ECONOMIC ANALYSIS OF DRYLAND FARMING TECHNOLOGIES - STUDY OF EFFICIENCY AND ADOPTION IN CENTRAL DRY ZONE OF KARNATAKA

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CERTIFICATE

This is to certify that the thesis entitled "**ECONOMIC ANALYSIS OF DRYLAND FARMING TECHNOLOGIES - STUDY OF EFFICIENCY AND ADOPTION IN CENTRAL DRY ZONE OF KARNATAKA**" submitted by **Mr. BONAVENTURE GLADWIN D'SOUZA** for the degree of **MASTER OF SCIENCE in AGRICULTURAL ECONOMICS** of the **University of Agricultural Sciences, Bangalore**, is a record of research work done by him during the period of his study in this University under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or any other similar titles.

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CHAPTER I

INTRODUCTION

To feed the ever growing population, India has to produce 240 million metric tonnes of foodgrains by the year 2000 A.D. The requirements of food grains by 2025 A.D. would be around 425 million metric tonnes for a population growth of 2.4 per cent per annum from the present year (Itnal, 1996). The other basic necessities of mankind and his livestock would also increase enormously. The present food production is 192 million tonnes (1994-95).

Of the total geographical area of 329 million hectares in the country, only 144 million hectares is under cultivation. Nearly 72 per cent of this cultivated area is subjected to varying degrees of weather vagaries and veseccitudes. The rainfed areas in arid and semi-arid tropical regions of India, usually called dry-farming areas, account for about two fifths of country's geographical area, one third of its rural population and one half of its cropped area and contribute to over 42 per cent of total food production. This tilts the balance of food production in view of its dependency on low and erratic monsoon. According to VIII plan commission, even if all the irrigation potential is fully exploited, over 50 per cent of total cultivated land continues to be under rainfed farming by the end of this century.

Agricultural productivity is vitally linked with rainfed farming. Rainfed farming accounts for 95 per cent of sorghum, 94 per cent of pearl millet, 66 per cent of ragi, 80 per cent of gram, 84 per cent of groundnut, and 70 per cent of cotton grown in India, in addition to fodder, fuel, fruit, etc. The situation in Karnataka is still worse, in view of the fact that 78 per cent of its total cultivated area of 10.41 million hectares is rainfed. Even if all the water resources are fully tapped, 70 per cent of the land would still be rainfed.

But the problems of rainfed agriculture are manifold, viz., low and erratic rainfall, soil erosion, degradation of soil fertility, low and unprofitable production, lack of suitable implements , poor resource base, energy scarcity, depletion of natural resources and farm fragmentation, under main limiting factors -- land, Water and Capital.

This situation has compelled our planners, political thinkers, scientists and administrators to evolve new improved dryland agricultural practices which are in line with the development objectives, as to increase land productivity and net income and to minimise production risks by;

a) Improving soil fertility management-aimed at increasing the bio-availability of soil nutrients, replenishing lost nutrients and maintaining soil structure through cropping system and balanced and economic applications of organic and inorganic fertilizers.

b) Increasing the productivity of rainfall through a combination of insitu moisture conservation and appropriate agronomic practices and retention, utilisation and safe conveyance of field runoff within the farm.

c) Improved land use system and revegetations emphasising agro-forestry techniques providing food, timber, fibre and/or fodder.

Therefore the development of rainfed farming gains paramount importance because of increased demand for foodgrains on one side and the potentiality for increasing food production on the other side. Realising this importance in light of these objectives, the Central and State governments have launched special programmes to improve rainfed farming.

The ambitious programme from Karnataka is the commissioning of Dry land Development Boards (DLDB's) in 1984-85. The other programme is the National watershed Development project for rainfed areas (NWDPRA) in 1990-91. The project is being implemented in 25 states and two Union Territories in the country involving an overall outlay of Rs. 13.38 billion. The project is fully operational in 2,543 micro watersheds spread over 115 agroclimatic zones and covers an area of about 4.6 million hectares. These programmes have shown that increases in yield is possible with the adoption of improved technologies. Yield increases in agricultural crops resulting from increased moisture availability induced by field bunds is 20 per cent, whereas substantial yield increase of 100 per cent or more can be realised when improved agronomic practices (tillage, seeds, fertilizer, pesticide, cropping system etc.,) are combined with soil and moisture conservation activities (Jensen, 1996). The impact of adopting bunding in red soils of Chitradurga has resulted in increasing crop yield, Jowar (20.8 per cent), Ragi (30.6 per cent) and groundnut (23.8 per cent) (Mohanrao, 1996).

NEED AND OUTLINE OF THE STUDY

Adoption of the technology by the farmer depends on several factors such as his socio-economic features, the economic viability etc. Farmers have to be convinced about the economic benefit that accrues by adopting new technology. This is very important in dryland farming as a considerable amount of risk is involved in the use of new technology which is basically an investment decision. Very few studies in the past attempted to this vital component of economic viability of dry land technology and the economics of adoption of the same by the farmer. The present study in this respect is a modest attempt in analysing the level of adoption of dryland technology under two headings : Soil and moisture conservation practices and Crop production practices for two important dry land crops namely, ragi and groundnut. The study also attempted to analyse the socio-economic features which influence the level of adoption as well as the efficiency of the farmers.

The specific objectives of the study are :-

1. To study the level of adoption of dryland technologies in Ragi and Groundnut production in Central Dry Zone of Karnataka,
2. to decompose the change in output into technological and input components,
3. to study the technical efficiency of ragi and groundnut production and the factors influencing the same, and
4. to document the opinions of the farmers with respect to technological option.

The following were the working hypothesis formulated to conduct the study :

1. Dry land technologies (DLT) are scale neutral and hence can be adopted by all categories of farmers.
2. A package of particular dryland technologies rather than the use of inputs is important in increasing the output of dryland crops.
3. Dry land farmers use more of marketed inputs such as fertilizer than locally available FYM.
4. High adopters are more efficient in the use of inputs than low adopters in dry land agriculture.
5. Adoption of technology is relatively more in the case of marketed commercial crop than the subsistence crop needed for home consumption.
6. Even with the associated risk and uncertainty in production, the farmers using dryland technologies can attain high technical efficiency levels.

Review Of Literature

CHAPTER II

REVIEW OF LITERATURE

This chapter attempts to define and explain the various concepts involved in the present study, with the backing of some reviews of relevant literature, in order to gain better understanding of the same. A review of past research helps in identifying the conceptual issues relevant to the study. This would enable the researcher to collect appropriate data on the problem and subject them to sound reasoning and meaningful interpretation. Accordingly this chapter has been organised under the following sub heads :

2.1 Concept of technical change and its measurement

2.2. Studies on decomposition analysis

2.3 Adoption of technology and the factors influencing adoption

2.4 Concept and measurement of technical efficiency

2.1 CONCEPT OF TECHNICAL CHANGE AND ITS MEASUREMENT

Various authors have defined technical change in different ways and adopted different methods to measure its effect on components of production. The relevant literature with respect to such definitions and measurements are reviewed.

Stout and Rutton (1958) defined technical change in the parameters of production function resulting directly from the use of new knowledge. This encompasses both natural shift and changes in the slope of production function.

Rutton (1960) measured technical change through its impact on cost structure, shifts in industry demand curves for factors of production and supply curves for final products.

Dantawala (1970) observed that the key factor behind green revolution was the new technology with the high yielding varieties as its core. He concluded that transformation of traditional agriculture was a quantitative technical phenomenon whose authenticity was not conditional upon a geographical coverage.

Hayami & Rutton (1970) compared the technological progress in agriculture between United States and Japan during 1880-1960, which was land augmenting for Japan and labour augmenting for United States respectively.

Peterson and Hayami (1973) denoted technical change as the act of producing new knowledge and the technological change as the incorporation of new knowledge in the production process. They further stated that the technical change could be measured either in terms of a change in the ratio of output to conventional inputs or shifts in the production function.

Shah (1980) stated that the technological innovations were responsible to make India self-sufficient in food which had been the main goal of our economic development. He defined technological innovation as a concrete identifiable new factor of production, material as well as non-material to which the increase in production was attributed.

2.2. STUDIES ON DECOMPOSITION ANALYSIS

The change in productivity may be attributed to increased use of inputs or due to adoption of modern technology or both. Hence, a few related studies on the effect of technical change on the yield of crops are reviewed below.

Singh *et al* (1972) studied the impact of new technology on production pattern and yield level of major food grains and oilseed crops in Mohindergarh district, a typical dry farming region in Haryana State. The study revealed that remarkable changes took place in cropping pattern after the introduction of new technology. Application of even small doses of fertilizers and plant protection material resulted in a remarkable increase in yield of crops.

Prabhakar (1973) in his study on the impact of improved dry farming technology in Dodaballapur taluk, Karnataka found that the adopters harvested 100 per cent higher yield of ragi (5.83 quintals per acre) than their non-adopters (2.92 quintals per acre). He also stated that the small (adopters) farmers obtained the highest yield as compared to other size groups in the same category, while non-adopter farmers obtained the highest yield and in both the cases medium farmers obtained the lowest yield.

Bisaliah (1977) decomposed the output change under new production technology in wheat farming for various factors of production for the data from Ferozpur district of Punjab and found that the per acre production of Mexican wheat was about 40 per cent higher than that of the local variety. The contribution of the components like technical change, increased use of labour, fertilizers and capital, were 15, 2, 15 and 8 per cent respectively.

Ram and Lalgupta (1978) studied the resource productivity on paddy farms in Chandaula block in Varanasi district. Using the Cobb-Douglas, function they found that the output elasticities of all the resources were significant, indicating that yield could be increased by using more of these resources. The marginal value products of all the inputs were quite high on adopter farms. There was further scope for increasing the use of these inputs on both adopter and non-adopter farms to increase income and profit.

Deshaiah (1980) made a comparative study of the economics of change in production technology in rainfed ragi and groundnut in Tumkur taluk, Karnataka. He found that the average per hectare yield of ragi under local varieties was 12.76 quintals which almost doubled to 24.64 quintals under high yielding varieties. The yield difference was statistically significant at 1 per cent level. The small farms obtained highest yield per hectare (13.46 quintals) under local varieties while large farms obtained the highest yield per hectare (26.01 quintals) under high yielding varieties.

In case of Groundnut, the average yield of local varieties was 6.79 quintals per hectare which increased to 14.07 quintals under improved varieties. This accounted for an increase of 107 per cent which was significant at 1 per cent level.

Kumar and Singh (1980) in their study at IARI, New Delhi, used decomposition analysis to apportion the total changes in milk production in terms of contribution of breed (technology). The study showed that, out of 70 per cent change in milk yield, 36 per cent was due to technological change (contribution of breeds) and 34 per cent was due to change in feed levels.

Sanjeev (1985) in his study on economic evaluation of rhizobium-gypsum technology in groundnut production in Karnataka, decomposed the total change in output due to gypsum and rhizobium adoption. He found that users of rhizobium and gypsum obtained 19.60 per cent more output. Where as the contribution due to efficiency of gypsum and rhizobium was estimated to 8.22 per cent and contribution due to input change was 10.99 per cent.

Umesh (1985) decomposed the total change in per acre output due to technological (variety) component and level of input used per unit area cultivated. The total change in output of three varieties of paddy such as Sonamassuri (V1), Tellahamsa (V2), and Massuri (V3) were studied in combination. The total change in output was found to be 28.1, 34.4, and 6.30 per cent between V1 and V2, V2 and V3, V1 and V3 varieties respectively. Out of the total change, the contribution of technology was to the extent of 18.98, 17.19 and 4.06 per cent, where as contribution of input change was to the extent of 9.09, 17.23 and 2.24 per cent.

Murthy (1987) decomposed the total change in labour input between the bullock and tractor farms due to technological change and estimated to be 179.17 man hours per hectare. This incremental labour employment to an extent 179.17 man hours in tractor farms was due to various technological effects like tractor ploughing effect (43.41 man hours), variety effect (73.84 man hours), mechanical threshing effect (25.5 man hours) and the interaction effect.

2.3 ADOPTION OF TECHNOLOGY AND THE FACTORS INFLUENCING ITS ADOPTION

A few studies related to logit analysis and adoption of technology are reviewed in this section.

Giriappa (1978) attempted to access the effectiveness of new potato varieties and see the performance index aggregating yield, income, cost ratio, man hours per quintal and material cost per quintal (labour capital). The new varieties were found to register 9.8 per cent higher performance than the existing varieties. Size wise medium farms performed better owing to high labour and capital coefficients. Smaller farms have low rate of adoption and performance. Apart from agro climatic conditions factors like high input cost, quality preferences have stood in the way of adoption of modern technology.

Rathore and Mohan (1978) examined the factors affecting the use of improved agricultural inputs in the hilly region of Rajasthan. The farmers were classified as adopters, non-adopters and reversionists. The inputs selected were hybrid maize, high-yielding varieties of wheat, chemical fertilizers and chemical plant production measures. The factors were grouped into two types namely Situational and External.

In Hilly regions, lack of technical know-how seems to be the factor responsible for non-adoption whereas in the case of plain region lack of funds was an important reason. The main reason for the reversion from improved practices in hilly region was lack of resources including irrigation.

Flin and Shakya (1985) conducted a study on the adoption and use rate of fertilizer on modern varieties (MV) of wheat in the Tarai of south-eastern Nepal using a multivariate Tobit regression model. Factors significantly related to fertilizers use on MV of wheat were the area under wheat, extent of irrigation, fertilizer, transportation cost and operators tenure status. Owner farmers with larger areas of wheat were more likely to use fertilizer and at higher rates than tenants with smaller wheat areas. Whereas formal sources of credit, his years of schooling and intensity of extension visits were non-significant factors. Fertilizer adoption was sensitive to cost of fertilizer procurement, and farmers in the area are responsive to fertilizer price.

Chattopadhya (1986) studied the farmers adoption behaviour, on the New Rice Technology in West Bengal using the logit model. He considered the Social-Institutional variables like education, farm size, ownership status and found that educated owner cum tenants, with bigger farm size have favourable impact on adoption. The next favourable situation was bigger farm size but illiterate owner cum tenants. The most unfavourable situation being illiterate small owners.

Lavaraj and Gore (1987) studied the process of cross bred goat adoption during the last decade in the town of Narayangaon, of Maharastra state. He assumes that the process of adoption is only through the interaction of adopters and potential adopters. He used the internal influence model (logistic model) and his analysis indicates that 39 per cent of the families will adopt C-B goats and no external influences such as advertisements, pamphlets, T. V., seem to have played any role in the spread of this innovation.

Lin (1991) examines the effects of education on the adoption of new technology. The study treats the adoption of rice as a portfolio selection problem. The variables included are price variables namely prices of seeds, fertilizer and pesticides. The other variables are household specific characters including endowments in land holding, labour, capital, dummies for credit availability and state rice procurement quota and average education level of adult household members. The last group of variables included were the household heads personal characteristics, including dummies for job type and sex, years of experience in agriculture and years of education and also dummies for the four provinces selected.

His results indicate that household heads education level has a positive effect on the probability and intensity of adoption. The other independent variable, like experience in agriculture, existence of government procurement quota, size of farm land have positive impacts and price of hybrid seeds have negative impacts.

Saleth (1991) studied the factors affecting farmers decision to buy ground water in the Indo-Gangetic region using logit model. It was postulated that the probability of a farmer buying ground water depends upon his individual attributes like farm size, no. of farm fragments, inputs used, etc.

Gowda (1992) in his study on the consequences of water shed development programme in Karnataka, finds continuous adoption among participant farmers to be around 66.22 per cent in case of strengthening of existing bund 17 per cent with regard to small section bund. Whereas non adoption was noticed in small section bund and dead furrows to the extent of 28.33 per cent and 20.56 per cent respectively. 100 per cent adoption was noticed in case of sowing across slope, 15 per cent in respect of paired row technique and 12 per cent have adopted seed-cum fertilizer drill. The main reason for non-adoption were lack of conviction, difficulty to establish, lack of capital and high cost.

Yaron, Dinar and Voet (1992) in their study on the identification of the factors affecting the adoption of different innovations that are not necessarily technically interdependent. The main factors considered are farm gross revenue, (area under each crop), crop yield per hectare, quantities sent to alternate markets, monthly prices, operators involvement in farm work. Price variance as a proxy for the farmers risk tolerance, factors of production (farm fixed capital including irrigation equipment, tractors, orchards, green houses but not value of land, annual quota of irrigation water (m^3), total no. of work days per year including self employment, family members and hired labourers. Land area (La), weighted sum of irrigated and non-irrigated areas. Extension, education, population of the villages specialising in olive cultivation.

Innovativeness is affected positively by risk tolerance, extension and water quota aliotment and affected negatively by the farm's land area. Innovativeness is affected by extension and not necessarily education.

Traxler and Byerlee (1993) studied the adoption of Modern Cereal Varieties in developing countries. They found that with input levels fixed in the short run, varietal adoption depends on relative prices of grain and straw and on input use. In a study conducted by Hegde (1994) on non-timber forest products and tribal economy, logit regression model was employed to capture the probability of a particular tribal household going in for collection of NTFP's . He found out that in block I, i.e., the tribal settlement situated on the periphery of forest, the variables like education, size of family, dependence in the family, and income from agriculture lowered the probability and income from wage labour was found to push up the probability of going for collection of NTFP's.

In the block II, settlements situated in the interior forest, variables like education, and family size were found to increase the probability of tribals going for collection of NTFP's, while variables such as percentage dependence of family income from agriculture, income from subsidiary occupations and income from wage labour were found to reduce the probability.

2.4 CONCEPT AND MEASUREMENT OF TECHNICAL EFFICIENCY

Under this head, studies related to the measurement of efficiency i.e. technical and allocative efficiency and factors affecting the same are reviewed.

Schultz (1964) has argued that there are comparatively few significant inefficiencies in the allocation of the factors of production in traditional agriculture. Supply response, allocative test and profitability of investment were studied systematically to examine the hypothesis regarding efficiency or inefficiency of farming in traditional agriculture.

Hopper (1965) tested the hypothesis that Indian cultivators who use traditional technology make rational profit maximising allocations of factors, by observing the allocation of four major inputs to four production alternatives in North-Central India. He found that, these farmers were efficient within the static economic meaning of the term. The farmers on the average appear to have successfully economised their scarce resources.

Miller (1966) argues that the peasant agriculture is characterised by low levels of utilisation of certain resources, low levels of productivity, and relatively high levels of efficiency in combining resources and enterprises. Efficiency is high in peasant agriculture, as measured by the technical-economic measure of equating marginal returns to resources in alternative use.

Chennareddy (1967) supports the opinion of Schultz (1964), Hopper (1965) and Welsch (1965) that in traditional and technologically stagnant agriculture, farmers are aware of efficient use of traditional inputs. This lends support to the conclusion that agricultural production under such circumstances may not be increased simply by increasing all inputs in the traditional state of the art. A rapid and massive development of agriculture can be achieved only by breaking through the traditional state of the art and introducing modern technology in a package.

Timmer (1971) imposed a Cobb-Douglas specification on the frontier to compute an output based measure of efficiency. This stochastic frontier model assumes an error term that has two components-symmetric component which reflects random factors and a one side component which captures the effects of the inefficiency relative to the stochastic frontier.

Kalirajan (1980) indicated that agricultural policies in developing countries are mostly concerned with the means of increasing production especially of foodgrains. The prime objective of any agricultural policy is to achieve high rates of adoption of new technology by farmers. The fact that success depends on the efficient use of technology receives less attention. Under this head, studies relating to the measurement of efficiency i.e., technical and allocative efficiency under different technological situations are reviewed.

Rana (1982) studied efficiency of resource allocation on Pakistani farms. Econometric and production function analysis were used to study three types of problems relating to resource allocation efficiency of the irrigated farms. Production elasticities and marginal productivities of important resource inputs were measured. Serious evidence of misallocation of resources was identified on both large and small farms.

Alan (1983) considered farm resource productivity under co-operative and individual management condition in a study in Bangladesh. A Cobb-Douglas type of production function analysis as well as a residual method of analysing efficiency revealed that farmer under co-operative management showed lower performance than individually operated farms. Differences in production performance between the two groups were due to poor management of co-operative farms.

Kontos and Young (1983) attempted to measure the degree of technical efficiency on a sample of Greek farms. They revealed that, the mean level of efficiency for the sample farms was 57 per cent, with almost 40 per cent of the sample recording less than 50 per cent efficiency, and with approximately 70 per cent of the farms below the 60 per cent efficiency level. Further, their results indicated that within this group of farms substantial gains in technical efficiency could be achieved, that is same level of total output could be achieved with substantially fewer inputs.

Russel and Young (1983) estimated both Timmer and Kopp measures of technical efficiency by employing frontier production function for 56 farms in north-west England. They found that, the ranking of efficiency levels was the same in both the methods. Moreover, the results indicated that, approximately 36 per cent of the farms were atleast 75 per cent efficient, 75 per cent of farms were 64 per cent efficient and the entire sample was atleast 39 per cent efficient.

Shah (1983) studied allocative efficiency in respect to tenure and technology for Punjab's irrigated agriculture, using the production function approach. Marginal value products were calculated for each input for the average sample farm and for different farm groups i.e., mechanised and non-mechanised farms. Allocative efficiency was then determined statistically by testing the equality between the marginal value product and marginal factor cost of the inputs. The results showed a considerable potential for increasing profit through a reallocation of resources. Excess labour supply was found in average farms, although large and mechanised farms were using the input efficiently. Fertilizer use was found to be non optimal on average, tenant and non-mechanised farms, but large and small farms were using the resource efficiently.

Kalirajan (1984) undertook a study to examine how crucial the issue of efficient use of technology in increasing levels of production by using the stochastic production frontier. Farm-specific technical efficiency were empirically estimated for individual sample observations. Results showed wide variations in the level and technical efficiency among the sample farmers and extension service was identified as an important factor causing the variations.

The estimation of the frontier function by Dawson (1985) for 56 farms in North-West England during a single year (1977/78) indicated that the ordinary least square measure implied that the 'worst' farm was 44 per cent as efficient as the best. However, when the same estimates were computed using 4 year data (i.e., 1974/75 to 1977/78), the 'worst' farm was 57 per cent as efficient as the best. He also argued that the estimates of efficiency based on one years data were little value to the agricultural policy makers because year specific abnormalities may dominate.

Gundurao *et al* (1985) estimated the effect of technology led efficiency gain on the amount of resources saved due to the production of old technology output level using new technology and the potential loss of resources which could have resulted if the new technology level of ragi output per hectare had been produced under local ragi variety and its associated cultural practices. They indicated that the introduction of transplanting method into farms using local ragi variety and broadcasting had contributed to efficiency gains in terms of resource saving (to the tune of about Rs. 53 per ha) and in terms of resource loss averted (to the tune of about Rs. 61 per ha). The introduction of new varieties of ragi into local variety farms, following the transplanting technique has contributed Rs.192 and Rs. 279 per hectare in terms of resources saved and resource loss averted respectively. Further, new ragi varieties, coupled with the transplanting technique into the production situation of broadcasting local ragi variety farms has contributed to saving resources to the tune of Rs. 220 per hectare and averting resource loss to the extent of Rs. 363.

Ranaweera and Hafi (1985) observed, while estimating the technical efficiency of the maize growing farmers by using the frontier production function, that the mean technical efficiency for the sample was 52 per cent, which indicates that the total maize output can be almost doubled if farmers could be encouraged to use the 'best practice technology' and by removing the socio-economic constraints. Nearly one-fourth of the sample farmers were found to be in the technical efficiency range of 51 to 60 per cent and about 58 per cent within the 41 to 70 per cent range.

Kalirajan and Shand (1987) in their study on firm specific technical efficiencies in a multiproduct cycle system, measured technical efficiency using stochastic translog production frontiers. The results show that on an average, sample participants can increase their farm output by 30 per cent by efficiently using existing inputs rather than incurring any additional expenditure on inputs. Farming experience and extension officials visits were found to explain the technical efficiency gap.

Reddy (1987) studied the efficiency levels of small and large farmers in silk cocoon production, using frontier production function analysis. He found that more than 82 per cent of the sample farmers were obtaining atleast 91 per cent of the potential silk cocoon yield. Regarding the use of selected factors in silk cocoon production, the percentage excess use of factors ranged from 42 to 44 in the case of small farms, while it ranged from 58.11 to 60.34 in case of large farms. A higher percentage of large farms (84) were getting more than 91 per cent of potential yield than small farms (82).

Jayaram (1988) employed the frontier production function, to analyse the efficiency in production, both in terms of physical output and the organisation of resources in the production of paddy and ragi in Mandya district. He found that the output efficiency was higher in paddy compared to ragi and the average efficiency for large farms was 97.61 per cent and for small farms it was almost the same at 97.54 per cent in paddy. The output efficiency in ragi was marginally lower at 94.6 per cent among large farms and 92.98 per cent for small farms. Thus the level of technical inefficiency ranged between 3 and 6 percent for paddy and ragi respectively. Further he made an attempt to ascertain whether there was any excess use of resources. In case of paddy there was higher level of input use efficiency among large farms compared to small farms. In case of ragi, most of the large and small farms achieved an input use efficiency level ranging between 41 and 71 per cent respectively. He concludes that the input use efficiency was more in large farms compared to small farms.

Methodology

CHAPTER III
METHODOLOGY

The adoption of a sound methodology and perfect understanding of the design of the study are *Sine Qua non* for any rigorous economic investigation. Hence a brief description of the methods used in this study are presented.

This chapter is dealt under the following heads :

3.1 Characteristics of the study region

3.2 Methods adopted in selecting the sample respondents

3.3 Nature and source of data

3.4 The analytical techniques employed

3.5 Definition of variables

3.1 CHARACTERISTICS OF THE STUDY REGION

The study was conducted in Madhugiri taluk of Tumkur district which comes under the Central Dry Zone (CDZ). The CDZ, agro-climatically classified as zone-4 covers all the nine taluks of Chitradurga district, six taluks of Tumkur district and one taluk of each of Hassan and Chickmagalur districts. The CDZ is spread over a total geographical area of 19,98,509 hectares covering 49 per cent of the total geographical area of Karnataka. It is geographically located at 30° 59' latitude and 17° 37' longitude. The CDZ in general is undulating plateau with an average elevation of 800-900 m above sea level, studded with rocky patches and shrubby jungles. the major rivers of the zone are Vedavathi, Suvarnamukhi and Gayathri. The minor rivers are Kumudavathi and Shimsha which are all seasonal. The zone has a variety of soils : red sandy to red loams are the major types. Scattered patches of shallow to very deep black soils also occur. Tumkur district is located between 12° 45' and 14° 20' North latitude and between 76° 21' and 77° 21' East longitude, in Southern part of Karnataka state, with an area of 106,06 sq. Kms. It comprises of 10 taluks, 50 hoblies and 2,506 villages. The district is bounded by Kolar, Bangalore, Mandya, Hassan, Chitradurga districts of Karanataka and Anathapur district of Andhra Pradesh. Madhugiri taluk has an area of 1,131 sq. Km with 6 hoblies and 285 villages. Some of the basic statistics are presented in Table 3.1.

3.1.1 Population

According to 1991 census the total population of Tumkur district was 23.06 lakhs and that of Madhugiri taluk was 2.45 lakhs. About 83.40 per cent of the district population lives in the rural areas and the remaining 16.65 per cent population in urban areas . In Madhugiri taluk, the total population of 2.23 lakhs consists 91.13 per cent living in rural areas and remaining 0.21 lakhs (0.08 per cent) live in urban areas. About 12.94 per cent of taluks population were agricultural labourers. The literacy level of the district was 46.38 per cent and that of the taluk was 42.07 per cent.

TABLE 3.1 : Some basic statistics of Tumkur district and Madhugiri taluk (1991 census)

Sl. No.		Tumkur district	Madhugiri taluk
1	Area (Sq. Kms.)	10,600	1,131
2	No of taluks	10	
3	No of hoblies	50	6
4	No of inhabited villages	2506	285
5	No of uninhabited villages	221	36
6	No of town and cities	12	1
7	Population (lakhs)		
a.	Total	23.06	2.45
b.	Rural	19.24	2.23
c.	Urban	3.82	0.21
d.	Male	11.77	1.25
e.	Female	11.29	1.19
8	Literacy level (per cent)		
a.	Male	66.49	65.03
b.	Female	41.93	34.96

Source : Anonymous, 1996a, 1996b.

3.1.2 Agricultural economy

Table 3.2 presents some important aspects of agricultural economy of the district and the taluk. Madhugiri taluk had 11.5 per cent of the total cropped area of the district. Twenty three per cent of the net cultivated area in Madhugiri taluk was irrigated, while for the district as a whole the percentage was only thirteen. In the district as well as in the taluk, the important cereal crops are ragi, paddy, maize and other minor millets. Groundnut and sugarcane are the important commercial crops.

3.1.3 Climate and rainfall

Madhugiri taluk comes under the Central Dry Zone. The year may be divided into four seasons. The dry season, with clear bright weather is from December to February. The period from March to May constitutes the hot season and the South West monsoon is from June to September, October and November may be termed the Post monsoon season. The monthly rainfall varies from 40.5 mm in May to 118.6 mm in October. The post monsoon month of October having the heaviest downpour. The soils of Madhugiri are a mixture of red fine loam and red sandy loam.

3.2 SAMPLING DESIGN

Ragi is cultivated in Tumkur, Hassan, Bangalore rural, Mysore and Kolar districts of Karnataka. Groundnut is predominantly grown in Tumkur, Chitradurga,

TABLE 3.2 : Agricultural economy of Tumkur district and Madhugiri taluk, (1991 census)

Sl. No.		Tumkur 000 ha.	Madhugiri 000 ha.
1. a.	Total geographical area	1065	112
b.	Gross cropped area	590	67.5
c.	Net cropped area	561	61.4
d.	Net irrigated area	73	14.05
e.	Net area irrigated as a per cent of net sown area	13.01	22.8
2.	Area under important crops		
a.	Ragi	166.4	5.86
b.	Groundnut	177.02	37.10
c.	Paddy	22.50	2.82
d.	Maize	3.17	2.31
e.	Sugar cane	2.90	1.42

Source : Anonymous, 1996.

Dharwad, Kolar, Belgaum, Bijapur and Bellary districts. The districtwise area, production and productivity of ragi and groundnut in karnataka during 1994-95 is presented in Tables 3.3 and 3.4 respectively. In Karnataka ragi is grown in an area of 944155 hectatres with a production of 1352668 tonnes. Groundnut is cultivated in Karnataka in an area of 1200135 hectares with a production of 945501 tonnes (Anonymous, 1996).

3.2.1 Sampling

Tumkur district was purposely selected because it is one of the important ragi and groundnut growing areas under rainfed conditions and it also stood first in area under both the crops. Madhugiri taluk of Tumkur district was chosen as it represented the agro-climatic characteristics of the district and large no of farmers cultivated both ragi and groundnut crops. As mentioned earlier the rainfall in this area is very low and hence it was selected with the objective of studying the contribution of dry land technologies to output.

Simple Random sampling technique was employed for the selection of villages and farmers. Four villages were randomly selected for the study purpose and a list of farmers who were growing ragi and groundnut under rainfed conditions was obtained from the village accountants of the selected villages. From each village 30 farmers were randomly selected, (15 for ragi and 15 for groundnut) to make for the total of sample 120 farmers. Farmers growing exclusively ragi or groundnut were not available. Therefore ragi or groundnut farmers are not

TABLE 3.3 : Area, Production and Yield of ragi (1994-95)

Sl. No.	DISTRICTS	AREA (in ha)	PRODUCTION (in tonnes)	YIELD (Kg/ha)
1.	TUMKUR	166399	200798	1206.726
2.	HASSAN	145839	213527	1464.128
3.	BANGALORE RURAL	132238	218851	1654.978
4.	MYSORE	102489	141605	1381.66
5.	KOLAR	95140	161184	1694.177
6.	CHITRADURGA	76238	97040	1272.856
7.	MANDYA	57736	73090	1265.935
8.	CHICKMAGALUR	55135	81411	1476.576
9.	BANGALORE	48556	93594	1927.548
10.	BELLARY	27081	26010	960.452
11.	SHIMOGA	26020	33514	1288.009
12.	DHARWAD	8514	8151	957.3643
13.	BELGAUM	1884	2709	1437.898
14.	KODAGU	704	963	1367.898
15.	UTTRA KANNADA	143	173	1209.79
16.	GULBARGA	39	48	1230.769
	State Total	944155	1352668	1432.67

Source : Anonymous, 1996

TABLE 3.4 : Area, Production and Yield of Groundnut (1994-95)

Sl.No.		AREA (in ha)	PRODUCTION (in tonnes)	YIELD (Kg/ha)
1.	TUMKUR	177022	122196	690.28
2.	CHITRADURGA	170814	125331	733.72
3.	DHARWAD	153819	117527	764.06
4.	RAICHUR	111240	70672	635.31
5.	GULBARGA	98225	72623	739.35
6.	KOLAR	94322	89894	953.05
7.	BELGAUM	88381	80530	911.16
8.	BELLARY	88272	74497	843.94
9.	BIJAPUR	85460	49128	574.86
10.	MYSORE	49041	48475	988.45
11.	BANGALORE RURAL	26352	27958	1060.94
12.	SHIMOGA	16074	20975	1304.90
13.	CHICKMAGALUR	13571	20261	1492.96
14.	MANDYA	9519	6113	642.18
15.	HASSAN	5222	5923	1134.24
16.	UTTRA KANNADA	4715	6634	1406.99
17.	BIDAR	3569	1412	395.62
18.	DAKSHINA KANNADA	3356	3919	1167.75
19.	BANGALORE	1147	1416	1234.52
20.	KODAGU	14	17	1214.28
	STATE TOTAL	1200135	945501	787.82

Source : Anonymous, 1996

mutually exclusive. The sample villages chosen and the sample farmers from these villages are presented in Table 3.5.

3.3 NATURE AND SOURCE OF DATA

Using a pre-tested schedule prepared for the purpose, the selected respondents were interviewed personally. The data pertaining to general information of farmers and the total land holding, cropping pattern, production, labour use, marketing and other related information were collected. The data pertaining to ragi and groundnut crops cultivated during the kharif season of 1995-96 were collected during the months of August and September 1996.

3.4 ANALYTICAL TOOLS

The following statistical and econometric tools were used for analysing the data collected for the sample farmers.

3.4.1 Tabular Analysis

Tabular analysis was employed to analyse the information regarding size of land holding, age of respondent, family size, educational level, crop and animal husbandry activities, etc., by calculating simple averages and proportions for the data collected.

Table 3.5 : Sample villages and respondents of Madhugiri taluk

Sl. No.	Villages	No. of Farmers selected	
		Ragi	Groundnut
1.	Siddapura	15	15
2.	Marithimanahalli	15	15
3.	Bijawara	15	15
4.	Bhaktrahalli	15	15
	Total	60	60

3.4.2 Output decomposition model

In order to quantify the contribution of technology to the growth in output among the adopters, an output decomposition model (Bisaliah 1977) was employed. The procedure consisted of fitting two separate regression equations, one for the low adopters and another for the high adopters. The dryland technologies practiced by the farmers were measured on a three point continuum and the total score was worked out for each respondent. The respondent whose score was lower than the average score were considered as low adopters and the respondent whose score was above the average score were considered as high adopters. The Cobb-Douglas (C-D) form of the production function was used for decomposing total change in output. The general form of the model employed was

$$Y = A\ S^{a}\ Fy^{b}\ Fe^{c}\ H^{d}\ Bp^{e}\ U \qquad \text{----------- (1)}$$

Where,

Y = Output in Kilograms per acre.

S = Quantity of seed (kgs) used per acre.

Fy = Cart loads of FYM used per acre.

Fe = Value of Fertilizer measured in rupees per acre.

H = Human labour input used in mandays per acre.

Bp = Bullock power used in bullock pair days per acre.

A = is the scale parameter

and a , b, c, d, e denote output elasticities of the respective inputs.

U is a random disturbance term independently distributed with zero mean and finite variance.

In logarithmic form, C-D production function for low adopters of technology was :

$$\text{Ln } Y_1 = \text{Ln } A_1 + a_1 \text{ Ln } S_1 + b_1 \text{ Ln } F_{y1} + c_1 \text{ Ln } Fe_1 + d_1 \text{ Ln } H_1 + e_1 \text{ Ln } Bp_1 + U_1 \quad \text{---------} \quad (2)$$

Similarly the production function for high adopters of technology was estimated as below :

$$\text{Ln } Y_2 = \text{Ln } A_2 + a_2 \text{ Ln } S_2 + b_2 \text{ Ln } Fy_2 + c_2 \text{ Ln } Fe_2 + d_2 \text{ Ln } H_2 + e_2 \text{ Ln } Bp_2 + U_2 \quad \text{---------} \quad (3)$$

Definition of variables and parameters in (2) and (3) are the same as in (1)

Taking the difference between (3) and (2) and adding and subtracting the same terms we get,

$$\text{Ln } Y_2 - \text{Ln } Y_1 = [\text{Ln } A_2 - \text{Ln } A_1] + [(a_2 \text{ Ln } S_2 - a_1 \text{ Ln } S_1 + a_2 \text{ Ln } S_1 - a_2 \text{ Ln } S_1) + (b_2 \text{ Ln } Fy_2 - b_1 \text{ Ln } Fy_1 + b_2 \text{ Ln } Fy_1 - b_2 \text{ Ln } Fy_1) + (c_2 \text{ Ln } Fe_2 - c_1 \text{ Ln } Fe_1 + c_2 \text{ Ln } Fe_1 + c_2 \text{ Ln } Fe_1) + (d_2 \text{ Ln } H_2 - d_1 \text{ Ln } H_1 + d_2 \text{ Ln } H_1 - d_2 \text{ Ln } H_1) + (e_2 \text{ Ln } Bp_2 - e_1 \text{ Ln } Bp_1 + e_2 \text{ Ln } Bp_1 - e_2 \text{ Ln } Bp_1)] + (U_2 - U_1) \quad \text{------------} \quad (4)$$

Rearranging the terms in equation (4) results in,

$$\text{Ln } Y_2 - \text{Ln } Y_1 = [\text{Ln } A_2 - \text{Ln } A_1] + (a_2 - a_1) \text{ Ln } S_1 + (b_2 - b_1) \text{ Ln } Fy_1 + (c_2 - c_1) \text{ Ln } Fe_1 + (d_2 - d_1) \text{ Ln } H_1 + (e_2 - e_1) \text{ Ln } Bp_1 + a_2 (\text{Ln } S_2 - \text{Ln } S_1) + b_2 (\text{Ln } Fy_2 - \text{Ln } Fy_1) + c_2 (\text{Ln } Fe_2 - \text{Ln } Fe_1) + d_2 (\text{Ln } H_2 - \text{Ln } H_1) + e_2 (\text{Ln } Bp_2 - \text{Ln } Bp_1) + (U_2 - U_1) \quad \text{-------} \quad (5)$$

Equation (5) can also be written as,

$$\begin{aligned} Ln [Y_2 / Y_1] = {} & Ln [A_2 / A_1] + [(a_2 - a_1) Ln S_1 + (b_2 - b_1) Ln Fy_1 + (c_2 - c_1) Ln Fe_1 \\ & + (d_2 - d_1) Ln H_1 + (e_2 - e_1) Ln Bp_1] + [a_2 Ln (S_2 / S_1) + b_2 Ln (Fy_2 / Fy_1) + c_2 Ln (Fe_2 / Fe_1) + d_2 Ln (H_2 / H_1) + e_2 Ln (Bp_2 / Bp_1)] + (U_1 - U_2) \end{aligned} \quad \text{------------- (6)}$$

The decomposition equation (6) involves decomposing the natural logarithm of the ratio of high adopters output to low adopters output. It is a measure of the percentage change in output with the adoption of technology.

The first bracketed expression on the right hand side is a measure of percentage change in output due to shift in scale parameters (A) of the production function. The second bracketed expression which gives the sum of arithmetic changes in output elasticities each weighted by the logarithm of the volume of that input used by the low adopters, is a measure of change in output due to shifts in slope parameters (output elasticities) of the production function. The third bracketed expression is the sum of the logarithms of the ratios, of the inputs of high adopters to low adopters each of which was weighted by the output ealsaticity of that input pertaining to the high adopters. This expression is a measure of change in the output due to changes in the per acre quantities of seed, FYM, fertiliser, human labour and bullock power used given the output elasticities of the inputs under high adopters of technology.

3.4.3 Structural Break in production relations.

Chow test is the proper statistical technique for identifying whether the parameters governing the production relations in the high adopters are different from the low adopters of technology. The cause of the structural break was identified as to whether it was due to change in efficiency parameters or in slope parameters or in both.

The null hypothesis for the purpose was, the parameters of production function in equations (2) and (3) are the same.

$H_o : A_1 = A_2 , \ a_1 = a_2 , \ b_1 = b_2 , \ c_1 = c_2 , \ d_1 = d_2 , \ e_1 = e_2$

This null hypothesis was tested against the alternative hypothesis that the parameters of the production functions are not the same.
The chow test is given by

$$F_{(K,\, n1 + n2 - 2K)} = \frac{[\,RSS_P - (RSS_1 + RSS_2)\,] / (K)}{(RSS_1 + RSS_2) / (n_1 + n_2 - 2K)} \qquad \text{---------- (1)}$$

Where,

RSS_P = Residual sum of squares of Pooled regression.

RSS_1 = Residual sum of squares of regression 1 (High adopters).

RSS_2 = Residual sum of squares of regression 2 (Low adopters).

K = No of parameters.

n_1 = sample size of high adopters.

n_2 = sample size of low adcpters.

The degrees of freedom for chow test is given by K, ($n_1 + n_2 - 2K$).

3.4.4 Logit model

The factors contributing to adoption of technology were studied using, the logit Model . Farmers decisions 'to adopt' or 'not to adopt' are of discrete or qualitative (such as 'yes' or 'no') in nature. Even if they are constructed on the basis of an underlying continuous variable, there may be number of observations about which we do not have information. In those cases the values for which information is not available they are simply taken as zero. In both cases, where the dependent variable is of 'binary choice' (Like yes = 1, no=0) or truncated with a sudden jump in the value from the zero (like 0, 1000, 2000..), we cannot use the usual 'ordinary least square' (OLS) procedure in studying the functional relationship between dependent and the independent variables as it takes non linear form. In such cases a special estimation technique known as 'maximum likelihood estimation' (MLE) will be used by constructing the qualitative choice models (Pindyck and Rubinfeld, 1991). The logit model used in the study is discussed briefly below.

Let Yi = response of adoption by i^{th} farmer and

Xi = independent variable determining Y.

Then,

Yi = A + b Xi + Ui and describes the response of farmers to adoption.

Ui = is the error term.

Assuming E (Ui)= 0, we have,

$$E(Y_i) = a + b X_i \qquad \text{------------} \quad (1)$$

Since Yi can take only two values, one and zero, we can describe the probability distribution of Y by letting Pi = probability of Yi = 1, i.e. probability that the farmer is an adopter, 1-Pi = probability that Yi = 0, i.e. the probability that the farmer is not an adopter.

Then E (Yi given Xi) = Yi (Probability of Yi)

$$= 0 (1 - Pi) + 1 (P) = Pi \qquad \text{----------} \ (2)$$

Comparing (1) and (2), we have

$$E (Yi \text{ given } Xi) = a + b Xi = Pi \qquad \text{-----------------} \ (3)$$

The above function (3) is a linear probability model (LPM) giving the conditional probability of adoption given the level of independent variables. In order to estimate LPM, we cannot use ordinary least square (OLS) because,

1. The error term Ui is not normally distributed, since Ui becomes discrete as the choice is binary.

2. Variance (Ui) is heteroscedastic, as Ui is discrete.

3. The OLS estimate of Pi may not lie between zero and one because the predicted values lie even outside (0, 1) range.

4. Estimation of the LPM by OLS assumes that probability of adoption increases at a constant rate irrespective of the value of the independent variable. But in reality the relationship between Pi and Xi is not linear.

The Probability (Pi) of adoption approaches zero at a slower and slower rate as Xi becomes small and the probability approaches one at slower and slower rate as Xi becomes large.

Since,

Pi = E (Yi = 1, given Xi) non linearly increases with Xi, let us consider Pi to be a logistical function of 'Z' given by

$$P = \frac{1}{[1 + e^{(-Z)}]}$$

Where **Z = A + ∑ bi Xi** and Xi's are the independent variables,

We observe that as Z ranges from negative (-) to positive (+), P ranges from 0 to 1, and that Pi is non-linearly related to Z.

$$\text{If } P = \frac{1}{[1 + e^{(-Z)}]} \qquad \text{------------ } (4)$$

subtracting P from 1 on both sides in equation (4), we have,

$$1 - P = 1 - \frac{1}{[1 + e^{(-Z)}]}$$

$$\text{or } 1 - P = 1 - \frac{e^{-Z}}{[1 + e^{(-Z)}]} = \frac{1}{[1 + e^{(Z)}]} \qquad \text{-------- } (5)$$

Therefore, $[P / \{1 - (1 - P)]] = e^{-Z}$

Here [P/(1-P)] is called the odds ratio, which indicates the ratio of the chances in favour of adoption to one chance of non-adoption. Taking logarithm of the odds ratio to the base e, we get

$$\log_e [P/(1-P)] = Z = A + \sum bi \ X i \qquad \text{-----------} \ (6)$$

$$\text{or } L^* = Z = A + \sum bi \, Xi \qquad \text{----------------} \ (7)$$

Here, L* is called the logit as it follows logistical regression. Given the caveats of OLS, the maximum likelihood estimation (MLE) procedure has to be employed in estimating L*. The conditional probability for the overall effect of all the variables is given by estimated P (at arithmetic mean level of the dependent variables). Similarly the conditional probability with respect to each of the independent variables is obtained under *ceteris paribus* condition. The marginal effect of the i^{th} variable on P is given by the first order derivative of P (Probability of adoption) with respect to Xi.

From equation (6), differentiating P on both sides with respect to Xi, we have

$$\frac{1-P}{P} \times \frac{((1-P)(dP/dXi) - P(0-dP/dXi)}{(1-P)^2} = bi$$

$$\frac{1-P}{P} \times \frac{(dP/dXi)\ (1-P+P)}{(1-P)^2} = bi$$

$$\text{or} \quad \frac{1}{P(1-P)} \times \frac{dP}{dXi} = bi$$

i.e. $dP/dXi = bi\,Pi\,(1 - Pi)$ ------------ (8)

The elasticity of probability is estimated as

$$Ep = \frac{dP/P}{dXi/Xi}$$

Substituting for dP/dXi from equation (8) we have

$$Ep = bi\,(1 - P)\,Xi \qquad \text{-------------} \quad (9)$$

This gives the percentage change in probability due to a one per cent change in the level of independent variable considered.

3.4.5 Measure of technical efficiency

Since the Cobb-Douglas production function assumes that all techniques of production are identical across all farms and regions, it does not distinguish between technical efficiency and allocative efficiency. Farrel (1957) rejected the idea of an absolute measure of efficiency, and instead, proposed that efficiency be measured in a relative sense as a deviation from the best performance in a representative peer group. He also differentiated between technical (in) efficiency and allocative (in) efficiency. Technical inefficiency arises when less than maximum output is obtained from a given bundle, when resources are used in proportions which do not lead to profit maximisation.

It is therefore suggested that within a static frame work measures of technical efficiency retain validity as a measure of goal achievement in a materialistic society (Russel and Young, 1983)

The idea of frontier production function is built around the concept of efficiency as evidenced by Farrel (1957). Timmer (1971) modified the procedure in a number of ways. He imposed a Cobb Douglas specification on the frontier and computed an output based measure of efficiency. The approach adopted here is to specify a fixed parameter frontier amenable to statistical analysis.

It takes the general form

$$Y = f(x)e^{U}, U < 0$$

and the Cobb-Douglas form

$$\ln Y = \ln A + a \ln S + b \ln Fy + c \ln Fe + d \ln H + e \ln Bp + U$$

Where Y = output in kgs per acre

S = Quantity of seed (kgs) used per acre

Fy = Cart loads of FYM used per acre

Fe = Value of fertilizer measured in rupees per acre

H = Per acre human labour used measured in mandays

Bp = Per acre bullock power used measured in bullock pair days

The above equation was estimated by the technique of corrected Ordinary Least Square (COLS), the procedure followed is detailed below.

Step 1

OLS is applied to the above equation and the best linear unbiased estimates (the bi coefficients) were obtained,

Step 2

The estimated value of Y of the above equation was calculated and the deviation from the actual was obtained.

Step 3

The largest positive deviation was obtained which were added to the intercept of OLS estimate obtained in step 1. Thus the frontier production was obtained. Green (1980) has shown that a consistent, though biased, estimate of the intercept which imposes the sign uniformity on the residuals, will be generated.

Step 4

By this procedure the potential output (Y*) was obtained.

Step 5

The farm specific technical efficiency as given by the Timmer measure was calculated. It is the ratio of actual output to potential output, given the level of input use on farm `i' . It thus indicates how much extra output could be obtained if the farm `i' were to be located on the frontier.

$$\text{Timmers' Technical efficiency} = \frac{Y}{Y^*} \leq 1$$

Where Y* = maximum value of output obtainable for given level of inputs.

The mean technical efficiency was calculated using,

$$E = \sum_{i=1}^{60} \frac{ei}{N}$$

Factors influencing the farmers technical efficiency gap was studied using the model

$$ei = a + \sum bi\,Xi + Ui$$

where ei refers to technical efficiency gap of the ith farmer and Xi's the variable like human labour, land holding, media exposure, adoption of technology, education, extension participation, experience and Ui's the disturbance term introduced to represent errors in measurements.

3.4.6 Definitions of variables used

The definition of some of the important variables used in the analysis are

3.4.6.1 Education : Education refers to the level of schooling of an individual respondent. The quantification of this variable was arrived at using the following scoring pattern

Education level	Score
Illiterate	0
Middle School	1
High School	2
PUC	3
Degree and above	4

3.4.6.2 Extension participation : It refers to the interaction of the farmer in different extension educational activities conducted during the year. This variable was quantified by following the procedure suggested by Gowda (1983). The extension activities considered were visits by the agricultural extension officer, field visits, farmers training, demonstrations, general meetings, participation in exhibitions and krishimela. The repondents were asked to delineate their extent of participation under each of them. The extension activities were included to asses the extension participation.

The scoring pattern used was as follows

Participation	Score
Never	0
Occasionally	1
Regularly	2

and then an average extension participation score was obtained for each respondent.

3.4.6.3 Mass Media Participation : This refers to the degree to which a farmer participated in different mass communication media. The list of mass media were finalised after a pre survey of the area. The mass mediums considered were radio, television, newspapers and farm publications. The degree of participation was measured on a three point continuum namely,

Partcipation	Score
Regularly	2
Occasionally	1
Never	0

respectively. The average score obtained by a respondent constituted the mass media score.

3.4.6.4 Organisational Participation : It is the degree of involvement of the respondents from mere membership/directorship to organisational positions and his active participation in the activities at local formal organisations. The different organisations considered were PACS, MPCS, land development banks, Mandal panchayath and others which included Sericulturists society, Kasaba society and oilseed growers society. The quantification was done following the procedure suggested by Gowda (1992)

	Items	Weightage
1	Membership in Organisation	
	Not a member	0
	Member in organisation	1
	Director in organisation	2
2	Frequency of attendance in the meetings	
	Never	0
	Occasionally	1
	Regularly	2

The average score for each individual worked out by pooling the scores obtained in each organisation.

3.4.6.5 Human Labour : The labour input was measured in terms of mandays for different farm operations. Both men and women days were converted into adult mandays of eight hours per acre. Female labour was converted into mandays of eight hours per day based on the wage differential between men and women

3.4.6.6 Bullock pair days : Average number of bullock labour used (of 8 hours) per acre was computed. Tractors used was also converted into bullock pair days based on the price differential.

3.4.6.7 Adoption : Adoption refers to the levels of recommended technologies adopted by the farmers. The technologies were considered under two heads namely, Soil and moisture conservation meausres and crop production practices. The soil and moisture conservation measures included were fall ploughing, ploughing across the slope, deep ploughing, dead furrows, vegetative bunding and water ways. The crop production practices included were variety, input application such as FYM, fertilizer application in split doses, plant protection measures etc. The technologies practiced by the farmers were measured on a three point continuum,

Adoption of practice	Score
Full	1
Partial	0.5
Non	0

and the total score was worked out for each respondent. The average score for the sample was found out and the respondents with a score lower than the average were considered as low adopters and those with scores which were above the average were considered as high adopters.

Results

CHAPTER IV

RESULTS

The results of the study have been presented keeping in view the objectives of the study and have been presented in the following sequence.

4.1 Socio-economic characteristics of sample farmers

4.2 Factors influencing the adoption of technology

4.3 Input use, Output decomposition and allocative efficiency

4.4 Technical efficiency and efficiency gap

4.5 Opinion of farmers regarding the technology option

4.1 SOCIO-ECONOMIC CHARACTERISTICS

A review of the Socio-economic characteristics of the sample farmers will provide valuable insights into their adoption and efficiency of crop production.

4.1.1 Education, size of family and holdings

The Socio-economic characteristics of ragi and groundnut growing farmers are presented in Tables 4.1 and 4.2 respectively. The average age of respondents in the case of ragi was 43.98 years, with the low adopters age being relatively low (43.02 years) than that of the high adopters whose average age 45.3 years. The average size of the family was 7.06 for pooled sample. High adopters

TABLE 4.1 : Socio-economic features of sample respondents (ragi crop)

		Factors	High adopters	Low adopters	Pooled
1.		Age of respondents (years)	45.31	43.02	43.98
2.		Family size (Number)	7.92	6.42	7.06
3.		Holding size (acres)	7.20	4.09	5.41
4.		Distribution based on holding size			
	a.	Less than 2.5 acres	8 (30.77)	17 (50.00)	25 (41.67)
	b.	2.6 - 5.0 acres	8 (30.77)	10 (29.41)	18 (30.00)
	c.	above 5 acres	10 (38.46)	7 (20.59)	17 (28.33)
5.		Education			
	a.	Illiterate	12 (46.15)	10 (29.41)	22 (36.67)
	b.	Middle School	7 (26.92)	12 (35.29)	19 (31.67)
	c.	High school	5 (19.23)	8 (23.53)	13 (21.66)
	d.	P.U.	0 (0.00)	1 (2.94)	1 (1.66)
	e.	Degree and above	2 (7.69)	3 (8.83)	5 (8.34)
6.		Total number of respondents	26 (100.00)	34 (100.00)	60 (100.00)

Note : Figures in parentheses indicate percentages to respective totals.

TABLE 4.2 : **Socio-economic features of sample respondents (groundnut crop)**

	Factors	High adopters	Low adopters	Pooled
1.	Age of respondents (years)	44.61	38.27	41.62
2.	Family size (Number)	7.59	7.63	7.61
3.	Holding size (acres)	7.52	6.03	6.8
4.	Distribution based on holding size			
a.	Less than 2.5 acres	4 (12.50)	5 (17.86)	9 (15.00)
b.	2.6 - 5.0 acres	13 (40.63)	13 (46.43)	26 (43.33)
c.	above 5 acres	15 (46.87)	10 (35.71)	25 (41.67)
5.	Education			
a.	Illiterate	12 (37.50)	7 (25.00)	19 (31.67)
b.	Middle School	7 (21.87)	9 (32.14)	16 (26.67)
c.	High school	8 (25.00)	5 (17.86)	13 (21.67)
d.	P.U.	2 (6.25)	3 (10.71)	5 (8.33)
e.	Degree and above	3 (9.38)	4 (14.29)	7 (11.66)
6.	Total number of respondents	32 (100.00)	28 (100.00)	60 (100.00)

Note : Figures in parentheses indicate percentages to respective totals.

had a family size of 7.92. Of the 60 farmers chosen, around 37 per cent were illiterate and 32 per cent had education upto middle school level. The average size of holding was 7.02 acres in the case of high adopters, 4.09 acres in the case of low adopters and the pooled average was 5.41 acres.

In the case of the sample farmers considered for analysis of adoption of technology and technical efficiency in groundnut crop, the average age was 41.62 years. The low adopters average age was 38.27 years while the high adopters had an age of 44.61 years. The average size of the family was 7.61 for the pooled sample. The difference between the size of families of high and low adopters was marginal. Of the 60 farmers selected, 31.67 per cent were illiterate, and 26.67 per cent had education upto middle school level. The average size of holding of the sample farmers was 7.52 acres in case of high adopters, 6.03 acres in case of low adopters and the pooled average was 6.80 acres.

4.1.2 Crop and Animal Husbandry Activities

Table 4.3 indicates that the sample farmers considered for analysis of ragi, the high adopters had 7.20 acres of land while the low adopters had 4.09 acres of land. The high adopters had 1.76 acres (26 farmers) under ragi, 3.36 acres (nine farmers) under groundnut and 1.44 acres (13 farmers) under paddy cultivation. while the low adopters had 1.23 acres (34 farmers) under ragi, 2.18 acres (15

TABLE 4.3 : Crop and animal husbandry activities of respondents (Ragi crop)

		Particulars	Low Adopters	Per cent	High Adopters	Per cent
1		**Area under (acres)**				
	a.	Dryland	3.12 (34)	100.00	4.50(26)	100.00
	b.	Wet land	0.90(15)	44.11	2.38(17)	65.38
	c.	Garden land	0.60(4)	11.76	0.29(4)	15.38
		Total	4.09(34)	100.00	7.20(26)	100.00
2		**Crop activities**				
i		**KHARIF (acres)**				
	a.	Ragi	1.23(34)	100.00	1.76(26)	100.00
	b.	Groundnut	2.18(15)	44.12	3.36(9)	34.62
	c.	Paddy	0.66(14)	41.18	1.44(13)	50.00
ii		**RABI (acres)**				
	a.	Ragi	0.21(1)	2.94	0.15(1)	3.85
	b.	Groundnut	0.68(4)	11.76	0.90(8)	30.77
	c.	Paddy	0.51(5)	14.71	0.96(11)	42.31
iii		**PERENNIALS**				
	a.	Flowers (acres)	0(0)	0.00	0.01(2)	7.69
	b.	Mulberry (acres)	0.02(1)	2.94	0.15(4)	15.38
	c.	Arecanut (Nos.)	37.11(4)	11.96	13.46(2)	7.69
	d.	Coconut (Nos.)	20(4)	11.76	52(4)	15.38
3		**ANIMALS (Nos.)**				
	a.	Bullocks	2.13(15)	44.12	2.44(18)	69.23
	b.	Cows/Buffaloes	2.35(20)	58.82	2.5(21)	80.77
	c.	Sheep/Goats	2.66(3)	8.82	30.75(4)	15.38

Note : Figures in parentheses indicate the number of farmers.

TABLE 4.4 : **Crop and animal husbandry activities of respondents (Groundnut crop)**

		PARTICULARS	Low Adopters	Per cent	High Adopters	Per cent
1		**Area under (acres)**				
	a.	Dryland	4.01(28)	100.00	5.42(32)	100.00
	b.	Wet land	1.64(15)	53.57	1.86(20)	62.50
	c.	Garden land	0.37(10)	35.71	0.22(4)	1.95
		Total	6.03(28)	100.00	7.52(32)	100.00
2		**Crop activities**				
i		**KHARIF (acres)**				
	a.	Groundnut	3.34(28)	100.00	4.82(32)	100.00
	b.	Ragi	1.32(22)	78.57	1.12(28)	87.50
	c.	Paddy	0.98(19)	67.88	1.06(16)	50.00
ii		**RABI (acres)**				
	a.	Groundnut	0.68(5)	17.85	0.68(7)	21.86
	b.	Ragi	0.43(4)	11.26	0(0)	0.00
	c.	Paddy	0.67(8)	28.57	0.74(9)	28.12
iii		**PERENNIALS**				
	a.	Flowers (acres)	0.05(3)	10.71	0.01(1)	3.12
	b.	Mulberry (acres)	0.06(2)	7.14	0.14(6)	18.75
	c.	Arecanut (Nos.)	110(11)	39.26	50.1()	3.12
	d.	Coconut (Nos.)	60(7)	25.00	50(5)	15.62
3		**ANIMALS (Nos.)**				
	a.	Bullocks	2.18(22)	78.56	2.21(23)	71.87
	b.	Cows/Buffaloes	2(23)	82.16	2.52(23)	71.87
	c.	Sheep/Goats	22(6)	21.43	27.4(5)	15.62

Note : Figures in parentheses indicate the number of farmers.

farmers) under groundnut and 0.66 acres (14 farmers) under paddy during the kharif season. Animal husbandry activities were predominant under high adopter category farmers. 69.23 per cent of the farmers had a pair of bullocks, 80.77 per cent of the farmers had two cows or buffaloes and 15.38 per cent of the farmers had 30 heads of sheep/goats.

The sample farmers considered for groundnut cultivation, the high adopters had 7.52 acres of land while the low adopters had 6.03 acres of land. The high adopters had 4.82 acres (32 farmers) under groundnut, 1.12 acres (28 farmers) under ragi and 1.06 acres (16 farmers) under paddy. The low adopters had 3.34 acres (28 farmers) under groundnut, 1.32 acres (22 farmers) under ragi and 0.98 acres (19 farmers) under paddy during the kharif season. The low adopters had more area under arecanut and coconut cultivation. Animal husbandry activities were predominant under both the categories. 78.56 per cent of the low adopters and 71.87 per cent of the high adopters had a pair of bullocks. The low adopters had 22 heads of sheep/goats while the high adopters had 27 heads of sheep/goats.

4.2 FACTORS INFLUENCING THE ADOPTION OF TECHNOLOGY

The factors that influence the adoption of technology under dry land agriculture are presented below.

4.2.1 Levels of Adoption

The level of adoption and reason for non adoption of dry land technologies in the case of ragi and groundnut was studied and the results are presented in Table 4.5 and Table 4.6 respectively. Adoption of technology was studied under two different heads, viz., Soil and moisture conservation category and crop production category. The practices considered under soil and moisture conservation category were fall ploughing, ploughing across the slope, deep ploughing, dead furrows, vegetative bunding and maintenance of water ways. The practices considered under crop production category included variety, seed treatment and seed hardening, sowing using seed drills or transplanting technique, fertilizer application - Basal and Top dressing, Plant protection measures and intercropping. The qualitative data like whether they have followed a particular practice or not was used in the collection of the data.

It can be seen from the Table 4.5 that there was 100 per cent adoption of fall ploughing, and ploughing across the slope by the farmers growing ragi. Vegetative bunding was followed by 63.57 per cent, of which 13.3 per cent of farmers had partially adopted. Under crop production practices, HYVs were used by 10 per cent of sample farmers. The nursery bed preparation and transplanting technique was followed by 55 per cent of the farmers.

TABLE 4.5 : Level of adoption of different technologies by sample ragi farmers

	Practices		Adoption (percent of respondents)	Reasons for non-adoption
1.	**Soil and moisture conservation**			
a.	Fall ploughing		100.00	-
b.	Ploughing across the slope		100.00	-
c.	Deep ploughing		0.00	lack of awareness, lack of conviction
d.	Dead furrows		0.00	lack of awareness, lack of conviction, wastage of land
e.	Vegetative bunding	Full	50.27	wastage of land, operational inconvenience
		Partial	13.33	
f.	Water ways	Partial	40.00	wastage of land, financial constraint
2.	**Crop production practices**			
a.	Variety	Indaf	10.00	Non availability of seed locally, preference for palatability and taste of locals
b.		Seed treatment and seed hardening	0.00	lack of awareness
c.	Sowing by	transplanting	55.00	failure of monsoons, seed drill does not match with intercultural implements.
		Seed drill	0.00	
d.	FYM application		90.80	Non availability in the season
e.	Fertilizer application	Basal	68.85	High cost of fertilizer, non-availability at the right time.
		Top dressing	65.57	lack of moisture during the later stages, non economical
f.	Inter cropping		63.00	interference during the next crop season
g.	Plant protection chemicals		0.00	not economical

TABLE 4.6 : Level of adoption of different technologies by sample groundnut farmers

	Practices		Adoption (percent of respondents)	Reasons for non-adoption
1.	**Soil and moisture conservation**			
a.	Fall ploughing		100.00	-
b.	Ploughing across the slope		100.00	-
c.	Deep ploughing		0.00	lack of awareness, lack of conviction
d.	Dead furrows		0.00	lack of awareness, lack of conviction, wastage of land
e.	Vegetative bunding	Full	43.40	wastage of land, operational inconvenience
		Partial	21.6	
f.	Water ways	Partial	47.20	wastage of land, Financial constraint
2.	**Crop production practices**			
a.	Variety		100.00	
b.	Seed treatment and seed hardening		2.80	lack of awareness
c.	Sowing by	Seed drill	0.00	failure of monsoons, seed drill does not match with intercultural implements
d.	FYM application		72.85	Non availability in the peak season
e.	Fertilizer application	Basal	87.14	High cost of fertilizer, non availability at the right time.
		Top dressing	21.42	lack of moisture during the later stages, non economical
f.	Gypsum application		22.85	lack of conviction, non availability
g.	Inter cropping		100.00	-
h.	Plant protection chemicals		0.00	not economical

Similar rates of adoption of soil and moisture conservation practices were observed in case of groundnut sample farmers for fall ploughing and ploughing across the slope (Table 4.6). Vegetative bunding was followed by 65 per cent of farmers of which 21.6 per cent had adopted partially. Gypsum application was followed by 22.85 per cent of the sample farmers and seed treatment was adopted by 2.8 per cent. There was large scale non adoption of dead furrow technique and deep ploughing in both the cases.

4.2.2 Factors Influencing Adoption

The factors influencing the probability of adoption of technology by ragi and groundnut growing farmers were studied using logit regression model, the results of which are presented in Table 4.7 and Table 4.8 for ragi and groundnut respectively.

In the case of ragi, total land holding, experience in farming, participation in extension activities, organisational participation, media exposure and occupation were the variables found to increase the probability of adoption of technology. However education was found to lower the probability. Total land holding and occupation were the significant variables whose values of elasticity were 0.44 and 1.96 respectively. The overall probability was 0.38 and the

TABLE 4.7 : Estimates of the probability of adoption of technology by the ragi farmers

	Variables	Logit coefficient	Average Value	Elasticity of probability
1.	Total land holding (acres)	0.131 ***	5.416	0.44
2.	Farming Experience (no. of years)	0.01	23.983	0.15
3.	Education (ranks)	-0.45	1.131	-0.31
4.	Extension participation (avg. score)	0.204	6.8	0.08
5.	Organisational participation (avg. score)	0.244	0.314	0.04
6.	Mass Media (avg. score)	1.721	0.392	0.35
7.	Occupation (score)	3.73**	0.852	1.96
8.	Constant	-4.893**		
9.	Per cent of right predictions	65.57		
10.	Probability (P)	0.38		

Note : ** denotes significance at 5 per cent level
*** denotes significance at 10 per cent level

TABLE 4.8 : Estimates of the probability of adoption of technology by the groundnut farmers

	Variables	Logit coefficient	Average Value	Elasticity of probability
1.	Total land holding (acres)	0.042	6.822	0.13
2.	Farming Experience (no. of years)	0.019**	23.385	0.2
3.	Education (ranks)	-0.251	1.385	-0.16
4.	Extension participation (avg. score)	-1.426	0.427	-0.28
5.	Organisational participation (avg. score)	2.521**	0.317	0.37
6.	Mass Media (avg. score)	0.243	0.316	0.03
7.	Occupation (score)	0.882	0.982	0.38
8.	Constant	-1.343		
9.	Per cent of right predictions	67.14		
10.	Probability (P)	0.53		

Note : ** denotes significance at 5 per cent level

percentage of right predictions was 65.57 testifying to the adequacy of the model.

In the case of groundnut, total land holding, experience, organisational participation, media exposure and occupation were found to increase the probability of adoption. Education and participation in extension activities were found to lower the probability of adoption. Organisational participation and experience in farming was found to be significant variables whose elasticity values were 0.37 and 0.20 respectively. Occupation though not significant had a very high elasticity value of 0.38. The overall probability of adoption was 0.53 and percentage of right predictions was 67.14.

4.3 INPUT USE, OUTPUT DECOMPOSITION AND ALLOCATIVE EFFICIENCY

Input use and allocative efficiency are the measures of farmers efficiency in maximising his output. An attempt was made to study how the different categories of farmers had allotted the scarce resources available to them for best use in crop production.

4.3.1 Input Use

The actual use of inputs in the production of ragi by the sample farmers is presented in Table 4.9. Use of FYM among the high adopters was 9.99 cart loads. This was 77.75 per cent higher compared to the low adopters. Similarly High adopters had used 21.75 per cent more of fertilizer. However use of seed and bullock power was less by 29.26 per cent and 16.92 per cent respectively among the high adopters compared to the low adopters.

The actual use of inputs in the production of groundnut by the sample farmers is presented in Table 4.10. Use of FYM among the high adopters was 5.45 cart loads per acre. This was 90.55 per cent higher compared to the low adopters. Similarly high adopters had utilised 55 per cent more of fertilizer. However use of seed, bullock power and human labour was less by 8.38 per cent, 7.45 per cent and 13 per cent respectively among them compared to the low adopters. Gypsum (42.31 Kgs) was used only by the high adopters.

4.3.2 Output decomposition

A Cobb-Douglas regression equation was fitted separately for low and high adopters, with output of ragi as dependent variable and seed, FYM, fertiliser, human and bullock power as independent variables. The results are presented in Table 4.11 and the results show that among the low adopters, bullock power had a significant influence on output of ragi. Among the high

TABLE 4.9 : Per acre input use by the respondents (ragi crop)

Inputs	High Adopters	Low Adopters	Difference	Per cent change	Recommendation
1. Seed (kg.)	3.07	4.34	-1.27	-29.26	2.5
2. FYM (cartloads)	9.99	5.62	4.37	77.75	60.0
3. Fertilizer (Kg.)	74.71	61.36	13.35	21.75	50.0
4. Human labour (man days)	46.17	45.66	0.51	1.11	-
5. Bullock power (bullock pair days)	9.03	10.87	-1.84	-16.92	-

Note : The per cent change refers to change from low to high adopters.

TABLE 4.10 : Per acre input use by the respondents (groundnut crop)

Inputs	High Adopters	Low Adopters	Difference	per cent change	Recommendation
1. Seed (kg.)	35.09	38.3	-3.21	-8.38	40
2. FYM (cartloads)	5.45	2.86	2.59	90.55	6
3. Fertilizer (Kg.)	60.74	39.16	21.58	55.1	40
4. Gypsum (Kg.)	42.31	-	-	-	150
5. Human labour (man days)	29.45	33 87	-4.42	-13.04	-
6. Bullock power (bullock pair days)	6.21	6.71	-0.5	-7.45	-

Note : The per cent change refers to change from low to high adopters.

adopters FYM as well as bullock power significantly influenced the output. Fertiliser had a negative coefficient in both the functions but these coefficients were not significant. In general the coefficients of high adopters were higher than the low adopters.

In order to see whether the parameters governing the two production relationships are different in these two categories, the chows test was performed. The F-value of 2.35 for ragi was found to be significant at five per cent level for five and 50 degrees of freedom. This implies that the two functions are statistically different and hence qualify for decomposition analysis.

The results of the decomposition analysis which explains the contribution of the different factors to total change in ragi output are presented Table 4.13. These values were derived by using the parameter values and geometric mean values of respective production functions. These values are given in Table 4.11 and Table 4.12 for ragi.

Ragi output per acre in the case of high adopter farmers who adopted improved dry land technologies was significantly higher compared to low adopters by 15.62 per cent. How much of this increased output is due to technical change and how much of it is due to change in the input levels is indicated by the analysis. It is important to note that adoption of improved dry

TABLE 4.11 : Per acre production function estimates for high and low adopters of technology (ragi crop)

Adoption	No of observations	Variable	Elasticity of output
low adopters	34	Seed (kg)	0.091 (0.117)
		FYM (cart loads)	0.006 (0.018)
		Fertilizer (Rs.)	-0.001 (0.012)
		Human labour (man days)	0.058 (0.162)
		Bullock power (bullock pair days)	0.262 ** (0.120)
		Constant	5.634
			$R^2 = 0.207$
High adopters	26	Seed (kg)	0.182 (0.153)
		FYM (cart loads)	0.122 ** (0.055)
		Fertilizer (Rs.)	-0.069 (0.116)
		Human labour (man days)	0.068 (0.212)
		Bullock power (bullock pair days)	0.258 ** (0.110)
		Constant	5.868
			$R^2 = 0.263$

Note : ** denotes significance at 5 per cent level

TABLE 4.12 : Sample geometric mean levels of per acre input and output of ragi

Sl. No.	Item	Low adopters	High adopters
1	Seed (kg)	3.81	2.9
2	FYM (cart loads)	1.57	8.63
3	Fertilizer (Rs.)	39.51	377.11
4	Human labour (man days)	42.7	44.61
5	Bullock power (bullock pair days)	9.93	8.64
6	Output (kg.)	716.75	837.72

TABLE 4.13 : Decomposition analysis of total change in per acre ragi output between high and low adopters.

		Item	per cent attributable
1.		Total change in measured output	15.62
2.		Sources of Change	
	a.	Technology	18.63
	b.	Inputs	-3.01
		i. Seed	-4.92
		ii. FYM	20.76
		iii. Fertilizer	-15.56
		iv. Human labour	0.29
		v. Bullock power	-3.58

land technologies as a whole has contributed to increase in the output of ragi. However changes in the levels of use of inputs, except farm yard manure, have not contributed for this increased output.

The contribution of technology to total change in output was 18.63 per cent. This value was obtained by adding the values of the first and second bracketed expressions on the right hand side of the decomposition equation (6) presented in methodology chapter.

The contribution of FYM and human labour have increased the output by 20.76 per cent and 0.29 per cent, respectively. This increased contribution was offset to a large extent by seed (-4.92 per cent), fertilizer (-15.56 per cent) and bullock power (-3.58 per cent). Therefore the overall contribution due to inputs was negative at 3.00 per cent.

Similarly a Cobb-Douglas regression equation was fitted separately for low and high adopters, with output of groundnut as dependent variable and seed, FYM, fertiliser, human and bullock power as independent variables. The results are presented in Table 4.14. The results show that seed, FYM and bullock power had a significant influence on output of groundnut. Among the high adopters seed as well as human labour significantly influenced the output. The elasticity of seed in both the cases were high.

TABLE 4.14 : Per acre production function estimates for high and low adopters of technology (groundnut crop).

Adoption	No of observations	Variables	Elasticity of output
low adopters	28	Seed (kg)	0.576 ** (0.220)
		FYM (cart loads)	0.043 ** (0.019)
		Fertilizer (Rs.)	-0.0003 (0.015)
		Human labour (man days)	0.197 (0.210)
		Bullock power (bullock pair days)	0.261 ** (0.116)
		Constant	2.61
			$R^2 = 0.516$
High adopters	32	Seed (kg)	0.595 ** (0.222)
		FYM (cart loads)	-0.02 (0.030)
		Fertilizer (Rs.)	0.016 (0.075)
		Human labour (man days)	0.300 ** (0.122)
		Bullock power (bullock pair days)	-0.124 (0.172)
		Constant	2.933
			$R^2 = 0.278$

Note : ** denotes significance at 5 per cent level

TABLE 4.15 : Sample Geometric mean levels of per acre input and output of groundnut

Sl. No.	Item	Low adopters	High adopters
1	Seed (kg)	37.01	34.02
2	FYM (cart loads)	0.23	2.71
3	Fertilizer (Rs.)	36.4	301.61
4	Human labour (man days)	31.77	28.43
5	Bullock power (bullock pair days)	6.03	5.81
6	Output (kg.)	324.37	362.78

TABLE 4.16 : Decomposition analysis of total change in per acre groundnut output between high and low adopters.

	Item	per cent attributable
1.	Total change in measured output	11.19
2.	Sources of Change	
a.	Technology	20.72
b.	Inputs	-9.53
	i. Seed	-5.00
	ii. FYM	-5.15
	iii. Fertilizer	3.50
	iv. Human labour	-3.34
	v. Bullock power	0.46

The Chow test revealed that the two functions were statistically different and hence qualified for decomposition analysis. The F-value of 3.18 was found to be significant at five per cent level for five and 50 degrees of freedom. The results of the decomposition analysis which explains the contribution of the different factors to total change in output are presented Table 4.16. These values were derived by using the parameter values and geometric mean values of respective production functions. These values are presented in Table 4.14 and Table 4.15 for groundnut.

The per acre production of groundnut was estimated to be 11.19 per cent higher for high adopters compared to low adopters. The contribution of technology to total change in output was estimated to be 20.72 per cent higher compared to the low adopters.

The contribution due to input change was negative at 9.53 per cent. The positive contribution of fertiliser (3.50 per cent) and bullock power (0.46 per cent) was offset largely by the negative contribution of seed (5.00 per cent), FYM (5.15 per cent) and Human labour (3.34 per cent).

4.3.3 Allocative Efficiency

The allocative efficiency was computed as the ratio of marginal value product (MVP) to marginal factor cost (MFC). If the ratio of MVP to MFC was greater than one, implied that the resource was under used. The ratio being less than one implied the resource was over used.

The dependent variable (output) and the independent variables like seed, FYM, human labour and bullock power were taken in physical quantities. Since fertilizer was considered in monetary terms, MVP of the explanatory variable itself gives the allocative efficiency. The results are presented in Table 4.17

In the case of low adopter category of the farmers growing ragi, the ratio of MVP to MFC was less than one for FYM (0.19), fertilizer (- 0.06), human labour (0.13) and bullock power (0.79), indicating the over use of these resources. However the seed is under utilised by the low adopters as explained by the ratio value of more than one (14.38).

Under the category of high adopters excepting seed and bullock power all other explanatory variables were over used. The ratio of MVP to MFC was less than one for FYM (0.82), fertilizer (-0.64), human labour (0.17) indicating that

TABLE 4.17 : Allocative efficiency of the farmers.

Input	Ragi crop		Groundnut Crop	
	High adopters	Low adopters	High adopters	Low adopters
Seed	44.02	14.38	5.03	3.99
FYM	0.82	0.19	-0.53	12.67
Fertilizer	-0.64	-0.06	0.23	-0.03
Human labour	0.17	0.13	1.53	0.77
Bullock power	1.05	0.79	-0.89	1.6

these resources were over used . The ratio of MVP to MFC was less than zero for fertilizer (-0.06 and -0.64) for low and high adopters respectively. It indicated that at the geometric mean level, any additional level of inputs used would result in reduction of the output.

Under the category of low adopter groundnut farmers, seed (3.99), bullock power (1.6) and FYM (12.67) were under used as indicated by the ratio of MVP to MFC. However fertilizer (-0.03) and human labour (0.77) were over used by this category.

The high adopter category farmers had under used seeds (5.03) and human labour (1.53). The ratio of MVP to MFC was less than one for bullock power (-0.89), fertilizer (0.23) and FYM (-0.53). The ratio was less than zero for fertilizer under low adopters and under high adopters it was less than zero for FYM and bullock power indicating that at the geometric mean level, any additional level of input used would result in reduction of the farmers output.

4.4 TECHNICAL EFFICIENCY AND TECHNICAL EFFICIENCY GAP

The technical efficiency was studied using a frontier production function, the results of which are presented below.

4.4.1 Technical efficiency

Farm specific and crop specific technical efficiencies for individual sample farmers were calculated using Timmers measure of technical efficiency following the corrected ordinary last squares technique. The mean technical efficiency was 0.503 for ragi and 0.500 for groundnut, indicating farmers can double their yields by increasing their efficiency (Table 4.18).

There was a wide variation in the level of technical efficiency across the sample. For farmers growing ragi, the efficiency ranged between 0.25 to 1.00 and for groundnut the efficiency ranged between 0.16 to 1.00. A careful examination of Table 4.18 which gives the frequency distribution of technical efficiency for sample shows that 78.34 per cent of the sample farmers were in the efficiency range of 0.25 to 0.60 for ragi and 78.3 per cent of the farmers were in the efficiency range of 0.16 to 0.60 for groundnut. These inefficiencies may be due farm specific constraints and the cultural practices followed by the farmers.

4.4.2 Technical efficiency gap

As shown above in section 4.4.1, the productivity differences are due to farm specific constraints. Therefore identification of the factors influencing the farmer's technical efficiency gap was attempted and the results are presented in Table 4.19. In the case of ragi a double log function was found to be superior to linear specification and hence results pertaining to the former are presented.

TABLE 4.18 : **Frequency distribution of Technical efficiency**

Efficiency interval	Ragi crop		Groundnut crop	
	number of farmers	percent to total	number of farmers	percent to total
lessthan 0.20	0	0	1	1.67
0.21 - 0.40	16	26.67	12	20.00
0.41 - 0.60	31	51.67	34	56.67
0.61 - 0.80	11	18.33	9	15.00
above 0.81	2	3.33	4	6.66
Mean Technical Efficiency of the sample		0.503		0.500
Efficiency level of Least efficient farmer		0.25		0.16

TABLE - 4.19 : Factors influencing the technical efficiency gap

Variables	Ragi Crop B coeffs.	Ragi Crop T-Value	Groundnut Crop B coeffs.	Groundnut Crop T-Value
Adoption of Technology (Score)	0.885*	3.018	0.033**	2.448
Education (ranks)	0.014	0.850	0.009	0.549
Farming experience (years)	0.060	0.954	0.001	1.008
Extension participation (Average)	-0.120	-1.419	-0.217 **	2.285
Human labour (man days)	-0.109	-1.651	-0.0004 **	2.566
Mass media participation (Average)	0.030	1.699	0.071	0.8
Constant	-2.501		0.243	
R^2	0.25		0.18	

Note : * denotes significant at one per cent level.

** denotes significant at five percent level.

However in case of groundnut the linear specification was able to explain the changes in efficiency than its double log counterpart. Therefore the results of linear specification have been presented and interpreted. The R^2 value increased from 0.14 to 0.20 in case of ragi and in case of groundnut R^2 value decreased from 0.18 to 0.12 when the double log functions were fitted.

Adoption of technology, education, experience and mass media participation had a positive influence on efficiency of ragi farmers whose elasticity values were 0.885, 0.014, 0.060, 0.03 respectively. Contrary to our expectation the independent variables like extension participation and human labour had an inverse relationship on technical efficiency whose elasticity values were 0.12 and 0.109 respectively. Adoption and mass media participation were found to be significant factors at one and five per cent levels respectively.

In the case of groundnut farmers, adoption of technology, education, experience and media participation had a positive relationship with efficiency whose coefficients were 0.033, 0.009, 0.001, 0.071, respectively. Extension participation (-0.217) and human labour (-0.0004) had inverse relationships with efficiency. The variables adoption, extension participation and human labour were found to be significant. The R^2 value was found to be low which suggests some important variables particularly those of a qualitative nature, like quality of labour, timeliness of input use, and the knowledge and skills have been omitted since they are difficult to quantify. With the inclusion of these variables, which is beyond the scope of this study, the fit may have improved.

4.5 OPINION OF RESPONDENTS REGARDING THE TECHNOLOGY OPTION

In the present study an attempt has been made to find out what technology option are preferred by the farmers. The opinions are presented in Table 4.20. A majority of the farmers were convinced that the soil and moisture conservation practices were necessary. 98.33 per cent of ragi farmers and 96.66 per cent of groundnut farmers expressed that they required financial assistance for technology adoption. Forty five per cent of the ragi farmers and 65 per cent of the groundnut farmers opined that they required regular technical guidance in addition to training and demonstration. Low cost technology was preferred by 76.66 per cent of ragi farmers and 56.66 per cent of groundnut farmers. Combination of improved practices and indigenous implements was preferred by 83.33 per cent of ragi farmers and 90 per cent of groundnut farmers.

TABLE 4.20 : Technology options of the farmers

Sl. No.	Options	Ragi farmers	Groundnut farmers
1.	More Training and Demonstration	45 (75.00)	51 (85.00)
2.	Regular technical guidance	27 (45)	39 (65.00)
3.	Low cost technology	46 (76.66)	34 (56.66)
4.	Financial help	59 (98.33)	58 (96.66)
5.	Use of indigenous implements for improved practices	53 (88.33)	54 (90.00)
6.	Variety		
	a. Withstand moisture stress	60 (100.00)	60 (100.00)
	b. Quick maturing and high stable yields	60 (100.00)	60 (100.00)
	c. Palatable and tasty	60 (100.00)	15 (25.00)
	d. High market acceptability	-	60 (100.00)

Note : Figures in parentheses indicate percentages to the total.

Discussion

CHAPTER V

DISCUSSION

The results of the present study are discussed in this chapter under the following headings,

5.1 Socio-economic characteristics of the sample farmers

5.2 Factors influencing the adoption of technology

5.3 Input use, output decomposition and allocative efficiency

5.4 Technical efficiency and efficiency gap

5.5 Opinion of the farmers regarding the technology option

5.1 SOCIO-ECONOMIC CHARACTERISTICS

The results relating to the socio-economic characteristics of the sample farmers are discussed in this section.

5.1.1 Education, Size of family and holdings

Around 64 per cent of the sample farmers were literate. Only ten per cent of the respondents were educated beyond high school level. This factor may influence the adoption of technology and inturn affect the efficiency in farming. This would be analysed in the succeeding section. The average family size of the high adopter category farmers growing ragi was higher compared to the low adopters. This might have helped the high adopters to timely employ sufficient labour for agricultural operations and obtain a higher yield. The average holding size of the high adopters growing ragi was around 7.02 acres which was higher by 75 per cent compared low adopters. Further 80 per cent of the farmers in the low adopter category were small and marginal, that is they had holding size of less than five acres. Whereas 60 per cent of the farmers in high adopter category were small and marginal. This proves that big farmers are more in high adopter category than the low adopter category. This implies that higher holding size facilitates the level of adoption of improved practices. This also partially proves scale biasness of dryland technologies.

Similarly, literacy among farmers growing groundnut was high (around 68 per cent). Twenty per cent of the sample farmers had education beyond high school level. The difference in the average family size between the low and high adopters was marginal. The average size of holdings was 7.52 acres in case of high adopters and was marginally high compared to low adopters. In the high adopter category 53 per cent of the farmers belonged to the small and marginal farmers category. Among the low adopters 64 per cent belonged to the small and marginal farmers category. These socio economic features of the sample farmers have their own impacts on the adoption of technology and efficiency in the farming which would be discussed in the consequent sections.

5.1.2 Crop and Animal husbandry activities.

The results presented in Table 4.3 and Table 4.4 show that groundnut is an important crop grown by the sample farmers. Groundnut is a cash crop, money income generated is more which can be used for different activities by the farmer. Ragi is primarily grown for home consumption and it is seen that very few (five per cent) of the farmers sell ragi occasionally.

The high adopters have more land compared to the low adopters under both ragi and groundnut crops. In case of groundnut farmers, the farmers had allocated more area under arecanut and coconut. Average size of cattle in the sample is four and they have a sheep population of around twenty. This might have supplemented the manurial requirement of the farmers as it was observed that farmers were using more than the recommended dose of farm yard manure in their crop production activities. Majority of the farmers keep a pair bullocks on their farm. This helps during the peak season of cultural operations and mitigates the shortage of draught power.

5.2 FACTORS INFLUENCING THE ADOPTION OF TECHNOLOGY

The level of adoption of dry land technologies and the factors influencing the adoption by the farmers growing ragi and groundnut are discussed below.

5.2.1 Adoption of technology

The adoption of two categories of dry land technology viz., soil and moisture conservation practices and crop production practices are discussed separately below.

5.2.1.1 Soil and Moisture conservation measures : Nearly 66 per cent of the farmers growing ragi have adopted vegetative bunding, of these partial adoption was around 13 per cent. The remaining 34 percent have not followed the vegetative bunding as small size of holdings do not permit vegetative bunds along the contour. The adoption of dead furrow technique was almost absent, whereas 40 per cent of ragi growing farmers and 47 per cent of groundnut farmers have gone in for construction of water ways.

To follow these techniques, farmers have to forego considerable amount of arable land. This loss in the cultivable land coupled with the high cost of construction might have prevented the small and marginal farmers from adopting these techniques.

5.2.1.2 Varietal Adoption : Adoption of Indaf the important high yielding ragi variety, is just 10 per cent. The remaining majority of the farmers either used the local varieties like Kari Gidda or improved varieties supplied through co-operative societies long ago. Non-availability of HYVs at right time, high cost of seeds, desirable taste and palatability of the local varieties and uncertain rainfall are the major reasons which prevented the farmers from adopting the high yielding varieties. They prefer locals saying that taste and nutrition of local variety is better. Inter cropping is widely practiced by the farmers in order to reduce the risk and uncertainty.

5.2.1.3 Input Application : Application of nutrients, even if they adopt is not at the recommended levels. Few farmers overuse and others underuse due to specific constraints. Over use of farm yard manure is done by farmers with the belief that fertility increases and yields will be stable and that it will be available in the next crop season due to slow decomposition of farm yard manure. Majority of the farmers had cattle in their house which provides sufficient dung and since the holding sizes were small there was a tendency to over use FYM. Around ten per cent of the farmers did not apply farm yard manure as it was not available in the peak season and due to the high cost prevalent during such periods.

Fertilizers were applied in excess as a basal dose since they perceive uncertain rainfall in the later stages of crop growth. There was imbalance in the use of fertilizes. Excess quantities of nitrogen was applied owing to the cost differential (e.g. urea was priced at Rs.180 per bag of fifty Kgs. whereas complex was priced at Rs. 380 per bag of 50 kgs). Top dressing was followed by a few due to the poor economic status. Gypsum application was followed by 22.85 per cent of groundnut farmers.

5.2.2 Factors influencing adoption

The Logit analysis was employed to find out the factors influencing the adoption of technology by the farmers growing ragi and groundnut in the study area. A perusal of Table 4.7 shows that total land holding and occupation of the farmer are the two variables which had significant effect on the probability of adoption of improved practices by farmers growing ragi. The elasticity value reveals that for one percent increase in size of holding the probability of adoption increases by 0.44 per cent. When the farmers' main occupation is agriculture, a shift from subsidiary occupation to agriculture, increases the probability by 1.96 per cent. This indicates that agriculture as a sole occupation induces the farmer to adopt more of dry land technologies and a shift towards diversification leads to reduction in the extent of adoption. Contrary to common belief of scale neutrality of bio-chemical technologies, the significance of total land holding on adoption indicates certain practices are in fact not scale neutral.

In the case of farmers growing groundnut, experience and organisational participation had a significant effect on the probability of adoption of improved practices. For every one percent increase in experience (number of years in farming) the probability of adoption increases by 0.20 per cent. This indicates that experience in farming had made the farmers to acquaint themselves with the improved technologies and their conviction about the profitability of the same. Experience also builds up confidence in the technologies. This may be more true in the case of groundnut a commercial cash earning crop in dry lands. Organisational participation also tends to increase adoption. As most of these organisations are agriculture oriented co-operative institutions, farmers contact with them had enhanced formal and informal interaction with extension agents, technicians and other farmers and thus induced them to adopt improved technologies. The recommended inputs such as fertilizers and gypsum are supplied through either the PACS and other institutions under kind component. Farmers' involvement in these institutions increased the application of these inputs.

Contrary to the findings of Chattopadhya (1986), Lin (1991), education in the study area does not have any significant impact on adoption. It is worth probing further from the effective extension point of view, the scepticism expressed by the enlightened farmers about the improved dry land technologies.

5.3 INPUT USE, OUTPUT DECOMPOSITION AND ALLOCATIVE EFFICIENCY

Input use, output decomposition and allocative efficiency in ragi and groundnut crops among the high and low adopters is discussed below.

5.3.1 Input Use

The level of use of inputs such as farm yard manure, fertilizer and human labour by high adopters growing ragi was more compared to low adopters. When considered individually the variation was marginal in the case of human labour (just 1.11 per cent) and high for farm yard manure and fertilizer (about 77.75 per cent and 21.75 per cent respectively). However both the categories of farmers maintained the recommended seed rate in the range of 2.5 to 4 Kgs per acre.

Similarly, the high adopter farmers growing groundnut used 90.55 per cent more farm yard manure and 55.10 per cent more fertilizer compared to low adopters. However, the low adopters used more seed, human labour and bullock power compared to high adopters. But seed rate adopted was found to be close to the recommendation of 40 Kgs per acre. Gypsum was found to be used by only the high adopters but in a much lesser quantity than the recommendation. It was found that there was irrational use of fertilizers, as discussed in the previous section. Instead of applying NPK in the ratio of 20:16:10 for ragi and 10:20:10 for groundnut, a vast majority of farmers were applying only nitrogen.

5.3.2 Output Decomposition

One of the objectives of the present study was to decompose the source of the total change in output into two different components such as change in technology and change in input use. For this purpose, two production functions, one for the low adopters and another for the high adopters were fitted separately for both ragi and groundnut crops.

The F-test suggested that the two production functions fitted were statistically different implying that the parameters governing the input -output relationship in the case of low adopter farmers was different from those of high adopter farmers, indicating a structural break in the production function. The findings of this study are in conformity with those of Bisaliah (1977) for Punjab wheat economy, Sanjeev (1985) for groundnut and Holikatti (1991) for chillies. The F-test provides the necessary foundation for decomposing the total change in per acre output. The results of decomposition are presented in Table 4.13

The per acre production of ragi in high adopter farms was 16 per cent more than that on the low adopter farms. The technology change due to adoption of improved practices, has contributed 18.63 per cent and change in the level of input use has made a negative contribution of three per cent to the change in output. This further suggests that the low adopters can increase their output to the extent of 18.63 per cent by adopting the improved practices at levels of the high adopters without changing their level of input use. However improved soil and moisture availability has a complimentary relationship with input use.

The per acre production of groundnut of high adopter farmers was 12 per cent higher than that of low adopters (Table 4.16). The technology change due to adoption of improved practices, has contributed 21 per cent and change in the level of input use has reduced the gap between the high and low adopters by nine per cent to the change in output. This however appears to be reasonable as the results of allocative efficiency show that the resources were being over used. The low adopters can increase their output by 12 per cent by adopting the improved practices at levels of the high adopters at the same levels of input use. The decomposition analysis has demonstrated that adoption of technology increases the output by shifting the values of scale and slope parameters. The contribution of inputs is negative and these results are corroborated by the results of allocative efficiency analysis which show that many of the inputs are overused.

5.3.3 Allocative Efficiency

In determining the allocative efficiency the value marginal product of each resource was equated with their respective factor cost. Allocative efficiency of the farmers has been presented in Table 4.17.

5.3.3.1 Allocative efficiency of farmers growing ragi

a. High adopters : The ratio of MVP to MFC shows that seed (44.02) was underused. The ratio for farm yard manure (0.82) and bullock power (1.05) was close to the optimum. The MVP of fertilizer was negative indicating there was excessive use of fertilizer for crop production purposes, implying that any additional use of fertilizer will decrease his profitability.

b. Low adopters : The MVP-MFC ratio for seed (14.38) showed that it was underused. The ratio in respect of FYM, human labour and bullock power was 0.19, 0.13, and 0.79 respectively indicating that these inputs were overused.

5.3.3.2 In the case of the farmers growing groundnut

a. High adopters : The ratio of MVP to MFC for seeds (5.03) and human labour (1.53) showed that these resources were underused, whereas the ratios of FYM (-0.53), fertilizer (0.23) and bullock power (-0.89) indicate their overuse.

b. Low adopters : The MVP-MFC ratio indicates seed (3.99), FYM (12.67) and Bullock power (1.6) were underused, while fertilizer (-0.03) and human labour (0.77) were overused.

The allocative efficiency has shown that there was excessive use of fertilizer for crop production purposes. Therefore any additional rupee spent on these inputs would decrease the profitability. These results are in conformity with the study of Shah (1983) who observed that fertilizer was used not at the optimal levels along with excess labour supply. It was seen in the previous sections that there was an imbalance in the use of fertilizers. It was found that the farmers were using more of urea in both the crops owing to the price differential. This shows that right combination of technology and input use can increase yields in dry land agriculture. However, those inputs whose ratio is greater than one indicates there is scope to intensify the use of these inputs to optimum level to increase output and profitability by reallocating the resources.

5.4 TECHNICAL EFFICIENCY AND EFFICIENCY GAP

5.4.1 Technical Efficiency.

The technical efficiency was calculated using Timmer's measure of technical efficiency following the corrected ordinary least squares technique. The mean technical efficiency was found to be 0.503 and 0.500 for ragi and groundnut, respectively. This indicates that farmers can increase their output by improving their efficiency levels. The mean technical efficiency reflects the efficiency of the sample as a whole but does not show the variability in efficiency of individual farmers. Hence, an attempt was made to calculate farm specific and crop specific technical efficiency. The results show wide variation in the levels of efficiency across the sample and more than 70 per cent of the farmers lie below the 60 per cent efficiency range as shown in Table 4.18. These productivity differences may be due to farm specific constraints. Identification of the factors influencing this gap was studied with the assumption that technical efficiency mainly depends on adoption of technology, education, experience, extension participation, human labour utilised and mass media participation. Identification of these factors could help policy-makers in formulating appropriate agricultural programmes to help the farmers realise the frontier output. The results are shown in Table 4.19. The analysis shows that adoption of technology and mass media participation are significant factors contributing towards technical efficiency in ragi farms. These results confirm with previous related studies like that of Kalirajan (1984) who says there is a wide variation in the level of efficiency. The important factors causing variations were education and extension service. Ranaweera *et al* (1985), observed that technical efficiency of maize growing farmers could be doubled if farmers could be encouraged to adopt 'best practice technology' and by removing the socio-economic constraints.

In case of groundnut farms the significant factors contributing to technical efficiency were adoption of technology, while extension participation and human labour have contributed negatively; perhaps suggesting that more emphasis needs to be given for adoption of soil and moisture conservation practices as the evidence shows majority of them did not follow recommended practices fully. Mass media may be used as an effective tool to disseminate information as it was found to have a significant effect on efficiency and help farmers to take appropriate managerial decisions. Extension agencies give more emphasis on input use which is probably why resources are over used. Technical efficiency which emphasises on the managerial aspects of cultivation is not emphasised by the extension agencies and hence the absence of any contribution of this variable. It is noticed that extension agents contact progressive or large farmers and then information is passed on to other strata of farmers by these chosen few, leading to dilution and distortion of information thereby rendering them ineffective. Education does not show a significant effect since education levels are low and were confined to formal school education. However, it appears skills and knowledge would have a bearing on efficiency rather the education *per se*.

5.5 OPINION OF THE FARMERS REGARDING THE TECHNOLOGY OPTION

It is evident from the opinion survey that farmers preferred low cost technology and a combination of improved practices which can be adopted with the existing agricultural implements possessed by them. A case in point here is that the use of seeddrill does not match with the indegenous implements possessed by them. The necessity of financial assistance evinced by the farmers indicates practices like vegetative bunding and waterway construction are expensive and they could be taken up with external financial assistance.

Since ragi is primarily grown for home consumption, farmers preferred varieties which were high yielding, in addition to being palatable and withstand moisture stress. However, in case of groundnut their preference indicates that varieties should have high market acceptability in terms of weight, boldness of the seeds and oil content, with other related characteristics such as quick maturing and withstand moisture stress. Palatability was not an important consideration in case of groundnut.

Summary & Conclusions

CHAPTER VI

SUMMARY AND CONCLUSIONS

This chapter presents the salient features of the study together with the broad implications.

6.1 FOCUS OF THE STUDY

The development of rainfed farming gains paramount importance in view of the fact that, the arid and semi-arid tropical regions, usually called dry-farming areas, constitute two fifths of country's geographical area, one third of its rural population and one half of its cropped area and contribute to over 42 percent of total food production. It is also projected that India needs to produce 240 million tonnes of food grains by 2000 A.D. in order to feed the ever growing population. Also the area under irrigation cannot be increased due to limited water resources and high cost associated with it. This makes the case for emphasis in dryland farming to augment food production.

Realising these facts the state and central governments have launched special programmes to develop rainfed regions from time to time through different agencies. The commissioning of Dry Land Development Boards (DLDB) in 1984-85 and the National Watershed Development Project for Rainfed Areas in 1990-91 are some efforts in this direction. Introduction of high yielding varieties is one such effort in raising production. Another such effort is the soil and moisture conservation programme. Ragi - a staple food crop and Groundnut - an important commercial crop, were selected for the present study. The present study was undertaken to find out the contribution of improved dry land technologies to output. In addition, the socio-economic factors which influence the adoption as well as efficiency of farmers was studied. Technology adoption was studied under two heads, namely, Soil and moisture conservation practices and Crop production practices.

The specific objectives of the study were as follows :

1. To study the level of adoption of dryland technologies in Ragi and Groundnut production in Central Dry Zone of Karnataka,
2. to decompose the change in output into technological and input components,
3. to study the technical efficiency of ragi and groundnut production and the factors influencing the same, and
4. to document the opinions of the farmers with respect to technological option.

6.2 SAMPLING DESIGN

The study was conducted in Madhugiri taluk of Tumkur district, of Karnataka which comes under the Central Dry Zone. A sample of 120 farmers, consisting of 60 cultivating ragi crop and 60 growing groundnut crop were selected.

Random sampling was employed to select four villages and 30 farmers from each village. The detailed data were collected with a pre-tested schedule for the period 1995-96 by personally interviewing the respondents.

6.3 ANALYTICAL FRAMEWORK

In conformity with the objectives of the study, tabular analysis, Cobb-Douglas production function and frontier production functions were used to quantitatively analyse the data.

6.4 EMPIRICAL RESULTS

The important findings of the study are summarised in the following section.

6.4.1 Socio-economic characteristics

In the case of farmers growing ragi, the average family size was 7.06. The high adopters had a family size of 7.92 and the low adopters had a family size of 6.42. Over 36.67 per cent of the sample farmers chosen were illiterate, 31.67 per cent had education upto middle school level. The percentage of respondents educated beyond degree level was just 8.34. The holding size in case of sample ragi farmers varied vastly. High adopters had a holding size of 7.02 acres, the low adopters had a holding size of 5.41 acres only. Eighty per cent of the farmers in the low adopter category were small and marginal.

The sample groundnut farmers had an average family size of 7.61. The difference between the size of families of high and low adopters was marginal. Illiteracy level in the sample was 31.67 per cent and 26.67 per cent had education upto middle school level. The average size of holding of the sample farmers was 6.82 acres. It was found that in both the crops, the small and marginal category farmers were more under low adopter category.

6.4.2 Adoption of technology

There was 100 percent adoption of fall ploughing and ploughing across the slope by the sample ragi farmers. Vegetative bunding was partially adopted by 13.33 per cent of farmers. Dead furrow technique and deep ploughing were not followed by the farmers. Local varieties were preferred due to their preference for taste, palatability and higher shelf life.

In case of sample farmers growing groundnut, 21.60 per cent had adopted vegetative bunding partially. There was 100 per cent non-adoption of dead furrow technique and deep ploughing. Gypsum application was followed by 22.85 per cent of sample. Lack of conviction, wastage of land, high cost, and operational inconvenience were the reasons stated for their non adoption. Inter cropping was widely practiced by the farmers in order to reduce yield risk and extend the cropping reason.

6.4.3 Factors influencing the probability of adoption

In case of ragi farmers, total land holding, experience in farming, participation in extension activities, organisational participation, media exposure and occupation were found to increase their probability of adoption of dry land technologies. Total land holding and occupation were significant indicating that adoption increases by 0.44 per cent with one per cent increase in his holding size whereas shift in his occupation would increase his adoption by 1.96 per cent. The overall probability of adoption was 0.38 at the mean levels of the variables.

In case of the sample farmers growing groundnut, farming experience was found to contribute significantly. With one per cent increase in farming experience probability of adoption increased by 0.20 per cent. The other variables were found to contribute positively to adoption . The overall probability of adoption was 0.53 at the mean levels of the variables.

This indicates the probability of adoption is more in groundnut, a cash crop, when compared to ragi, a food crop.

6.4.4 Input use

It was found that, in case of ragi farmers, the high adopters use of fertilizer, FYM and human labour was higher by 21.75, 77.75 and 1.11 per cent respectively. It was also found that the seed rate was maintained at the recommended level.

The high adopter farmers growing groundnut, were using more of FYM and fertilizer (90.55 per cent and 55.10 per cent, respectively). Gypsum was applied only by the high adopters. It was observed that fertilizer, a chief marketed input, was used in excess of the recommended level by both ragi and groundnut farmers.

6.4.5 Output decomposition

The significance of the chow's test implied that the parameters governing the input-output relationships for the production functions of high and low adopters of both ragi and groundnut crops were significantly different from each other.

The result on decomposition analysis of ragi output between high and low adopters of technology leads to the inference that per acre output of ragi was 15.59 per cent higher than that of low adopters. The net contribution of technology to the output change was 18.63 per cent. This implied that with the same level of inputs used by the low adopters, 15.59 per cent more output could be obtained by adopting technology at the levels of high adopters. The effect of input change was negative at 3.00 per cent.

In case of the groundnut farmers, the decomposition analysis has shown that 11.19 per cent more output could be obtained by the low adopters by adopting technology at levels of high adopters with their present levels of input use. The total input level influence was negative at 9.53 per cent, whereas the contribution due to technology was 20.72.

This proves that adoption of technology increases the yield in dry land agriculture under the main limiting factor moisture.

6.4.6 Allocative efficiency

The analysis of allocative efficiency showed that the sample farmers were using more fertilizer than was warranted as indicated by the ratio of MVP to MFC. The sign of the ratio in both high and low adopters was negative. The low adopters had over used FYM, human labour and bullock power with the MVP-MFC ratio values being 0.19, 0.13, 0.79 respectively. The high adopters had over used human labour and FYM was used optimally as the ratio was close to one.

In case of groundnut sample farmers, the allocative efficiency was more than one for seed, bullock power and FYM implying that there was scope for additional use of these inputs by the low adopters. The high adopters had over used FYM, fertilizer and bullock power.

Fertilizer was one input which was found to be excessively used by both ragi and groundnut farmers. The value of allocative efficiency was less than zero suggesting a reduction in the use of this input.

6.4.7 Technical efficiency.

There was a wide variation in the levels of technical efficiency across the sample farmers. The efficiency ranged between 0.25 to 1.00 in case of ragi and 0.16 to 1.00 in case of groundnut. The mean technical efficiency was 0.503 and 0.500 for ragi and groundnut sample farmers. This shows that farmers have scope to nearly double their yields by improving their efficiency levels.

6.4.8 Factors influencing the technical efficiency gap.

The analysis on technical efficiency gap indicated adoption of technology as a major factor influencing the technical efficiency significantly in both ragi and groundnut. Technical efficiency was positively influenced by education, experience in farming, and exposure to media. Participation in extension activities did not contribute to their efficiency.

6.4.9 Opinion on technological option of farmers

The opinion survey on technological option indicates that all the farmers preferred varieties which can withstand moisture stress and give stable high yields. Palatability, taste and shelf life were important considerations in ragi, a primary food crop. High market acceptability in terms of weight, boldness of seed were important considerations in case of groundnut a cash crop.

Over 75 per cent of sample ragi farmers and 85 per cent of ground farmers evinced that they required more of training and demonstrations.

Low cost technology was preferred by 76 per cent of sample ragi farmers and 56 per cent of groundnut farmers.

Eighty eight per cent of sample ragi farmers and 90 per cent of groundnut farmers preferred using indigenous implements for improved practices. More than 90 per cent of the farmers evinced their need for financial assistance.

Based upon the results the status of the hypotheses (proved/disproved) is presented in below.

Sl. No.	HYPOTHESIS	STATUS OF HYPOTHESIS	TECHNIQUES
1	Dry land technologies are scale neutral and hence can be adopted by all categories of farmers	disproved partially proved *	Logit model tabular analysis
2	Use of appropriate dry land technology rather than the level of use of a particular input will have a marked influence on the output.	proved	Decomposition analysis and allocative efficiency
3	Dry land farmers use less of marketed inputs such as fertilizer.	disproved	input use and allocative efficiency
4	High adopters are more efficient in the use of inputs than low adopters in dry land agriculture	disproved	allocative efficiency
5	Adoption of technology is relatively more in the case of marketed commercial crop than the subsistence crop needed for home consumption.	proved	logit analysis
6	Even with the associated risk and uncertainty in production, the farmers using dryland technologies can attain high technical efficiency levels	partially proved **	frontier production function

Note : * majority of them are small farmers

** more than 50 per cent farmers are in the range of 0.41-0.60

6.5 IMPLICATIONS AND RECOMMENDATIONS.

Few specific implications and recommendations that emerged out of the study are presented below.

1. A majority of the farmers had adopted soil and moisture conservation measures. A large scale nonadoption of dead furrow technique was seen. Contrary to common perception, farmers used inputs especially fertilizer, in more than the recommended dose. Fertilizer use was very imbalanced as they used more of nitrogen in the form of urea, due to government's policy such as giving more subsidy on nitrogenous fertilizer. Both extension agents and governments should take note of the excessive and imbalanced use of fertilizer and take appropriate measures to correct it.

2. Majority of the farmers did not use HYV of ragi due to preference for palatability, taste and high shelf life present in the locals. Varieties recommended for crops which are used especially for home consumption should have these preferential characteristics. Research effort should be directed to evolve such varieties.

3. Among the various factors influencing the level of adoption of dry land technology by farmers, area emerges as an important positive contribution. This implies that large farmers adopt technology better than small farmers. This

contrasts the common perception of scale neutrality in the case of bio-chemical technologies. This calls for special incentives to small farmers in order to encourage them to adopt technology to levels of large farmers.

4. Even though adoption of dry land technology has increased the yield in the case of both ragi and groundnut, the increase in yield has mainly come from the technology component such as soil and moisture conservation measures and not from levels of use of inputs like fertilizer, manure and labour. These inputs, infact, have a negative contribution on the yields of high adopter farmers. Over use of these inputs, especially chemical fertilizer under uncertain moisture conditions might have caused this effect. In the light of this finding, extension agencies must concentrate on the managerial aspects of resource use. The role of agricultural economists would go a long way in arriving at economic optimum levels of input use and incorporating the same in the package of practices.

5. Extension participation by the farmers neither enhanced the adoption of technology nor improved their technical efficiency. Hence extension agencies may think of following effective disseminating techniques such as group approach, rather than the present contact/progressive farmer approach.

6. The extension mechanism should be oriented towards improving the technical efficiency through educating farmers on correct management practices and ensuring that inputs are available at the right time and in required quantities. The incentive mechanism / subsidy should also be restructured so as to facilitate the balanced use of inputs. The role of infrastructure in fostering efficiency cannot be discounted and creating rural infrastructure will go a long way in improving the efficiency in dryland areas.

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CHAPTER VII

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