer. This is followed by manure and other costs. In the non-command area the next highest cost is accounted for by manure. This is followed by other costs and fertilizer.

The proportion of cost of fertilizer and human labour in the command area is much higher, compared to the non-command area. Thus average cost per unit of land for all crops (paddy and non-paddy) in the command area is greater than in the non-command area. From this we can understand that irrigation directly induces the farmers to use higher quantity of inputs in their farms.

Cost Differences

From the above analysis we can understand the following facts. Modern Technology of HYV is adopted only under paddy and coconut crops. All other crops belong to local variety of seeds.

Among the various crops raised in the command and non-command areas the average cost per unit of land for banana is found to be much higher than that of the other crops. This is followed by paddy, coconut, tapioca, vegetables and arecanut respectively.

In the case of paddy crop, the cost difference between HYV and local variety in the command area is 16.64 per cent, whereas in the non-command area it is 8.49 per cent.

In the case of coconut crop, the cost differences between HYV and local variety in the command and non-command areas are 21.27 per cent and 4.04 per cent respectively. The cost difference per acre between the command and non-command areas is only 13.71 per cent higher in the command area.

The cost difference per acre for arecanut and banana is 5.84 and 9.59 per cent respectively. The cost is higher in the command area compared to that in the non-command area. But the average cost for tapioca and vegetables in the command area is less than the non-command area, which accounts for9.59 and 8.42 per cent respectively.

SECTION II

Yield Structure

The yield of a crop depends on several inputs that go into the production of that crop. Among these inputs irrigation is one of the important determinants. The difference in farm production or for that matter the differences in net income or net return between command and non-command areas arise mainly because of the assured supply of water. Supply of canal irrigation varies with reaches to reaches. Generally in an unlined canal irrigation system upper reaches face the problem of overirrigation, and the lower reaches or tail end suffers from inadequate supply of water. Unequal distribution of canal irrigation creates variations in the yield rate per unit of land among the reaches.

In this Section an attempt is made to find out the yield structure and its difference between the command and non-command areas. To calculate the total yield of each crop per unit of land both main and subsidiary yields are taken into account.

Yield Structure of All Crops

The yield difference of individual crops and all crops in the command and non-command areas are analysed in table 8.8. Table 8.8 shows that the average yield per unit of land for all crops in the command area is higher than in the non-command area.

The yield difference per acre for paddy, coconut, arecanut, banana, tapioca and vegetables is Rs.644, Rs.2585, Rs.1349, Rs.2603, Rs.1278 and Rs.958 respectively. The cost difference in terms of rupee for banana is the highest in the command area. It is followed by coconut, arecanut, tapioca, vegetables and paddy.

Table 8.8

Details of Yield Structure of All Crops in the Command and Non-Command Area

(in rupees)

	Command Area					Non Command Area				
Crop	Cropped Area in Acre	Main Income	Subsidy Income	Gross Income	Mean Average	Cropped Area in (in acre)	Main Income	Subsidy Income	Gross Income	Mean Average
Paddy	432.89	1291898	672442	1964340	4538	201.51	533766	250999	786765	3894
Coconut	9.11	104305	3291	107596	11811	14.22	126014	5182	131196	9226
Arecanut	1.84	11920	-	11920	6475	7.99	40960	-	40960	5126
Banana	8.49	108279	5627	113906	13417	0.77	8006	321	8327	10814
Tapioca	32.21	137820	6624	144444	4484	7.63	26852	1428	28280	3206
Vegetabl-es & Oth.	6.34	34116	-	34116	5381	2.82	12474	-	12474	4423
Total	490.88	1688338	687984	2376322	4841	234.94	748072	257930	1006002	4282

In percentage terms the change in yield for paddy, coconut, arecanut, banana, tapioca and vegetables and others are 16.54, 28.02, 26.38, 24.07, 39.36 and 21.66 per cent respectively. Among these crops, the percentage of yield difference per acre for tapioca is the highest followed by coconut, arecanut, banana, vegetables and paddy. The paddy crop accounts for the lowest percentage of yield difference among these crops.

Yield Structure of Paddy Crop and Non-paddy Crops

The yield structure of paddy and non-paddy crops in the command and non-command area is analysed in table 8.9. The per acre productivity of all crops (paddy and non-paddy) is noticed to be higher in the command area than the non-command area. Further it is noticed that productivity of non-paddy crops per unit of land is greater than the productivity of paddy crop both in the command and in the non-command areas.

Table 8.9

Details of Yield Structure of Paddy and Non-Paddy Crops

(in rupees)

	Command Area					Non-Command Area				
		Yield					Yield			
Crop	Cropped Area	Main	Subsidiary	Total Income	Mean Average Per acre	Cropped area	Main	Subsidiary	Total Income	Mean Average Per acre
Paddy Crop	432.89	1291898	672442	1964340	4538	201.51	533766	250999	784765	3894
Non-Paddy	57.99	396440	15542	411982	7104	33.43	214306	6931	221237	6618
Total	490.88	1688338	687984	2376322	4841	234.94	748072	257930	1006002	4282
Mean average Per acre	-	3439	1402	4841	-	-	3184	1098	4282	-

The average yield per acre for all crops (paddy and non-paddy) in the command and non-command areas is Rs.4841 and Rs.4282 respectively. The net yield difference between these two areas is Rs.559, which constitutes 13.05 per cent higher on command area.

Paddy crop yield per acre in the command area is Rs.4538, as against Rs.3894 in the non-command area. The difference in yield accounts for 16.54 per cent higher on command area, whereas in the case of non-paddy crops the average yield difference per acre is 7.34 per cent higher on command area.

Yield Difference — Individual Crops

To find out the real impact of irrigation on yield of different crops, it is necessary to analyse the yield structure of individual crops between command and non-command areas. The yield structure and its difference between command and non-command areas for paddy crop, coconut, arecanut, banana, tapioca and vegetables and others are analysed here separately.

Paddy Crop

The yield structure of paddy crop is analysed season-wise and reaches-wise separately. Paddy crop is raised in all the three seasons in the command area, as against only two seasons in the non-command area. The third crop in the non-command area is not raised due to nonavailability of canal irrigation.

Yield Structure of Paddy Crop by all Seasons

The yield structure of paddy crop in all seasons in the command and non-command areas is analysed in Table 8.10. Table 8.10 shows that the average yield per acre in the command and non-command areas is Rs.4538 and Rs.3894 respectively. The yield difference per acre comes to Rs.644, which accounts for about 17.00 per cent higher on command area. The average yield rate of HYV is higher than the average yield rate of local variety, both in the command and in the non-command areas. The increase in yield per unit of land for HYV and local variety of seeds as a result of irrigation is 12.63 and 8.13 per cent respectively.

Table 8.10

Details of Yield Structure of Paddy Crop by All Seasons

(in rupees)

	Command Area					Non- Command Area				
	Area	Main income	Subsi-diary income	Total	M.A per acre	Area	Main income	Subsi-diary income	Total	M.A per acre
HYV	212.9	711758	351411	1063169	4994	33.24	107249	40134	147383	4434
Local	219.99	580140	321031	901171	4096	168.27	426517	210865	637382	3788
Total	432.89	1291898	672442	1964340	4538	201.51	533766	250999	784765	3894
M.A	--	2984	1554	4538	--	--	2649	1248	3894	

Note: M.A is Mean average

Source: Survey Data.

Paddy-Viruppu Season

The yield structure of paddy during viruppu season between command and non command areas is presented in table 8.11. The yield difference per acre during viruppu season is Rs.485. This shows that yield is higher by 12.58 per cent in the command area as compared to the non-command area. As compared to average yield per acre by all seasons in the command area, it is 4.39 per cent lower during viruppu season. Irrigation increased the yield rate of both HYV and local variety in the command area. But the rate of increase in yield per unit of land for local variety is higher than HYV. The increase in yield per unit of land for HYV and local varieties account for 7.28 and 10.92 per cent respectively.

Table 8.11

Details of Yield Structrue of Paddy Crop During Viruppu Season by Variety of Seeds wise

Command Area

(in rupees)

Command Area					
Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average per acre
HYV	27.45	98233	31997	130230	4744
Local	54.07	143129	80336	223465	4133
Total	81.52	241362	112333	353695	4339
Mean Average per acre	--	2961	1378	4339	---

Non-Command Area

Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average Per acre
HYV	16.18	51456	20093	71549	4422
Local	71.51	178403	88029	266432	3726
Total	87.69	229859	108122	337981	3854
Mean Average Per acre	--	2621	1233	3854	--

Source: Survey Data.

Paddy-Mundakan Season

The yield structure of paddy crop during mundakan season between command and non-command areas is analysed in Table 8.12.

Table 8.12
Details of Yield Structure of Paddy Crop During Mundakan Season by Variety of Seeds Wise

Command Area (in rupees)

Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average per acre
HYV	36.70	116840	54728	171568	4675
Local	165.92	437011	240695	677706	4084
Total	202.62	555851	295423	849274	4191
Mean Average per acre	--	2743	1458	4191	--

Non-Command Area

Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average per acre
HYV	17.06	55793	20041	75834	4445
Local	96.76	248114	122836	370950	3834
Total	113.82	303907	142877	446784	--
Mean Average per acre	--	2670	1255	3925	--

Source: Survey Data.

The yield per acre for mundakan crop in the command area is Rs.4191 as against Rs.3925 in the non-command area. The net difference accounts only 6.78 per cent higher in the command area. It is mainly due to the fact that area under cultivation of HYV of paddy crop during mundakan season is comparatively less than that of the other two seasons. Most of the sample farmers prefer to raise only local variety during mundakan season. The yield difference for HYV and local variety between command and non-command areas is 5.17 and 6.52 per cent respectively. The yield difference between command and non-command areas for HYV of seed is less than that of the local variety during mundakan. As compared to viruppu, average yield per acre for mundakan crop is, less by 3.4 per cent.

On the whole, the average yield per acre for paddy crop in the command area is higher than in the non-command area during mundakan season.

Paddy - Puncha Crop

The yield structure of puncha crop is analysed in Table 8.13.

Table 8.13

Details of Yield Structure of Paddy Crop During Puncha Season by Variety of Seeds Wise

Command Area (in rupees)

Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average per acre
HYV	148.75	496685	264686	761371	5118
Local	--	--	--	--	--
Total	148.75	496685	264686	761371	--
Mean Average per acre	--	3339	1779	5118	--

Source: Survey Data.

Puncha crop is not raised in the non-command area due to lack of canal water. From table 8.13 we can understand that nobody in the command area adopted local seeds for paddy cultivation. Since availability of water is restricted to three months during puncha season farmers are forced to use HYV seeds in the command area. The average yield per acre for paddy crop during puncha season is Rs. 5118. As compared to the other two seasons, namely viruppu and mundakan, the average yield per acre for puncha crop has increased by 17.95 and 22.12 per cent respectively.

Yield Structure of Paddy Crop by Reaches-Wise

Here the reaches-wise classification of paddy yield is analysed to find out the variation in yield between different reaches. This classification is done to find out to what extent quantity of irrigation varies the yield rate among the reaches.

Upper Reaches

Table 8.14 indicates the yield structure of paddy crop in the upper reaches.

Table 8.14

Details of Yield Structure of Paddy Crop in the Upper Reaches

Command Area

(in rupees)

Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average per acre
HYV	118.26	383272	292598	585870	4954
Local	76.32	204608	110969	315577	4135
Total	194.58	587880	313567	901447	4633
Mean Average per acre	--	3021	1612	4633	--

Source: Survey Data.

The average yield per acre for paddy crop in the upper reaches is Rs.4633. The yield per acre for HYV seeds is Rs.4954, as against Rs.4135 for local seeds. The yield difference per acre between HYV seeds and local seeds is Rs.819, which forms 19.81 per cent higher on HYV seeds.

Middle Reaches

Yield structure of paddy crop in the middle reaches is analysed in table 8.15.

Table 8.15

Details of Yield Structure of Paddy Crop in the Middle Reaches

Command Area

(in rupees)

Variety	Cropped Area	Main income	Subsidiary income	Gross income	Mean Average per acre
HYV	64.65	217419	109951	327370	5064
Local	40.00	107316	58177	165493	4137
Total	104.65	324735	168128	482863	4614
Mean Average	--	3103	1607	4614	--

Source: Survey Data.

The average yield per acre for paddy crop in the upper reaches was Rs.4709. This shows that yield rate in the middle reaches is higher than in the upper reaches. It is mainly because the middle reaches is totally free from the problems of water logging and water shortage.

The average yield per acre for HYV and local varieties in the middle reaches is Rs.4954 and Rs.4135 respectively. The yield difference between these two varieties forms 19.81 per cent higher on HYV seed.

Lower Reaches

The yield structure of paddy crop in the lower reaches is presented in Table 8.16. Area under cultivation of HYV of paddy in the lower reaches is lower than in the area under cultivation of HYV in the upper reaches and middle reaches. The average yield per acre for paddy crop in the lower reaches is Rs.4265 as against Rs.4633 and 4709 in the upper and middle reaches respectively. As compared to the other two reaches, the average yield per acre for lower reaches is very low. The yield differences between HYV and local varieties account for 6.93 per cent in the case of HYV seeds.

Table 8.16

Details of Yield Structure of Paddy Crop in the Lower Reaches Command Area

(in rupees)

Variety	Cropped Area	Main income	Sub-sidiary income	Gross income per	Mean Average acre
HYV	29.99	111067	388621	149929	4999
Local	103.67	268216	15185	420101	4052
Total	133.66	379283	190747	570030	4265
Mean Average	--	2838	1427	4265	--

Source: Survey Data.

On the whole, it is clearly understood that the average yield per acre for middle reaches is the highest, Rs.4709. It is followed by upper reaches (Rs.4633) and lower reaches (Rs.4265).

Even though the quantity of irrigation in the upper reaches is high, the yield rate per unit of land in the upper reaches is lower than in the middle reaches. It is mainly because, water logging problem in the upper reaches reduces the fertility of soil. Ultimately it reduces yield rate per unit of land.

Coconut

The yield structure of coconut crop between command and non command areas is analysed in table 8.17. The productivity of coconut crop per unit of land in the command and non-command areas is Rs.11811 and Rs.9226 respectively. The yield difference between these two area is Rs.2585 (i.e., 28.02 per cent). The yield difference between HYV and local varieties in the command and non-command areas accounts for 18.07 and 22.45 per cent respectively. It shows that yield difference between HYV and local variety in the command area is less than that of the non-command area.

Table 8.17

Details of Yield Structure of Coconut Crop Between

Command and Non-Command Areas

(in rupees)

Variety	Command Area					Non_Command Area				
	Cropped Area	Main income	Sub-sidiary income	Gross income	Mean Average income	C.A	Main income	Sub-sidiary income	Gross income	M.A. per acre
HYV	7.49	90018	2674	92692	12375	8.21	83171	2874	86045	10481
Local	1.62	14287	617	14904	9200	6.01	42843	2308	45151	7513
Total	9.11	104305	3291	107596	11811	14.22	126014	5182	131196	9226
Mean Average	--	11450	361	11811	--	—	8862	364	9226	—

Source: Survey Data.

recanut

Price of arecanut has been increased for the last ew years which increased yield rate in money terms per unit f land both in the command and in the non-command areas. ere we have to find out the yield difference between these wo areas. Yield structure of arecanut between command and on-command areas is analysed in Table 8.18.

The table indicates that only local variety of recanut is raised both the areas. The production of arecanut er acre in the command and non-command areas is Rs.6478 and s.5126 respectively. As compared to non-command area, the roduction per unit of land is increased by 26.38 per cent.

Table 8.18

Details of Yield Structure of Arecanut Crop Between

Command and Non-Command Areas

(in rupees)

	Command Area					Non-Command Area				
Variety	Cropped Area	Main income	Sub-sidiary income	Gross income	Mean Average per acre	C.A	Main income	Sub-sidiary income	Gross income	M.A. per acre
HYV	--	--	--	--	--	--	--	--	--	--
Local	1.84	11920	--	11920	6478	7.99	40960	--	40960	5126
Total	1.84	11920	--	11920	6478	7.99	40960	--	40960	5126
Mean Average	--	6478	--	6478	--	—	5126	--	5126	—

Source: Survey Data.

Banana

Banana is another important commercial crop grown by the sample farmers in the command and non-command areas. But area under cultivation of banana in the command area is much higher than the non-command area, after provision of irrigation.

Yield structure of banana between command and non-command areas is analysed in table 8.19. Like arecanut crop, here also only local varieties have been raised in the command and non-command areas. The average yield per acre for banana in the command area is Rs.13417, as against Rs.10814 in the non-command area. The yield difference between these two areas is Rs.2603, which accounts for 24.07 per cent higher on command area.

Table 8.19

Details of Yield Structure of Banana Crop Between

Command and Non-Command Areas

(in rupees)

	Command Area						Non-Command Area			
Variety	Cropped Area	Main income	Sub-sidiary income	Gross income	Mean Average per acre	C.A	Main income	Sub-sidiary income	Gross income	M.A. per acre
HYV	--	--	--	--	--	--	--	--	--	--
Local	8.49	108279	5627	113906	13417	0.77	8006	321	8327	10814
Total	8.49	108279	5627	113906	13417	0.77	8006	321	8327	10814
Mean Average	--	12754	663-	13417	--	—	10397	416	10814	—

Source: Survey Data.

Tapioca

The yield structure of the tapioca is analysed in Table 8.20. The average yield for tapioca per acre in the command area is Rs.4484, as against Rs.3206 in the non-command area. The variation in yield per acre for this crop between command and non-command areas is Rs.1278. This shows the yield is 39.86 per cent higher in the command area as compared to the non-command area.

Vegetables and Others

The yield structure of vegetables and others between the command and non-command areas is presented in Table 8.21.

The average yield per acre for the category of egetable, and others in the command area is Rs.5381, as gainst Rs.4423 in the non-command area. This shows that the ield is 21.66 per cent higher in the command area.

Table 8.20

Details of Yield Structure of Tapioca Between

Command and Non-Command Areas

(in rupees)

Variety	Command Area					Non-Command Area				
	Cropped Area	Main income	Sub-sidiary income	Gross income	Mean Average per acre	C.A	Main income	Sub-sidiary income	Gross income	M.A. per acre
HYV	--	--	--	--	--	--	--	--	--	--
Local	32.21	137820	6624	144444	4484	7.63	26852	1428	28280	3206
Total	32.21	137820	6624	144444	4484	7.63	26852	1428	28280	3206
Mean Average	--	4279	206	4484	--	—	3519	187	3206	—

Source: Survey Data.

Table 8.21

Details of Yield Structure of Vegetable and Others Between

Command and Non-Command Areas

(in rupees)

	Command Area					Non-Command Area				
Variety	Cropped Area	Main income	Sub-sidiary income	Gross income	Mean Average per acre	C.A	Main income	Sub-sidiary income	Gross income	M.A. per acre
HYV	--	--	--	--	--	--	--	--	--	--
Local	6.34	34116	--	34116	5381	2.82	12474	--	12474	4423
Total	6.34	34116	--	34116	5381	2.82	12474	--	12474	4423
Mean Average	--	5381	--	5381	--	—	4423	--	4423	—

Source: Survey Data.

SECTION III

Net Income, Rate of Change in Return and Output-Input Ratio

Net income indicates the profit or loss from farm business. It is the residual of gross income after deducting total cost from it.

Net Income-Gross Area Sown

The net return and its difference for all crops to between command and non command areas to gross area sown is analysed in table 8.22. The per acre net income for all crops in the command area is Rs.1034, as against Rs.844 in the non-command area. The net difference per acre is Rs.190, which accounts for 22.51 per cent higher in the command area.

Among the various crops the net return per acre for coconut crop is the highest, which is about Rs.8668. The second highest net return crop is banana (Rs.8365). It is followed by arecanut (Rs.5771), vegetables and others (Rs.3912), tapioca (Rs.2835) and paddy (Rs.533). The net return from paddy crop is the lowest as compared to the other crops in the command area.

Table 8.22

Details of Net Return and Its Difference Between Command and Non-Command Areas(To Gross Cropped Area)

(yield and cost in rupees)

	Command Area					Non Command Area						
Crop	Gross Cropped Area (in acres)	Total Revenue	Total Cost	Net Return	M.A Per Acre	Gross C.A (in acres)	Total Revenue	Total Cost	Net Return	M.A Per Acre	Net Income Difference/Acre	Net Income Difference by%
Paddy	432.89	1964340	1733689	230631	533	201.51	784765	735851	48914	243	290	19.34
Coconut	9.11	107596	28631	78965	8668	14.22	126014	39304	86710	6098	2570	42.44
Arecanut	1.84	11920	1301	10619	5771	7.99	40960	5337	35623	4458	1313	29.45
Banana	8.49	113906	42890	71016	8365	0.77	8327	3550	4777	6204	2161	37.83
Tapioca	32.21	144444	53130	91314	2835	7.62	28280	13916	14364	1883	952	50.56
Vegetables & Oth.	6.34	34116	9314	24802	3912	2.82	12474	4523	7951	2820	1092	38.72
Total	490.88	2376322	1868955	507367	1034	234.94	1000820	802481	198339	844	190	-

In the case of non-command area, the net return for banana crop is the highest amounting to Rs.6204. It is followed by coconut (Rs.6098), arecanut (Rs.4458), vegetables and others (Rs.2820), tapioca (Rs.1883) and paddy (Rs.243). As in the command area, here also paddy is the only crop which yields the lowest return as compared to the other crops.

Net income for all individual crops in the command area is much higher than that of the non-command area as a result of provision of irrigation. The percentage of net income difference for paddy crop is the highest constituting 119.34 per cent in the command area. It is followed by tapioca (50.56%), coconut (42.14%), vegetable and others (38.72%), banana (34.84%) and arecanut (29.45%).

Thus under all concepts the returns are higher for all the categories of crops in the command area as compared to the non-command area.

Net Income- Net Area Sown

The details of net income for net area sown for all crops are analysed in Table 8.23.

Table 8.23

Details of Net Return and Its Difference Between Command and Non-Command Areas(To net Area sown)

(yield and cost in rupees)

	Command Area					Non Command Area						
Crop	Total Net Area (in acres)	Total Revenue	Total Cost	Net Return	M.A Per Acre	Total Net area (in acres)	Total Revenue	Total Cost	Net Return	M.A Per Acre	Net Income Difference/Acre	Net Income Difference by%
Paddy	22381	1964320	1733689	230631	1030	109.63	784765	735851	48914	446	584	30.99
Coconut	9.11	107596	28631	78965	8668	14.22	126014	39304	86710	6098	2570	42.14
Arecanut	1.84	11920	1301	10619	5771	7.99	40960	5337	35623	4458	1313	29.45
Banana	8.49	113906	42890	71016	8365	0.77	8327	3550	4777	6204	2161	34.83
Tapioca	32.21	144444	53130	91314	2835	7.63	28280	13916	14364	1883	952	50.56
Vegetables & Oth.	6.34	34116	9314	24802	3912	2.82	12474	4523	7951	2820	1092	38.72
Total	81.8	2376302	1868955	507347	1800	1430.6	1000820	802481	198339	1386	414	-

From table 8.23 it can be understood that net income per acre to net area sown for all crops in the command area is greater than the net income per acre to net area sown in the non-command area. The net income per acre to net area sown for all crops in the command area is Rs.1800 as against Rs.1386 in the non-command area. The difference in net income to net area sown per acre is Rs.414, which accounts for 29.87 per cent.

The net income difference per acre between command and non-command areas for paddy crop to net area sown is Rs.584, which constitutes 130.94 per cent higher on command area. The other crops viz. coconut, arecanut, banana, tapioca and vegetable constitute the net income difference by 42.14, 29.45, 34.83, 50.56 and 38.72 per cent higher in the command area. The percentage of net income differences for non-paddy crops (individual) between command and non-command areas to net area sown and gross area sown is equal. But in the case of paddy it is different.

It was tested statistically to find out of there is any significant difference in the net income per acre for all individual crops to net area sown between command and non-command areas.

(i) For Paddy Crop

H_0 : There is no siginificant difference in net income per acre between command and non-command areas.

H_1 : There is a significant difference.

$$Z_0 = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$= \frac{|1030 - 446|}{\sqrt{\frac{412.09}{223.61} + \frac{652.80}{109.63}}} = \frac{584}{2.79} \doteq 209.31$$

$$= Z_0 > Z_\alpha$$

Hence we reject the null hypothesis and accept the alternate hypothesis that there is a significant difference in revenue per acre between command and non-command areas.

For Coconut

H_0 : There is no siginificant difference.

H_1 : There is a significant difference.

$$Z_o = \frac{\left| 8668 - 6098 \right|}{\sqrt{\frac{110.85^2}{9.11} + \frac{150.75^2}{14.22}}} = \frac{2570}{14.22} = 47.34$$

$$Z_\alpha = 1.96$$

Hence we reject the null hypothesis and accept the alternate hypothesis that there is a significant difference in net return per acre for coconut between command and non-command areas.

For Arecanut

H_o : There is no siginificant difference.

H_1 : There is a significant difference.

$$Z_o = \frac{\left| 5711 - 4458 \right|}{\sqrt{\frac{105.51^2}{1.84} + \frac{112.32^2}{7.99}}} = \frac{1253}{102.84} = 12.18$$

$$Z_o > Z_\alpha$$

$z_\lambda = ?$

Hence we reject null hypothesis and accept the alternate hypothesis that there is a significant difference in net return per acre for arecanut between command and non-command areas.

Banana

H_0 : There is no siginificant difference.

H_1 : There is a significant difference.

$$Z_0 = \frac{|8365 - 6204|}{\sqrt{\frac{85.67^2}{8.49} + \frac{95.32^2}{0.77}}} = \frac{2161}{116.31} = 18.58$$

$Z_0 > Z_\alpha$

Hence we reject the null hypothesis and accept the alternate hypothesis that there is a significant differenc in net return of banana crop between command and non-command areas.

For Tapioca

H_0 : There is no siginificant difference.

H_1 : There is a significant difference.

$$Z_0 = \frac{|2835 - 1883|}{\sqrt{\frac{62.35^2}{32.21} + \frac{53.35^2}{7.63}}} = \frac{952}{118.41} = 8.04$$

Hence there is a significant difference in net return per acre for tapioca between command and non-command areas.

For Vegetables and Others

H_0 : There is no siginificant difference.

H_1 : There is a significant difference.

$$Z_o = \frac{|3912 - 2820|}{\sqrt{\frac{30.56^2}{6.34} + \frac{28.39^2}{2.82}}} = \frac{1092}{120.23} = 9.08$$

$Z_o > Z_\alpha$

Hence reject null hypothesis. There is significant difference in yield per acre for vegetables and others between the command and non-command areas.

Rate of Change in Cost and Yield

Irrigation has increased both cost and yield per unit of land in the command area. But it is very essential to know about the rate of change in cost and yield per unit of land as a result of irrigation. The rate of change in costs and yields between command and non-command areas is analysed in Table 8.24.

Table 8.24

Details of Rate of Change in Cost and Yield Per Acre for All Crops Between

Command and Non-Command Areas (To Net Area)

(yield and cost in rupees)

	Non command Area					Command Area						
		Cost		Revenue			Cost		Revenue			
Crop	C.A	Total	Average Per acre	Total	Average Per acre	Cropped Area	Total	Average Per acre	Total	Average Per acre	% of Change in cost	% of Change in Revenue
Paddy	201.51	735851	3652	784765	3694	432.89	1733689	4005	1964320	4358	9.67	16.54
Coconut	14.22	39304	2764	126014	8852	9.11	28631	3143	107596	11811	13.71	33.28
Arecanut	7.99	5337	668	40960	5126	1.84	1301	707	11920	5478	5.84	26.4
Banana	0.77	3550	4610	8327	10614	8.49	42890	5052	113906	13416	9.59	24.06
Tapioca	7.63	13916	1824	28280	3705	32.21	53130	1649	144444	4484	-9.59	20.99
Vegetable & Others	2.83	4523	1598	12474	4408	6.34	9314	1469	34116	5381	-8.08	22.07
	234.94	802481	3416	1000820	4260	490.69	1868915	3807	2376322	4841	11.45	13.64

Table 8.24 shows that irrigation has increased both cost and yield per unit of land for all crops by 11.45 and 13.64 per cent respectively. The increase in cost per unit of land for paddy crop, coconut, arecanut and banana is 9.67, 13.71, 5.84 and 9.59 respectively. At the same time the average cost per unit of land for tapioca and vegetable decreased by 9.59 per cent and 8.08 per cent respectively. Increase in cost per unit of land for coconut is the highest. It is followed by paddy, banana and arecanut.

Provision of irrigation did not create any negative impact on yield of any crop. The yield per unit of land for all individual crops viz. paddy, coconut, arecanut, banana, tapioca and vegetables and others have increased by 16.54, 33.28, 26.40, 24.06, 20.99 and 22.07 per cents respectively. It shows that the percentage of increase in yield for coconut is the highest. This is followed by arecanut, banana, vegetables and others, tapioca and paddy. The percentage of increase in yield for paddy is the lowest, as compared to the other individual crops in the command area. Thus, irrigation increased both cost and yield per unit of land. But yield per unit of land increased more than proportionately to cost increased.

Output-Input Ratio

To estimate the return per rupee of investment in cultivation, output-input ratio is calculated for the command and non-command areas. This is presented in table 8.25.

The output-input ratio for all crops in the command area is Rs.1.27 and it is Rs.1.25 in the non-command area. From table 8.25 we can understand that output-input ratio for all individual crops in the command area is higher than in the non-command area, except arecanut. The output-input ratios for paddy, coconut, arecanut, banana, tapioca and vegetables and others are Rs.1.13, Rs.3.76, Rs.4.98, Rs.2.66, Rs.2.72 and Rs.3.66 respectively in the command area as against Rs.1.07, Rs.3.34, Rs.7.67, Rs.2.35, Rs.1.75 and Rs.2.76 respectively to paddy, coconut, arecanut, banana, tapioca and vegetables and others in the non-command area.

In the command area the output-input ratio for arecanut is the highest. The main reason for this is the fact that the cultivation cost incurred for arecanut is the lowest, as compared to the cultivation cost of other crops. Moreover, the price of arecanut nowadays has increased to a large extent.The next highest output-input ratio crop is coconut (Rs.3.76). It is followed by vegetables and others (Rs.3.66), tapioca (Rs. 2.72), banana (Rs.2.66) and paddy (Rs.1.13).

Details of Output-Input Ratio for All Crops Between
Command and Non-Command Areas

Crop	Command Area			Non Command Area		
	Input Per acre in Rs.	Output per acre in Rs.	Output input Ratio	Input per acre in Rs.	Output per acre in Rs.	Output Input Ratio
1. Paddy & Season						
1) Viruppu	4003	4339	1.08	3676	3854	1.05
2) Mundakan	3759	4191	1.11	3633	3925	1.08
3) Puncha	4341	5118	1.18	--	--	--
Total	4005	4538	1.13	3652	3894	1.07
Reaches						
Viruppu	4009	4633	1.16	--	--	--
Mundakan	4138	4929	1.19	--	--	--
Puncha	3894	4614	1.18	--	--	--
Total	4005	4514	1.13	--	--	--
2. Coconut	3143	11811	3.76	764	9226	3.34
3. Arecanut	1301	6475	4.98	668	5126	7.67
4. Banana	5052	13417	2.66	4610	10814	2.85
5. Tapioca	1649	4484	2.72	1824	3206	1.76
6. Vegetables & Others	1469	5381	3.66	1604	4423	2.76

Source: Survey Data.

In the case of non-command area arecanut crop constitutes the highest output-input ratio (Rs.7.67). It is followed by coconut (Rs.3.34), vegetables and others (Rs.2.76), banana (Rs.2.35) and paddy (Rs.1.07).

As compared to other crops, the output-input ratio for paddy is the lowest, both in the command and non-command areas. This lowest output-input ratio discourages the farmers to raise paddy crops more than twice a year even after provision of irrigation. This is one of the main reasons for not increasing the gross cropped area in the command area after commissioning of the irrigation project.

CHAPTER IX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study was carried out with the following objectives:

1. To assess the nature and direction of change in the cropping pattern due to irrigation.
2. To know the changes in intensity of cropping as a result of irrigation.
3. To understand the effects of irrigation on adoption of modern technology.
4. To estimate the extent of increase in crop production per acre of gross cropped area due to irrigation.
5. To understand the impact of irrigation on employment and on the changing composition of male and female labour.
6. To examine the cost ~~of~~ and yield difference between irrigated and non-irrigated land.
7. To estimate the net return per acre in the command and non-command areas by different crops.

The study leads to the following conclusions:

1. Cropping Pattern

The cropping pattern in the command and non-command areas, are analysed to ascertain the preferred crops under irrigated conditions. The analysis shows that paddy is the principal crop raised in the command and non-command areas. It accounts for 88.19 and 85.77 per cent respectively in the command and non-command areas. It shows that the percentage of area under paddy cultivation in the command area is higher than in the non-command area as a result of assured water after the introduction of irrigation. The percentage of area under non-paddy crops to gross cropped area is less in the command area than in the non-command area.

Among the non-paddy crops, the percentage of area under tapioca cultivation is the highest in the command area. This is followed by coconut, banana, vegetables and others and arecanut. In the non-command area, on the other hand, the percentage of area under coconut is the highest among the non-paddy crops. It is followed by arecanut, tapioca, vegetables and others and banana.

Irrigation has increased the percentage of area under cultivation of banana, tapioca and vegetables to a large extent in the command area. But area under coconut has not increased in any significant manner as a result of irrigation.

2. Intensity of Cropping

Impact of irrigation on intensity of cropping was analysed in the study. The analysis shows that irrigation has increased the overall crop intensity in the command area. But a significant factor that is noticed in this case is that the intensity of paddy crop has declined in the command area in comparison with the non-command area. The intensity of crop of non-paddy crops has increased to a large extent in the command area, i.e. more than two-fold as compared to the non-command area.

The reasons for low intensity in the case of paddy cultivation are mainly due to low price of paddy, high cost of production and low net return per unit of land.

Reaches-wise analysis of impact of irrigation shows that the intensity of crop for non-paddy crops is higher in the lower reaches. This is followed by middle and upper reaches in that order.

3. Impact of Irrigation on Adoption of Modern Technology

The study shows that adoption of modern technology like HYV of seeds, fertilizer applications and introduction of mechanisation is comparatively high in the command area than in the non-command area. Adoption of modern technology in the case of paddy cultivation is found to be much higher than the case of non-paddy crops. About 50 per cent of the gross cropped area in the command area has adopted HYV, which is only 16.5 per cent in the case of the non-command area.

Fertilizer application per unit of land for all crops and paddy crop increased by 64 and 51.32 per cent respectively in the command area due to adoption of HYV as a result of irrigation. The percentage of area under mechanisation in the command area is 7.06 per cent, as against 6.69 per cent in the non-command area. This shows that the impact of irrigation on mechanisation is really insignificant.

On the whole, irrigation has a positive impact on adoption of HYV of seeds and fertilizer application.

4. Impact on Production

The average yield per unit of land in physical units in the command and non-command areas have been analysed. The result shows that the yield per unit of land for all crops and individual crops in the command area is greater than in the non-command area.

Paddy-Crop

The yield per unit of land for paddy crop in the command area is higher by 15.65 per cent as result of irrigation.

The average yield per unit of land in all seasons in the command area is also higher, as compared to the non-command area. It is the result of application of more inputs and adoption of more High yielding varieties of seeds in the command area because of the assured supply of water after the introduction of irrigation.

Reaches-wise impact of irrigation on paddy has been analysed. This reveals that among the three reaches in the command area, yield per acre for paddy crop in the middle reaches is the highest. It is followed by upper and lower reaches.

Analysis was also made on the basis of before and after commissioning of the project. It shows that after irrigation, production of paddy has increased by 12.79 per cent in the command area.

Non-Paddy Crops

Impact of irrigation on production of non-paddy crops shows a positive result. The average yield per unit of land for non-paddy crops in the command area is also higher than in the non-command area. The rate of increase in yield per unit of land as a result of irrigation for vegetables and others is the highest. It is followed by coconut, arecanut, banana and tapioca.

The impact of irrigation on production by reaches-wise was also analysed. It shows that except in the case of coconut and tapioca the average yield per unit of land in the case of all other non-paddy crops is the highest in the upper reaches. This is followed by middle and lower reaches in that order. The average yield per unit of land for coconut in the lower reach is higher than the other two reaches because area under HYV of coconut in the lower reaches is higher, compared to the other two reaches.

5. Impact on Employment

Impact of irrigation on employment has been studied. This shows that the provision of irrigation has increased the labour absorption per unit of land in the case of both paddy and non-paddy crops. But increase in labour absorption per unit of land in the case of non-paddy crops is found to be higher in the case of paddy crop as a result of irrigation.

The labour absorption per unit of land for paddy crop by all seasons in the command area is found to be 56.26, as against 54.96 in the non-command area. This shows that provision of irrigation has absorbed additional labour per unit of land to the extent of 2.37 per cent only.

The percentage of male and female labour absorption per unit of land to total labour absorption for paddy crop in the command area is found to be 18.15 and 81.85 per cent respectively, whereas in the case of non-command area it is 15.13 and 84.87 per cent respectively. This shows that the provision of irrigation has increased the percentage of male labour absorption per unit of land and reduced the percentage of female labour absorption per unit of land.

As a result of irrigation, non-paddy crops in the command area absorbed 23.45 per cent additional labour mandays per unit of land.

It is also noticed that labour absorption per unit of land for HYV of seeds is higher than the local variety of seeds. It is true for all individual crops also. The labour absorption per unit of land by HYV and local variety of seeds in the command area is higher as compared to in the non-command area.

On the whole, the study shows that irrigation has helped to absorb additional labour in the cultivation of crops such as paddy, coconut, arecanut and banana. But the other two crops namely, tapioca and vegetables absorbed only less labour mandays. The provision of irrigation ultimately absorbed additional labour mandays per unit of land for all crops only by five per cent.

6. Cost and Yield Structure

Cost Structure

Provision of irrigation invariably induces farmers to apply more inputs on their land. The average cost per unit of land for all crops in the command area is thus pushed up in comparison with the non-command area. Again it is noticed that the average cost per unit of land for HYV seeds is greater than local variety of seeds.

Paddy Crop

The cost of cultivation of paddy crop shows that the average cost per unit of land on inputs like seed, fertilizer, pesticides, human labour, animal labour and water tax is higher in the command area than in the non-command area.

Season-wise change in cost per acre of paddy crop has also been analysed. As compared to the non-command area, percentage of increase in cost in the command area during viruppu and mundakan is found to be 8.9 and 3.47 per cent respectively. Cultivation cost per unit of land during puncha season is much higher than the other two seasons. Reaches-wise cost of cultivation of paddy crop shows that among the three reaches in the command area, cost of cultivation per unit of land in the middle reaches is the highest. It is followed by upper reaches and lower reaches in that order.

Non-Paddy Crops

Cost difference per unit of land in the command and non-command areas for non-paddy crops shows that cost is 17.06 per cent higher in the command area.

Among the various non-paddy crops raised in the command and non-command areas, the average cost for banana is found to be much higher as compared to the other crops. It is followed by coconut, tapioca, vegetables and others, and arecanut.

Cost difference per unit of land shows that it is the highest for coconut. That is followed by paddy, banana and arecanut. But in the case of tapioca and vegetables and others, costs per unit of land has been reduced as a result of irrigation.

Yield Structure

The yield structure in money terms of all crops in the command and non-command areas shows that average yield per unit of land for all crops in the command area is higher than in the non-command area.

Paddy Crop

The yield difference between command and non-command areas for paddy crop by all seasons is found to be 17 per cent higher in the command area.

The yield difference between command and non-command areas for HYV and local varieties is found to be 12.63 and 8.13 per cent respectively. The yield difference for HYV is greater than the local variety.

Season-wise yield difference has also been analysed. It shows that the yield difference between command and non-command areas during viruppu and mundakan is 12.58 and 6.78 per cent respectively. Puncha crop was raised only in the command area. Its average yield per unit of land is much higher than the other two seasons.

The reaches-wise classification of yield per unit of land for paddy crop reveals that among the three reaches the average yield per unit of land in the middle reaches is found to be the highest. It is followed by upper reaches and lower reaches in that order.

Non-Paddy Crops

Yield per unit of land for non-paddy crops in the command area is higher than in the non-command area.

Among the non-paddy crops, the percentage of yield difference per unit of land for tapioca is the highest. It is followed by coconut, arecanut, banana and vegetables and others.

Net Return

Crop-wise net income per unit of land in the command and non-command areas for gross cropped area has been analysed.

Among the various crops in the command area the net income per unit of land for coconut is found to be the highest (Rs.8,668). It is followed by banana (Rs.8,365), arecanut (Rs.5,771), vegetables and others (Rs.3,912), tapioca (Rs.2,835) and paddy (Rs.533).

In the case of non-command area the net return for banana is found to be the highest (Rs.6,204). It is followed by coconut (Rs.6,098), arecanut (Rs.4,458), vegetables and others (Rs.2,820), tapioca (Rs.1,883) and paddy (Rs.243).

The net income per unit of land for paddy crop is the lowest both in the command and in the non-command areas.

The percentage of change in net income as a result of irrigation has also been analysed. Irrigation has increased net income per unit of land for all individual crops in the command area. The percentage of net income difference for paddy crop is found to be the highest. It is followed by tapioca, coconut, vegetables and others, banana and arecanut.

It is interesting to note that irrigation has increased both cost and yield per unit of land in the command area. But yield increase per unit of land is more than proportionate to cost increase. The other important finding of the study is that the output-input ratio for all crops and individual crops in the command area is higher than in the non-command area.

Recommendations

On the basis of the findings of the study the following recommendations are made:

1. The study found that the intensity of paddy crop in the command area is comparatively lower than the non-command area. So efforts should be made to enhance cropping intensity of paddy crop in the command area.

2. Where there is water logging, growing of other crops like coconut, arecanut etc. should be encouraged as these crops will prove more remunerative than paddy.

3. To solve the problem of water shortage at the tail end portion of the canal region lining of the canal is to be done.

4. Farmers may be encouraged to use High Yielding Varieties of seeds in the command area. This will help them to get better returns.

BIBLIOGRAPHY

Adinarayanan, S., (1984): "Impact of Irrigation on Employment, Farm Productivity and Income under Kakatiya Canal of Sriramsagar Project in Andhra Pradesh", Indian Journal of Agricultural Economics, Vol.39, No.3, p.534.

Aggarwal, J.C., (1993): "Eighth Five Year Plan" Planning and Development in India.

Azeemudin Khan., (1993): "Impact of Tube-well Irrigation on Paddy - A Study in Tribal and Non-Tribal Area," Agricultural Banker, Vol.16, No.2, April-June, pp.40-48.

Azimmoddin Khan., (1992): "Impact of Tube well Irrigation on Agricultural Development," Agricultural Banker: Vol.151, No.11, April-June, pp.15-17.

Aziz Abdul., (1979): Irrigation and Economic Change in a Karnataka Village, in G. Thimmaiah (Ed) Studies in Rural Development, Chugh Publications.

Baldev Singh., (1978): Economics of Irrigation - A Regional Perspective, (A Case Study of DPAP Dist), Surendra Nagar.

Bandopadyaya, Jayant., (1984): "Economics of Large Dams," in Goldsmith, E and Hildgard, N (eds), Social and Environmental Effects of Large Dams, Vol.2, pp.209-213.

Balgit Singh. and Misra., (1965): Benefit Cost Analysis of the Sarada Canal system, London, Asia Pulishing.

Bansil, P.C., (1972): "Production pattern and Green Revolution," Indian Journal of Agricultural Economics, Vol.XXVII, No.4, Conference Number, December, pp.104-108.

Basu, S.K. and Mukerjee, S., (1963): Evaluation of Damodar Canals (1959-60), Calcutta, Asia Publishing House.

Chambers, Robert., (1988): Managing Canal Irrigation, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.

Chawla, J.S. Gill, S.S. and Singh R.P., (1972): "Green Revolution, Mechanisation and Rural Employment: A Case Study in Amritsar District," Indian Journal of Agricultural Economics, Vol.XXVII, No.4, October-December, pp.200-204.

Chopra, Kancha Datna., (1972): Dualism and Investment Pattern — Analysis of Regional Contrasts (New Delhi, Tata McGraw Hill, Company.

Clark, Colin., (1957): The Conditions of Economic Progress, MacMillan and Company Ltd., London.

Cowered, E. Walter., (1980): Irrigation and Agricultural Development in Asia: Perspective from the Social Sciences, Cornel University Press, Ithaca and London.

Dantwala, M.C., (Ed.1971): Comparative Experience of Agricultural Development - Developing Countries of Asia and South East since World War II.

Das Gupta, K.K, Hemalatha Rao & Nelson, C.,(1979): "Impact of Tank Irrigation," in Nadkarni, MV (Ed), Impact of Irrigation - Canal, Tank and Well, Himalaya Publishing House, Bombay, pp.32-40.

Das Gupta, K.K., (1973): Agriculture and Economic Development in India, Associated Publishing House, New Delhi, pp.36-39.

Dastune, N.G., (1969): "Irrigation - New Concepts", Economic and Political Weekly, 4(13) A 27 to A 30.

Despande, R.S., (1987): "Impact Studies K.R.S. Farm Economy" (Mimco) I.S.E.C, Bangalore.

Dharam Narain., (1965): "Impact of Price Movement Areas Under Selected Crops in India", 1900-1939, Cambridge University Press.

Dhawan, B.D., (1985): "Labour Absorption in Irrigated Agriculture: The Case of Canal Irrigation in Maharashtra," in Proceeding of the seminar, Employment Generation Through Improved Irrigation, Indian Water Resource Society, Roorkee, pp.21-22.

—— (1986): "Output Impact According to main Irrigation Sources: Empirical Evidence from four selected States," paper presented at the seminar on Water management: The Key to Development of Agriculture, Indian National Science Academy, New Delhi.

—— (1986): Irrigation in India's Agricultural Development: Productivity, Equity and Stability, Sage Publications, New Delhi.

—— (1987): Water management in Mula Command : A Study in Productivity Impact of Canal water, Indian Journal of Agricultural Economics, Vol.XXXXII, No.1, January-March, p.49.

—— (1988): Irrigation in India's Agriculture, Sage Publications, New Delhi.

—— (1988): "Development and Management of Water Resource in North-Western India", Economic and Political Weekly, Vol.IX, October, pp.2217-2220.

Divakar, G.D., (1989): "Impact of mechanisation on Labour Employment in Well Irrigation in Western Rajasthan," Indian Journal of Agricultural Economics, Vol.XXXXIV, No.4, October-December, pp.44.

Epstein, T.S, (1962): "Economic Development and Social Change in South India," Manchester University Press, Manchester.

Feeder, Gerson., (1980): "Farm size, Risk Aversion and the adoption of New Technology under uncertainty", Oxford Economic Papers, Vol.2, No,2, (New Series).

Fijiwara Kenzo., (Ed), (1982): Geographical Field Research in South India, The Research and Sources Unit for Regional Geography, University of Hiroshima.

Frankel, F.R., (1971): India's Green Revolution; Economic Gains and Political Cost, Princeton university Press, Princeton, New Jersy.

Gadgil, D.R., (1948): Economic Effects of Irrigation: Report of the survey of the Direct an Indirect benefits of Godavari and Provara Canals, Gokhale Institute Political Economics, Poona.

Garg, J.S., Omprakash and Srivastava, N., (1972): "Impact of modern Technology on Rural Development". Indian Journal of Agricultural Economics, Vol.XXVII, No.4, October-December, pp.207-210.

George, P.S., (1981): "Agricultural Price Movement in Kerala," Seminar on Agricultural Development in Kerala, Economic Department, Calicut.

George P.T, and Raj K.N., (1981): Absorption of Human Labour in Command Area: A case Study of Nagarjuna Sagar Command Area, National Institute of Rural Development, Hyderabad.

Ghose, M.G., (1984): "Impact of Irrigation on Income and Employment: A Case Study of Bengal Village", Indian Journal of Agricultural Economics, Vol.XXXIX, No.3, July-August, p.549.

Ghodke, R.D. and Ryam, J.G., (1981): "Human labour Availability and Employment in Semi- arid Tropical India", Indian Journal of Agricultural Economics, Vol.XXXVI, No.4, October-December, pp.31-34.

Government of India., (1974): Irrigation Projects of Kerala, Public Works Department.

Gopinath, C. Mukunda Das., (1978): Intensive Rural Development Project in Thirthala Block of Kerala, Social Cost Benefit Analysis of Selected Blocks, Centre for Management of Agriculture, Indian Institute of Management Ahmedabad.

Gupta, S.P., (1987): "Growth and Instability in Food Grains Production: An Interstate Analysis", Economic and Political Weekly, Sep. 26 1987.

Government of India., (1985-90): Seventh Five Year Plan, Planning Commission.

Government of India., (1972): Report of the Irrigation Commission, Ministry of Irrigation and Power, Vol.III, Part II.

Government of India : Draft Five Year Plan 1978-83, Planning Commission.

Government of Kerala : Statistics for Planning, Directorate of Economics and Statistics,1977-1986

Government of Kerala., (1973): "Economic Review", Planning Board.

Hanumanth Rao, C.H., (1972): Technological change and Distribution of Gains in India's Agriculture, MacMillan, New Delhi.

Hemalatha Rao., Das Gupta and P.K. Ghose., (1979): "Impact of Tank Irrigation: A Case Study of Tunkuv District " in Nadkarni, MV (Ed) Impact of Irrigation Studies of Canal, Well and Tank Irrigation in Karnataka, Himalaya Publishing House, Bombay.

Ianstone., (1984): Canal Irrigation in British India, Cambridge University Press, London,

International Labour Organisation (1961): Employment Objectives in Economic Development, Report of a Meeting of Experts, Geneva,

Iqbal Ali, Balbeer Singh., (1992): "Impact of Irrigation on Adoption of Agricultural Innovation - A Case Study in Command Area", Agricultural Banker, Vol.12 No.4, October-December, pp.7-11.

Jassu Wala: Socio-Economic Benefits of Nizam Sagar, Hydrabad.

Jha, Diwakar., (1967): Evaluation of Benefits of Irrigation — Tribeni Canal Report (mimco), Orient Longmans, New Delhi.

Joshi, P.K., Bhal, D.K. and Jha, D., (1981): "Direct Employment Effects of Technical Change in Uttar Pradesh Agriculture", Indian Journal of Agricultural Economics, Vol.XXXIII, No.4, October-December.

Jose Jacob., (1993): "Effectiveness of Irrigation Projects in Kerala," Yojana, Vol.37, No.5, pp.8-10.

Kalra, G.S and Sangale, S.B., (1985): "Improved Irrigated Agriculture - An Aid to General Employment Potential," in proceedings of the Seminar on Employment Generation Through Improved Irrigation, Indian Water Resources Society, Roorkee, p.14.

Kamble, N.D., Abdul Aziz, C., Charles Wilson. and Nageswara Rao., (1979): "Economics of Well Irrigation: A Case Study of Kolar District, Karnataka" in Nadkarni MV (Ed), Impact of Irrigation - Canal, Tank and Well, Himalaya Publishing House, Bombay.

Kerala Planning Board., (1990): Draft Five Year Plan 1978-83, Economic Review.

Khusro A.M., (1968): The Indian Economy, Stability and Growth".

Krishna Rao, B., (1991): "Planning and Employment Growth", Southern Economist, February 1, pp.7-10.

Krishna Bharadwaj., (1974): Production conditions in Indian Agriculture - A Case Study based on Farm Management Surveys, Occational paper 33 (London, Department of Applied Economics, University of Cambridge.

Mahabir Singh Jaglan., (1993): "Indira Gandhi Canal Command Area: Impact of Irrigation" - Abstract of the doctoral thesis entitled Impact of Irrigation on Environmental and Socio-Economic Conditions- A Case Study of Indira Gandhi Canal Command Area.

Mehra, S., (1976): "Some Aspects of Labour use in Indian Agriculture" Indian Journal of Agricultural Economics, Vol.VII, pp.21.

Minhas, B.S, and Vaidyanathan., (1969): Water Requirements of Crops and Economic Eufficiency of Irrigation Water of India, Symposium on Water and Soil Management, New Delhi, (ICAR).

Minor irrigation in Bhojpur District, Bihar, Evaluation Series No.12, Agricultural Finance Division, Bombay 1982.

Misra, G.P. and Vivekananda, M., (1979): "Impact Irrigation in Rural Area, A Case Study of Canal Irrigation in Bellarry District," in MV Nadkarni (ed), Impact of Irrigation - Canal, Tank and Well, Himalaya Publishing House, Bombay.

Nadkarni, M.V., (1984): "Irrigation and Rural Development: A Skeptical View, "Economic and Political Weekly, Vol.XX, Review of Agriculture, June, pp.67-73.

—— et.al., (1979): Impact of Irrigation - Canal, Tank and Well, Himalaya Publishing House, Bombay.

Nagashimamurthy, M., (1978): Investment Criteria and Economic Development (Delhi), Ph.D Thesis, Department of Economics, University of Delhi.

Naidu, C. Devarayalu., (1987): Economics of Irrigation : A Study of Farm Productivity, Income and Employment Under Tungabhadra Project, Venkateswara University, Tirupathi, p.168.

Nagabushnam, K.S., Rao, B.S., Report of the Socio-Economic Survey of the Nagarjuna Sagar Project, Andhra Pradesh, Hyderabad, Nagarjuna Board, Government of Andhra Pradesh.

Narayanan, D.L., (1985): National Perspective for Rural Development, Presidential address for the National Seminar on Bank Finance and Rural Development, S.V. University, Tirupathy, p.5.

Nirmal Singh., Jain, K.K., Bhallawa, B.S., (1984): "Potential of Labour Absorption in Agriculture under the Normative Adjustments in Punjab," Indian Journal of Agriculture Economics, Vol.XXXVI, No.4, p.54.

Pant Niranjan., (1985): Productivity and Equity in Irrigation systems, Ashish Publication House, New Delhi.

Patel. and Patel., (1948): "Irrigation and Employment" in Chambers, Robert (ed) Managing Canal Irrigations, Oxford and IBH Publishing Company Ltd.

Patel, Arun s., (1981): "Irrigation and its Employment Impact on Command Areas of Medium Irrigation Projects in Gujarat," Indian Journal of Agriculture Economics, Vol.XXXVI, No.4, pp.22-51.

Patil, R.K., (1986): "A Neglected Aspects of Benefits - Cost Analysis in Irrigation Development," Paper Presented in the National Seminar on Water Management — The Key to India's Agricultural Development, National Science Academy, April, New Delhi.

Personal Communication to Bureau of Economics and Statistics.

Prakash, Mehta, T.V., Moorthi. and Anjala Kumari., (1985): Effects of Irrigation in Determining Human labour Employment in Himachal Pradesh, in proceedings of the Seminar on Employment Generation Through Improved Irrigation, Indian Water Resources Society, Roorkee, p.101.

Prasad Rao, B., Krishna Mohan, P., (1985): "Impact of Irrigation on Labour Absorption Wages, Productivity and Share of Labour - A Case Study," in proceedings of the seminar on Employment Generation Through Improved Irrigation, Indian Water Resource Society, Roorkee, p.29.

Project Evaluation, Organisation, Planning Commission., (1961): Report of regarding study of multiplication and Distribution of Improved Seeds.

Puttaswamiah, K., (1989): Cost-Benefit Analysis of Irrigation and Drought Proofing, Oxford and IBH Publishing Private Company Ltd, New Delhi.

Raj, K.N., (1960): "Economic Aspects of Bakranangal Project, New Delhi, Asia Publishing House.

Raj, K.N., (1959): "Employment and unemployment in Indian Economy," Economic Development and Cultural Change, April, Vol.IV, pp.25.

Raj, K.N., (1961): (Some Questions Concerning Growth, Transformation and Planning of Agriculture), Included in Economic Development in South Asia, Edited by Robinson, EAG and Kidron, Michel.

Ramachandra, V.K., (1984): "Irrigation Agriculture and Irrigation Labour - A Study of Chambur Valley, Madurai District," Paper presented to Community Responses to Irrigation, SSRC South Asia Committee Conference, January 4-7, Bangalore.

Rao, Hanumantha C.H., (1976): Technological Change and Distribution of Gains in Indian Agriculture (Delhi), McMillan Company of India (Ltd).

Rao, K.L., (1967): "Planning and Development of Water Resources in India, Ministry of Irrigation and Power, Government of India.

Rao, S.K., (1971): "Inter Regional, Variation in Agricultural Growth, 1952-53 to 1964-65 — A Tentative Analysis in Relation to Irrigation," Economic and Political Weekly, July 1971.

Rao, V.K. R.V., "Water management" - A Neglected Aspects of Indian Agriculture," Economic and Political Weekly (2,3,4, and 5) February, pp.335-340.

Roslow, W.M., (1971): The Strategies of Economic Growth, IInd Edition, Cambridge University Press

Roy, T.k., (1983): "Impact of Rajasthan Canal on Socio-Economic and Environment Condition, NCAER, New Delhi, Allied Publication Company.

Robinson, Joan., (1938): "Disguised unemployment," Economic Journal, Vol.46, June, pp.225-237.

Ruth, Meinzen-Dick and Mark Svendson. (eds)., (1991): Future Directions for Indian Irrigation - International Food Policy Research Institute, Washington D.C.

Sanjay, Sinha., (1990): The Development of Indian Silk, Oxford and IBH Private Limited, New Delhi.

Satpathy, T., (1985): Irrigation and Economic Development, Ashish Publishing House, New Delhi.

Satyapriya, V.S., (1981): Labour Utilisation in Agriculture, Shiny Publications, Bangalore.

Sen, S.R., (1970): Conjunctive Approach to Rainfall, surface and Ground Water and Cropping Pattern," Silver Jubilee Souvenir, 1945-70, W&PC, Ministry of Irrigation and Power Government of India, New Delhi, (161-165).

Shah, C.H., Vimal Shah, Sudharshan & Tengas, (1991): Agricultural Growth and Equity, Concept Publishing Company, New Delhi.

Sharma, A.V.K., (1990): "Self Employment Programmes : Retrospect and Prospect," SEDME, Vol.17 (2), June, pp.1-14.

Shetty, Pattana, C.C., (1972): Economics of Lift Irrigation Using Electric Power in South Canadra District, University of Agricultural Sciences, Dhawan (mimco).

Sonachalam, K., (1963): Benefit cost Evaluation of Cauvery Meltur Project, New Delhi, Planning Commission.

Sovani N.V. and Rath, Nilumasith., (1960): Economics of a Multipurpose River Dam (Poona, Gokhale Institute for Politics and Economics).

Srikantan, K.S., Narayanan, B.K. and Vasudeva Rao, D., (1978): Female and Child Work Participation in the integrate Development of a Command Area, Institute for Social and Economic Change, Bangalore, W.Q. Judge Press, Bangalore.

Staup, William, J. and Blase, Melvin Co., (1974): Indiced Technological change in Developing Agricultural Implication for Income Distribution and Agricultural Development: The Journal of Development Area, 8(4) July (581-596).

Vaidyanathan, A., (1978): Labour use in Indian Agriculture - An Analysis Based on farm Management Survey Data," in P.K. Basham, A Vaidyanathan and Alagh, Y, Bhella, G.S and Bhaduri (eds), Labour Absorption in Indian Agriculture - Some Exploratory Investigations, International labour Organisation, Bangkok.

Vaidynathan, A. and Jose, A.V., (1978): "Absorption of Human Labour in Agriculture - A Comparative Study of Some Asian Countries," in Bardhan, P.K Vaidyanathan A, Alagh Y, Bhulla, G.S. and Bhaduri (eds.), Labour Absorption in Indian Agriculture - Some exploratory Investigations, International Labour Organisation, Bangkok.

Vaidyanathan, A., (1986): "Labour use in Rural India - A Study of Spatial and Temporal Variations," Economic and Political Weekly, Vol.XXI, No.52, A-130, December.

Venkettaramani, G., (1974): Minor Irrigation in Tamil Nadu, Madras Institute of Development Studies, Sangom Publishers, Madras.

Venkata Reddy, War Band, (Rotational Water Supply) - A system for Egalitarion Distribution of Water in an outlet command.

Vidyaputh, M.P.K., (1980): An Investigation into the Socio-Economic Conditions of GHOD Command Area, Rohur, Ahmednagar,

Vinner, Jacob., (1957): "Some Reflections on the concept of Disguised unemployment, Indian Journal of Agricultural Economics, Vol.38, No.148, pp.17-23.

Vyas, U.S. and Mathai, G., (1978): "Farm and non Farm Employment in Rural Areas - A perspective for planning", Economic and Political Weekly, February, Vol.IX, p.337.

William, Donald A., (1968): Water Utilisation in India - Situations, Development and Recommendations (New Delhi) The Ford Foundation).

White, G.F., (1978): Environment Effects of Arid Land Irrigation in Developing Countries, MBA Technical Notes, UNESCO Publication, pais, p.5.