

**AN ECONOMIC STUDY OF INFLUENCING
FACTORS OF SUSTAINABLE AGRICULTURE
IN RAINFED AREA OF ANANTAPUR DISTRICT**

By

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CERTIFICATE

Miss. Y.SARALA KUMARI has satisfactorily prosecuted the course of research and that the thesis entitled **“AN ECONOMIC STUDY OF INFLUENCING FACTORS OF SUSTAINABLE AGRICULTURE IN RAINFED AREA OF ANANTAPUR DISTRICT.** ” submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by her for degree of any university.

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This is to certify that the thesis entitled "AN ECONOMIC STUDY OF INFLUENCING FACTORS OF SUSTAINABLE AGRICULTURE IN RAINFED AREA OF ANANTAPUR DISTRICT " submitted in partial fulfillment of the requirements for degree of **Master of Science in Agriculture** of the **Acharya N.G.Ranga Agricultural University, Hyderabad**, is a record of the bonafide research work carried out by **Miss.Y.SARALA KUMARI** under my guidance and supervision. The subject of the thesis has been approved by the **Student's Advisory Committee**.

No part of the thesis has been submitted for any other degree or diploma or has been published. The published part has been fully acknowledged. All assistance and help received during the course of investigations have been duly acknowledged by the author of the thesis.

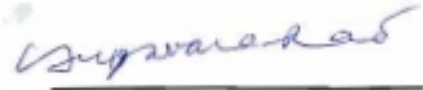

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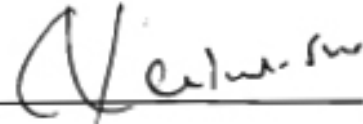
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DECLARATION

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ABSTRACT

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The present study entitled "An economic study of influencing factors of sustainable agriculture in rainfed area of Anantapur district" was aimed at identifying the indicators of sustainability and comparing the costs and returns from sustainable and non-sustainable farms. The study covered two mandals and four villages with 80 farmers and the sample farmers were stratified into two categories viz., sustainable and non-sustainable and again in to two size groups in each category i.e., small and large. Data pertained to the agricultural year 1997-1998 were collected through survey method with the help of pre tested schedules. Conventional and functional analyses were used to analyse the data and to arrive at valid conclusions.

The average size of the holding for the sample as a whole in case of sustainable forms was 8.51 ha as against 4.83 ha of non-sustainable farms. The size of the family was more on non-sustainable farms compared to sustainable farms. The per hectare value of assets on sustainable and non-sustainable farms exhibited negative relationship with the size of the holding. Intercropping, crop rotation, agro-forestry, integrated pest management and integrated nutrient management were identified as indicators of sustainability.

On an average, the cost of cultivation of groundnut and paddy worked out to Rs.12,735.27 and Rs.21,267.40 per hectare respectively where as the same was Rs.12,228.14 and Rs.21,171.50 per hectare respectively on non-sustainable farms. The total costs were higher on sustainable farms compared to non-sustainable farms.

The average gross returns per hectare of groundnut and paddy on sustainable and non-sustainable farms were Rs.15,631.63 and Rs.29,165.50 and Rs.14,218.13 and Rs.28,243.00 respectively. The benefit- cost ratios of groundnut and paddy of sustainable and non-sustainable farms were 0.26, 0.37 and 0.16, 0.33 respectively.

The functional analysis indicated that seed (X_2), machine labour (X_4) and fertilizers (X_3) had positive impact on the yields of groundnut in case of sustainable and non-sustainable farms. On sustainable and non-sustainable farms bullock labour, human labour, manures were termed out to be negative and significant in the production of paddy.

The inequality of income distribution was greater for small farmers of sustainable farms over small farms of non-sustainable farms. In respect of large category, the income inequality was slightly higher on non-sustainable farms over sustainable farms.

The reasons for non-adoption of methods of sustainable agriculture were non-availability of productive inputs, awareness of modern practices and improved technology.

Introduction

CHAPTER-I

INTRODUCTION

One of the finest Indian successes of post independence era has been the green revolution in the late sixties, which turned the country from a chronic importer of food grains into an exporter. The newly developed early maturing and high yielding dwarf varieties of wheat and rice during that period helped in increasing the production of food grains significantly. The impact of green revolution was so dramatic that India became a role model for many developing countries. This led to massive transformation in the rural economy which came about through the collaborative efforts of farmers, researchers, planners backed up with necessary administrative and political support.

As a result of the green revolution, the total food grain production increased from a mere 50.8 million tonnes during 1950-51 to an estimated 194.13 million tonnes in 1997-98 and productivity increased from 522 kg/ha to 1500 kg/ha. The productivity of wheat (237 kg/ha), rice (1850 kg/ha) and oilseeds (800 kg/ha) increased better than other crops. This increase in production of food grains was possible as a result of adoption of quality seeds, higher doses of fertilizers and plant protection chemicals, coupled with assured irrigation. The improved seeds have been the catalysts for making other inputs cost effective. The use of certified/quality seeds by the farmers has increased to 6,50,000 tonnes in 1994-95 from 2,00,000 tonnes during 1970-71. The fertilizer consumption has increased to 12.27 million tonnes (more than 75 kg/ha) in 1994-95 from 0.29 million tonnes in 1960-61.

Besides green revolution, significant production advances have been made in milk, fish, oilseeds, fruits and vegetables. In milk, India is the second largest producer in the world with production at about 66 million tonnes. In fisheries the country has ushered in Blue revolution with production level touching 4.5 million tonnes. Due to concerted efforts, on strategic research and production technology in oilseed sector, the country witnessed a yellow revolution with production increasing up to 22 million tonnes in less than a decade.

Agriculture is a dynamic and flexible system. The nature has sustained agriculture and environment over centuries. By manipulating the forces of nature to meet the growing needs, man has made agriculture growing and bountiful but has in the process caused environment unfriendly and degenerating. Advances in agricultural sciences and technology and their application have revolutionized crop production. The natural resources such as soil, water, air, sunlight and bio-world of plants, animals and microbes and their interactions are the foundation for progressive and sustainable agriculture and environment. But man has been overactive, insensitive and unfuturistic in the use of natural resources and exploited the same purely for immediate gain. The manipulation and exploitation of natural resources led to serious damage to environment owing to cutting down of forests, destroying bio-diversity, indiscriminate use of chemicals for nutrient supply and crop protection, degeneration of soil fertility and productivity, pollution of air and water, depleting ozone layer, global warming and acid rains.

Intensive cultivation of land without conservation of soil fertility and soil structure, would lead ultimately for springing up of deserts. Irrigation without arrangements for drainage would result in soils getting alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer or other diseases through the toxic residues present in the grains or other edible parts. Unscientific tapping of under ground water would lead to the rapid exhaustion of this capital resource left to us through ages of natural farming. The rapid replacement of numerous locally adopted varieties with one or two high yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out extensive crops as happened prior to the Irish Potato famine of 1845 and the Bengal Rice famine of 1942. Therefore the initiations of exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture and without first building up a proper scientific and training base to sustain it may only lead us into an era of agricultural disaster in the long run rather than to era of agricultural prosperity.

Land, water, climate, flora and fauna are the basic natural resources for agricultural development which are subject to various deteriorating influences. Since agricultural development cannot sustain on a deteriorating natural resource base, it is imperative to develop strategies for conservation and improvement of resources. The concept of sustainable resource management implies that the needs of the present can be met without compromising the ability of the resources to meet the needs of the future. In the past in

view of the over riding concern for ensuring food security and meeting other vital requirements of the large and rapidly growing population, the pursuit of research was directed towards utilization of resources to derive maximum benefits. There is now recognition that truly productive agriculture must have long term sustainability by way of sustenance of natural resources, economic viability and social acceptability of production systems and protection of environment.

Sustainability of agriculture has been interpreted in a number of ways in the recent literature. Organic methods of farming or 'permanent agriculture' which respected the integrity of the soil and related ecological systems have been referred to as 'sustainable'. The FAO (1989) on the other hand, defines sustainable agriculture as the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources. Parikh and Ghosh (1991) considered soil in particular to be an important resource base and it should be treated as the reference point for defining sustainability. Jodha (1991) treated sustainability as a characteristic of the agricultural system. "It is the ability of the system to maintain a certain well defined level of performance over time, and if required to enhance the same through linkages with other systems without damaging the ecological integrity of the system". The notion that seems to underlie the concept is that growth must be achieved without impairing the resource base. In other words, the land/soil and its intrinsic qualities should be maintained unimpaired in the process of growth. And this should hold true over a relatively long run. Sustainability is, in other words, the desired ideal of achieving growth while maintaining natural capital intact.

There are many indicators of sustainability such as intercropping, crop-rotation, agro-forestry, biological control of pest, integrated pest management, use of biological fertilizers, maintaining soil quality, post harvest technology, improvement in ground water recharge, increasing investments in protective irrigation, improvement in regeneration of all lands, etc for enhancing the sustainability. Sustainability of the system rises along with economic development and then starts falling consequent to excessive extraction from natural system.

In India, out of total land mass of 329 m.ha, 224 m.ha are under dry land, and 45 per cent of the country's food grain production comes from rainfed dry lands. Major percentages of important crops i.e., 86 per cent groundnut, 91 per cent pulses and 67 per cent cotton were grown under dry lands.

The present study was conducted in rainfed area of Anantapur district. Rainfed dry lands refer to areas with less than 800 mm rainfall per year. Dry lands are under increasing pressure due to the prevalence of poor agricultural practices, over grazing and intensive use of agricultural lands to meet human and animal food and fibre requirements. This has placed unprecedented demands on dryland resources which being characteristically fragile are subjected to accelerated soil erosion, loss of soil fertility and decreasing productivity.

Anantapur district is purposively selected for the study as it ranks first in area under rainfed crops among all districts of the Rayalaseema region and records greater variation in rainfall. Keeping in view all the above points, this research study was conducted on dry land area of Anantapur district with the following objectives:

- i. To identify and evaluate the indicators of sustainability;
- ii. To compare the costs and returns of sustainable and non-sustainable farms; and
- iii. To identify the constraints of adopting strategies of sustainability and to suggest appropriate ameliorative measures.

PLAN OF THE THESIS

The thesis has been presented in five chapters. The first chapter gives a brief introduction of the research work and the specific objectives of the study. In the second chapter, the past literature related to the present study is given. The sampling procedure adopted for the study, method of data collection and various techniques used to analyze the collected data are detailed in the third chapter. The fourth chapter deals with the results along with the discussion of the study. An over view of work done along with conclusions is given in the last chapter i.e., summary and conclusions.

*Review of
Literature*

CHAPTER-II

REVIEW OF LITERATURE

In this chapter an attempt is made to critically review the literature of the past research work relevant to the present study. The research work carried out by various research workers related to the problem under study has been reviewed under the following heads.

2.1 Indicators of sustainability

2.2 Costs and returns of sustainable and non sustainable farms

2.3 Constraints of adopted strategies and ameliorative measures of sustainability.

2.1 INDICATORS OF SUSTAINABILITY

Rao *et al*, (1980) stated that the greatest stability of yields were obtained in intercropping when compared to sole cropping over different seasons.

Mc Dicken (1981) found that the improvements in soil chemical properties produced by a natural fallow, could be produced in a much shorter time by soobabul fallow under proper management.

Pichot *et al*, (1981) has shown that removal of crop residue alone besides addition of fertilizers could result in yield decline with time.

Elswaify *et al.* (1983) concluded that in dry land farming, the use of organic manure was more efficient in terms of building the soil fertility in the long run.

Singh and Jha (1984) revealed from the results of multilocational trials conducted in sorghum based intercropping systems, that intercropping generated higher long term returns when compared to sole cropping.

Fussell and Seratini (1985) stated that intercropping of cereal with legumes was a common practice in semi-arid zone of West Africa and it was a system to withstand the scarcity of resources and could reduce the risks and labour requirements.

Madden (1987) indicated that sustainable agriculture includes economically viable systems that minimize the purchase of off-farm inputs such as pesticides, fertilizers etc.

Subbaramaraju *et al.* (1987) in their study indicated that land, bullock labour and fertilizers were significantly contributing to yields in rainfed groundnut.

Bali *et al.* (1988) revealed that incorporation of legume residues @ 5t/ha plus 50 per cent of the recommended nutrient rate through fertilizers, out-yielded the crop compared to recommended rate of fertilizers in a maize-wheat rotation in the dry lands of Jammu and Kashmir.

Patil and Kulkarni (1988) in their study showed that leucaena when planted as alleys with *rabi* sorghum and loppings used as manure added 87.6 kg N/ha to the soil and this input on sorghum yields was equivalent to that of 25 kg N/ha through fertilizer.

Swaminathan (1988) suggested that judicious husbanding of land and scientific management of water hold the key to achieve sustainability, which is defined as a non-negative trend in the productivity of a given plot over time.

Fenster (1989) in his study indicated that wheat yields were doubled due to elimination of stubble grazing and adoption of mulch tillage and improved weed control in the wheat fallow cropping systems.

Samui and Roy (1990) reported that the higher pod, seed and oil yield was obtained with alternate rows of groundnut and sunflower both in *kharif* and *rabi* seasons on sandy loam soil of Kalyani.

To maintain and improve soil productivity in fragile soils in rainfed areas with limited availability of inputs, Swindae (1990) recommended planting of small trees and shrubs that enhances sustainability by providing fuel wood, browse for livestock etc.

Devidayal and Reddy (1991) reported that groundnut with sunflower intercropping gave 30.5 per cent higher oil yield compared with sole groundnut crop on clay loam soils of Junagadh.

Lerohl (1991) indicated that wheat yields were highest in rotations of wheat followed by fallow or forage crops and wheat yields appeared relatively unaffected by length of rotation.

Chowdary *et al*, (1993) stated that high yielding varieties contributed to yield increase by 34 per cent, plant protection measures by 40 per cent deep tillage by 25 per cent and the optimum seed rate of 125 kg/ha by 17 per cent in groundnut crop.

Nadagouda *et al*, (1993) revealed that significant reduction in pod yield of groundnut was noticed when trees were not felled, as groundnut grown in between eucalyptus tree rows. Average pod yield with tree felling (1692 kg/ha) was 118% higher than no tree felling (774 kg/ha). He mentioned that reduction in yield with no felling was mainly due to shade and root effect of well grown eucalyptus trees.

Nadkarni (1993) in his study indicated that operational or observable indicators of sustainable development were helpful to the economists in assessing the development performance from the point of sustainability. The indicators were productivity, stability, sustainability of yield or income and equitability in terms of income distribution. He also stated that productivity in gross terms could not be an indicator of sustainable development.

George (1994) indicated various measures such as intercropping, crop rotation, agro-forestry, biological control of pests, integrated pest management, use of bio-fertilizers and cropping sequence for enhancing resource sustainability.

Malik (1994) indicated that development of ground water resources increased the area under rice in Punjab from 0.659 million hectares in 1970-71 to 2.7 million hectares in 1993-94.

Stockle *et al*, (1994) studied the behaviour of sustainability of agricultural production systems in USA. They stated that the frame work for evaluating the sustainability of a farming system included nine attributes i.e. profitability, productivity, soil quality, water quality, air quality, energy efficiency, fish and wild life habitat, quality of life and social acceptance.

Ahmed and Prasad (1996) revealed that the association of little millet with groundnut was more beneficial than pigeon pea and also the association of little millet with groundnut under 2:1, 4:1 or 2:2 ratios were more sustainable.

Karam singh *et al*, (1996) indicated that the yield difference between improved and local technologies were about 45 per cent in case of maize and 35 per cent in case of wheat in water shed region of Punjab.

Singh *et al*, (1996) indicated that green manuring with sesbania in rice-wheat sequence with recommended dosage of fertilizer during summer increased rice and wheat yields by 12 per cent. They also showed increase in the net profit of Rs.2,210 per cent ha from rice-wheat sequence with green manuring of sesbania before rice planting.

Pradhan and Mondal (1997) revealed that green manuring with sesbania and khesari was found equivalent to 19.4 and 31.1 kg fertilizer N/ha during rainy and summer season in rice respectively.

Chandrakar and Koshtar (1998) estimated that the aggregate energy requirement for the production of rice was 160.36 million joules per ha, 8429.83 million joules per ha and the benefit cost ratios were 0.76 and 0.58 under irrigated and rainfed rice respectively.

2.2 COSTS AND RETURNS

Goldstein and Young (1987) stated that yields were somewhat lower on sustainable farms as compared to conventional farms. However, the loss in yield was compensated on sustainable farms through lower input costs and higher net returns.

Subbaramaraju *et al*, (1987) indicated that on an average the net returns of groundnut per hectare were Rs. 523.50 and 221.21, cost of production per quintal was Rs.194.62 and 170.00 and benefit cost ratio was 1.17 and 1.14 under irrigated and unirrigated conditions respectively.

Dhoble *et al*, (1990) revealed that intercropping system of sorghum with pigeon pea recorded the highest monetary returns of Rs.125.65 per ha and it was significantly superior over all other intercropping systems.

Reganold *et al*, (1990) stated that the external costs like soil erosion, surface and ground water pollution were factored into the costs of farm production and the over all profitability and benefits to society would likely be greater for sustainable farming systems.

Selvam and Soundararajan (1991) indicated that the maximum groundnut equivalent (2,193 kg/ha), land equivalent ratio (1.61) and net returns of Rs.7,345 per ha were obtained in groundnut with long duration redgram in 7:1 ratio.

Rangaswamy *et al.* (1992) revealed that integrating crops with fish and poultry farming in the low lands of Tamil Nadu, indicated the best advantage over the conventional system of cropping. An additional income of Rs.15,320, Rs.11,574 and Rs.15,505 per ha per year was obtained during first, second and third year respectively.

Umrani *et al.* (1992) found that the grain yield of winter sorghum was improved by 34 per cent monetary returns by Rs.2,066 per ha and that of safflower seed by 14 per cent, monetary returns by Rs.628 per ha owing to inclusion of gram crop in the system compared with continuously growing either sorghum or safflower.

Alshi and Joshi (1993) revealed that variable cost, the average yield and the gross return from summer groundnut cultivation was Rs.6,542, 13.68 q per ha, Rs.13,972 per hectare respectively. The output-input ratio was 2.13 indicating that summer groundnut cultivation was comparatively profitable.

Jadhav *et al.* (1993) estimated that the per hectare average cost of production of summer groundnut was Rs.10,287 and the average per hectare gross income and net returns were Rs.12,014 and Rs.1,727 respectively.

Mulik *et al*, (1993) indicated that highest monetary returns (Rs.5,723/ha), land-equivalent ratio (1.23) and benefit-cost ratio (1.24) were obtained in the intercropping system of sunflower with pigeon pea in 2:1 row proportion than sole crops of sunflower and pigeon pea (Rs.4,736 and Rs.4,699/ha) respectively.

Thirupathaiah and Naidu (1993) found that there was a direct relationship among farm size, total labour cost and total cost of cultivation and the contribution of human labour cost in total labour cost was maximum and the cost-benefit ratio at net income level was 0.14 for overall farms.

Kathmale *et al*, (1995) indicated that the groundnut equivalent yield 2,210 kg per ha net returns Rs.10,727 as well as land equivalent ratio 1.28 and cost-benefit ratio 2.13 were highest for groundnut with soybean intercropping system than sole crop.

Jain and Idnani (1996) stated that the ~~per ha cost~~ was reduced as the size of holding increased, and on an average the cost of cultivation of rainfed paddy came to Rs.3,057.22 per ha, ranging from Rs.2,634.48 to Rs.3,580.32 per hectare. The productivity level on an average was 22.71 q per ha, ranging from 21.39 to 23.63 q per ha and the net profit per hectare on an average was Rs.1,279.88 per ha and it ranged from Rs.779.38 to Rs.2,011.49 in different size of holdings.

Mulik *et al*, (1996) estimated that the monetary returns were significantly highest i.e., Rs. 9,414 per ha from pearl millet with pigeon pea intercropping and also the highest sustainable value index (0.62) was observed in this combination, indicating more sustainability with intercropping during *kharif* season under dry land conditions.

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Rafey and Prasad (1996) found that the maximum monetary advantage of Rs.2,960 was recorded from the association of 100 per cent sorghum and 75 per cent black gram, than any other association which was close to cent per cent population of both the crops (Rs.2,862).

Dubey *et al*, (1997) estimated that the annual profit was maximum of Rs.23,000 and Rs.21,000 per ha from rice-wheat sequence at Jabalpur and Raipur respectively and about Rs.30,000 per ha from sorghum-wheat sequence at Indore with integrated use of fertilizers and organic manures.

Rajput *et al*, (1998) revealed that on an average cost of cultivation of groundnut was Rs.9,837 per hectare. A₁, B₁, B₂, C₁ and C₂ costs of cultivation per hectare of groundnut came to Rs.7,892, Rs. 8,112, Rs.9,362, Rs.9,737 and Rs.9,837 respectively. The returns over cost A₁, cost B₁, cost B₂, Cost C₁, and Cost C₂ worked out to Rs.10,197, Rs.9,977, Rs.8,727, Rs.8,352 and Rs.8,252 per hectare respectively.

2.3 CONSTRAINTS IN ADOPTING STRATEGIES OF SUSTAINABILITY

Trolldalen (1990) indicated that one of the key issues identified as an obstacle for sustainable development was the growth of present population which is likely to double over the next two decades.

Okigbo *et al*, (1990) in their study on development of sustainable agriculture in tropical Africa discussed climatic and soil related constraints to agricultural production. They had given 15 recommendations towards more sustainable agriculture in Africa covering agricultural policy, development and management strategies.

Mei (1992) in his study on agricultural development with sustainability in China indicated that sustainable agriculture encountered with difficulties mainly due to environmental pollution, rising costs, destruction of resources and severe food security problems.

Dilip kumar (1994) indicated that the food grain production which was 176 millions in 1991 has to be increased by 1.3 and 2.1 times to meet the food grain requirement of 225 and 364 million tonnes in 2000 and 2030 AD respectively and the per capita availability of pulses declined from 69 g in 1961 to 36.5 in 1990 owing to population rise.

Dubey and Sene (1994) felt the need to develop an alternative farming system for sustainable agriculture and to identify the major constraints on agricultural sustainability.

Hesterman and Thorburn (1994) stated that achievement of sustainable agriculture requires integrated farming systems that involve many diverse individuals and institutions in rural communities.

Mishra (1994) studied the role of fertilizers and irrigation in the development of Indian agriculture. He stated that over all consumption of fertilizers had increased more than fifteen folds in the last 5 years. It was felt that sustainable growth of agricultural output was not possible without removing soil fertility constraints.

Reddy (1995) indicated that the low input sustainable agriculture is less productive, less profitable and more risky compared to conventional technologies.

Napier *et al*, (1996) identified soil and water conservation problems, characteristics of technologies and techniques to resolve soil and water resource problems as socio-economic constraints of sustainable agriculture.

Beltagy *et al*, (1997) in their study discussed the strategies for developing a more sustainable agriculture in Egypt with reference to enhance the efficiency of water use for crop production. The discussion covered water resource quality and constraints, pesticide use, irrigation systems improvement, protected cultivation and infusion of modern, and appropriate technologies.

Singh (1999) revealed that for attaining food security, top priority must be given to promoting sustainable agriculture production systems. Increasing agricultural production at the cost of degraded soil, depleted and polluted water was antithesis of sustainable agriculture.



*Materials and
Methods*

CHAPTER-III

MATERIALS AND METHODS

A brief account of methods employed, terms and concepts used in the study are presented in this chapter. The earlier studies presented under review of literature partly formed the basis for developing the methodology presented here. The methodology adopted has been discussed under the following sub-heads.

- 3.1 Sampling design
- 3.2 Collection of data
- 3.3 Terminology and concepts used in the study
- 3.4 Methods of computation
- 3.5 Tools of analysis

3.1 SAMPLING DESIGN

3.1.1 Selection of District

Anantapur district was purposively selected for the present study as it ranked first in area under rainfed crops among the four districts of Rayalaseema region in Andhra Pradesh and recorded greater variation in rainfall. Ananthpur district falls under scarce rainfall zone with less than 600 mm. Agro soil-climatic conditions formed the most important criteria for the purposive selection of the Anantapur district for the present study. Familiarity of the researcher about farming practices of the district and its proximity and accessibility also weighed in favour of selecting the district.

3.1.2 Selection of Mandals

In Anantapur district, mandals exhibiting the greater variation in rainfall were selected. Two mandals Kadiri and Tanakallu were selected for the study.

3.1.3 Selection of Villages

The list of villages in the selected mandals was prepared and two villages from each mandal were selected on the basis of rainfed area of important crops.

3.1.4 Selection of Respondents

The respondents were randomly selected from the list of farmers in each village of the selected mandal. The total sample size for the study was 80 i.e., 20 farmers from each of the village. Later they were classified into two categories sustainable, non-sustainable and again two size groups in each category i.e., small and large. Those farmers with less than 3.75 hectares of land were considered as small and the farmers with more than 3.75 hectares were regarded as large.

3.2 COLLECTION OF DATA

Survey method was employed for gathering all the relevant particulars pertaining to the objectives of the present study. Detailed farm level data such as family composition, farm size, farm inventory, details about cropping pattern, technical coefficients, prices of inputs and outputs were collected directly from the farmers using a pre-designed questionnaire prepared specifically for the purpose. The data pertained to the agricultural year 1999.

3.3 TERMINOLOGY AND CONCEPTS USED IN THE STUDY

Terms and concepts used in the study are presented below.

3.3.1 Sustainable Agriculture

It is defined as successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources.

3.3.2 Sustainable Development

It is the development that meets the needs of present without compromising the ability of future generations to meet their own needs (WCED 1987).

3.3.3 Sustainability

It is the ability of a system to maintain a certain well defined level of performance over time and it required to enhance the same through linkages with other systems without damaging the ecological integrity of the system.

3.3.4 Indicators of Sustainability

Intercropping, crop rotation, agro-forestry, live stock component, water management, soil quality, post harvest technology, Integrated pest management, Integrated nutrient management and productivity are some of the indicators of sustainability.

3.3.4.1 Intercropping

Growing of two or more crops in the same field in sequence, in combination of both during a season or a year.

3.3.4.2 Crop rotation

Growing of different crops according to needs in succession on a piece of land in a specific period of time.

3.3.4.3 Agro-forestry

Self-sustaining land management system, which combines production of agricultural crops with that of tree, crops as also with that of livestock simultaneously or sequentially on the same unit of land.

3.3.4.4 Integrated pest management

It is a broad ecological approach that minimizes pest population below economic threshold level by employing all available pest control techniques like mechanical, biological, chemical and crop management practices in a compatible manner.

3.3.4.5 Productivity

It is the output per unit of a resource.

3.3.4.6 Integrated nutrient management

It is a system which envisages the use of organic manures, green manures, bio-fertilizers (organic) along with chemical fertilizers (inorganics).

3.3.10 Variable Costs

Costs associated with the use of variable inputs like seed, manures and fertilizers, fuel charges, plant protection chemicals, payments towards casual labour, services of cattle and machinery etc. Interest on working capital repairs and maintenance charges were also included under variable costs.

3.3.11 Fixed Costs

Costs associated with the owing of fixed resources. Depreciation on machinery, equipments, implements and farm buildings, interest on fixed capital, taxes (land revenue) insurance premium and rental value of owned land were regarded as fixed costs.

3.3.12 Gross Returns

Value of main and by products obtained in crop and livestock production at the market rates termed as gross returns of a farm.

3.3.13 Net Returns

Returns over and above the total costs formed the net returns.

3.3.14 Benefit-Cost Ratio

It is the ratio of net returns to the total costs.

3.3.5 Operated Holding

Extent of farm area under cultivation of each selected farmer was considered as operated holding.

3.3.6 Farm Assets

The physical property owned by a farm business viz., land, farm buildings, wells, tube wells, livestock farm machinery, farm implements etc., were included under farm assets.

3.3.7 Manday

Amount of work turned out by a normal healthy human being in a day of 8 hours was treated as a manday. For standardizing different categories of human labour 1.5 female days or 2 child days were considered to be equal to one manday.

3.3.8 Cattle Pair Day (CPD)

Amount of work completed by a pair of cattle in a day of 8 hours was considered as a cattle pairday.

3.3.9 Cost of Cultivation

All the expenses incurred in performing various operations and materials used in a crop on a unit area.

3.4. METHOD OF COMPUTATION

3.4.1 Human Labour

Actual days worked and employed for all farm operations were recorded separately. Human labour i.e., male and female, family and hired labour employed for all crop operations from seed to seed were gathered from the respondents. Human labour was quantified in terms of man workdays. Wages paid to the employed labour for various crop operations were considered while working out costs of human labour. Family labour was valued at the prevailing wage rates of the casual labour engaged for similar operations in the study area.

3.4.2 Bullock labour

It included both owned and hired bullock labour and was valued at the prevailing wage rates.

3.4.3 Tractor Power

Generally payment for tractor services is made on hourly basis. Prevailing market rates for different farm operations formed the basis for estimating the cost of tractor services.

3.4.4 Seed

Cost of seed either purchased or farm produced was valued at the prevailing market prices.

3.4.5 Manures and Fertilizers

Market price is used to estimate the cost of FYM owned or purchased and fertilizers.

3.4.6 Plant protection chemicals

Actual prices paid by the farmer at the time of purchase were used in computing the costs of plant protection chemicals

3.4.7 Irrigation Charges

Slab rate system is implemented on the basis of horsepower in Andhra Pradesh. These charges were apportioned based on the acreage under each crop.

3.4.8 Interest on Working Capital

Interest was calculated at the rate of 12 per cent of for half of the amount for full crop period and for the rest of the amount for half of the crop period, as the entire expenditure was not incurred at one time but spread over the crop period.

3.4.9 Land Revenue

Actual amount paid by the cultivator towards land revenue was taken into account

3.4.10 Rental value of Owned land

Prevailing lease amounts in the study area were considered for imputing rental value of owned land.

3.4.11 Depreciation Charges

Depreciation involves pro rating original cost of an asset over its useful life. Straight line method was employed to compute depreciation of various farm assets. Later depreciation was apportioned according to acreage under different crops.

3.4.12 Repairs and Maintenance Costs

Owners generally spend certain amount on maintenance of farm assets viz., buildings, machinery and implements to keep them in working condition. Actual amount incurred on repairs and maintenance of farm buildings, implements and machinery was collected from the respondent and apportioned according to acreage under selected enterprises.

3.4.13 Interest on Fixed Capital

For the entire farm assets excluding land, interest charges were computed at the rate of 10 per cent.

3.4.14 Cost Concepts

Cost A₁

Wages of hired human labour, hired and owned bullock labour, hired and owned machinery charges, value of manures, fertilizers, seed, and plant protection chemicals, fuel charges, land revenue, depreciation on farm assets and interest on working capital were included under cost A₁.

Cost A₂

Cost A₁ plus rent paid for leased in land formed cost A₂.

Cost B

All the cost items of Cost A₁ / Cost A₂ plus the rental value of owned land and interest on fixed capital excluding land formed the components of Cost B.

Cost C

It is the comprehensive cost which included all operational and fixed costs. All items of Cost B and imputed value of family labour were considered as Cost C

3.4.15 Farm Efficiency Measures

3.4.15.1 Farm Business Income (FBI)

It is the return to the producer for himself and his family labour and investment on owned land and fixed capital. It was worked out by deducting cost A₁ from gross income.

$$\text{FBI} = \text{Gross income} - \text{Cost A}_1$$

3.4.15.2 Farm Family Labour Income (FLI)

It is a measure of returns from cultivation of crop to family labour. It was obtained by deducting Cost B from gross income.

$$\text{FLI} = \text{Gross income} - \text{Cost B}$$

3.4.15.3 Farm Investment Income (FII)

It is a measure of return from cultivation to the fixed capital investment on farm. This was calculated by adding imputed rental value of owned land and interest on fixed capital to the net income.

$$\text{FII} = (\text{GI} - \text{Cost C}) + (\text{Cost B} - \text{Cost A}_1)$$

3.5 TOOLS OF ANALYSIS

Conventional as well as functional analyses were carried out to analyze the data in order to arrive at valid conclusions. Conventional analysis was carried out to assess the basic characteristics of the selected respondents viz., family size, literacy level, farm assets, labour requirements, cost of cultivation, productivity, returns etc.

Functional analysis was used to estimate the impact of indicators of sustainability on productivity of crops.

3.5.1 Multiple Linear Regression

In the present study, the regression model specified in order to measure the impact of indicators of sustainability on productivity of crops was formulated. Regression analysis was carried out for groundnut crop only.

3.5.1.1 Impact of indicators of sustainability on productivity

The model includes seven variables, one dependent and six explanatory variables.

The linear model used is

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + U_i$$

Where,

- Y = Yield in tonnes per farm
- X₁ = Land in hectares
- X₂ = Expenditure on seeds in Rupees
- X₃ = Expenditure on fertilizers in Rupees
- X₄ = Expenditure on machine labour in Rupees/ bullock labour in cattle pair days
- X₅ = Human labour per farm in man days
- X₆ = Manures per farm in tonnes
- a = Intercept term
- b_i = Unknown parameters to be estimated
- U_i = Disturbance term

*Results and
Discussion*

CHAPTER-IV

RESULTS AND DISCUSSION

The data collected from 80 farmers were processed and analyzed with reference to specific objectives. The results and discussion of the study are presented under the following heads.

- 4.1 Socio-economic profile of sample farmers
- 4.2 Existing cropping pattern
- 4.3 Indicators of sustainability
- 4.4 Costs and returns
- 4.5 Resource productivity and allocative efficiency
- 4.6 Pattern of income distribution and
- 4.7 Opinion survey

4.1 SOCIO-ECONOMIC PROFILE

The socio-economic profile shows the social and financial position of farm families. In this section average farm size, family size and availability of family labour and structures of assets are discussed.

4.1.1 Average farm size

The efficient use of resources, the level of production and the income generating capacity of the farm business largely depends upon the size of the holding. The land holding particulars of different categories of sustainable and non-sustainable farmers are presented in Table 4.1.

4.1.1.1. Average farm size of sustainable farms

It is observed from Table 4.1 that the average size of the holding was 8.51 ha on pooled farms. It ranged from 3.60 ha on small farms to 14.53 ha on large farms. The analysis further revealed that the average size of irrigated land was 2.20 ha accounting for 61.11 per cent of the total land holding on small farms while it was 5.48 hectares occupying 37.72 per cent of total land holding on large farms. The same on pooled farms was 3.67 hectares accounting for 43.13 per cent of the total land. The average size of dry land was 1.40 hectares (38.89 per cent), 9.05 hectares (62.28 per cent) and 4.84 hectares (57.87 per cent) on small, large and pooled farms respectively.

4.1.1.2 Average size of non-sustainable farms

It is seen from the Table 4.1 that average size of the farm was 4.83 ha for the sample as a whole. The same declined from 9.67 ha on large farms to 1.95 ha on small farms. Small and large farmers owned 1.25 ha and 2.15 ha of irrigated land respectively with an overall average of 1.58 ha on pooled farms and accounted for 64.10, 22.23 and 32.71 per cent of the land in that order. The average size of dry land varied between 0.70 ha and 7.52 ha accounting for 35.90 and 77.77 per cent of the total land among small and large farmers respectively. Non-sustainable farmers on the whole possessed 3.25 ha (67.29 per cent) of dry land.

The position of land resource on the selected farms brought to light that the average size of land holding was more on sustainable farms than on non sustainable farms. The dry land in absolute and relative terms was higher on sustainable and non-sustainable large farms compared to small farms. However, the proportion of irrigated land of sustainable and non sustainable small farms was more than that of large farms.

Table 4.1 : Average size of land holding of sample farms (area in hectares)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Dryland	1.40 (38.89)	9.05 (62.28)	4.84 (57.87)	0.70 (35.90)	7.52 (77.77)	3.25 (67.29)
2.	Irrigated land	2.20 (61.11)	5.48 (37.72)	3.67 (43.13)	1.25 (64.10)	2.15 (22.23)	1.58 (32.77)
3.	Total	3.60 (100.00)	14.53 (100.00)	8.51 (100.00)	1.95 (100.00)	9.67 (100.00)	4.83 (100.00)

(Figures in parentheses indicate percentages to respective totals)

4.1.2 Family composition

The structure of family with regard to male, female, children and farm family workers in the three size groups of sustainable and non-sustainable farms is presented in Table 4.2.

4.1.2.1 Family composition of sustainable farms.

The average family size was 5.0 and 6.55 members in case of small and large farms respectively while the same for pooled sample was 5.69 members. The composition of family with respect to male, female and children was larger on large farms compared to small farms. The average number of family members working on the farm was 2.8, 2.52 and 2.53 members on small, large and pooled farms respectively.

4.1.2.2 Family composition of non-sustainable farms

It is observed from Table 4.2 that the average size of family declined from 7.05 members on large farms to 5.83 members on small farms. The same on pooled farms was 6.49 members. The number of family members participating in farm work increased from 1.5 members on large farms to 2.7 members on small farms. As in the case of sustainable farms, the number of males, females and children was more in the case of large farms compared to small farms.

From the above analysis, it is clear that the family size exhibited direct relationship with the farm size. However, the participation of family members in the farm work showed inverse relationship with the size of the land holding. In general, women members of large farmers because of their social and financial status do not participate in farm work. It is also interesting to note that the average size of the family was more on non-sustainable farms compared to sustainable farms.

Table 4.2: Family composition and family labour contribution on selected farms (in number)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Male	1.0	2.18	1.53	1.50	2.06	1.71
2.	Female	2.0	2.06	2.02	1.83	1.87	1.85
3.	Children	2.0	2.31	2.13	2.50	3.12	2.93
4.	Total	5.0	6.55	5.69	5.83	7.05	6.79
5.	Working people	2.8	2.52	2.53	2.70	1.50	2.25

4.1.3 Farm inventory

The economic background and the adoption of technology by the farmers depend upon the composition and value of assets owned by him. The particulars of farm assets along with their values per hectare according to size groups of sustainable and non-sustainable farms is presented in Table 4.3.

4.1.3.1 Asset structure of sustainable farms.

A perusal of the Table 4.3 indicates that the per hectare value of assets was highest (Rs.2, 00,325.30) on small farms and lowest (Rs.1,93,556.50) on large farms. The same was Rs.1,95,129.65 for the sample as a whole.

It was found that land was the single most valuable asset on the sample farms. The share of land value increased from 87.35 per cent on small farms to 91.14 per cent on large farms. It was further observed that the value of non land assets per hectare was higher (Rs.25,325.30) on small farms compared to large farms (Rs.17,131.30) while the same was Rs.19,035.88 on pooled farms. Small farmers had invested more on machinery implements and livestock.

4.1.3.2 Asset structure of non-sustainable farms

It is observed from Table 4.3 that the per hectare value of assets ranged from Rs.2,05,231.89 on small farms to Rs.1,97,553.50 on large farms with an average of Rs.1,99,492.50 on pooled farms. The land value contributed most towards the total asset value and its share increased from 85.86 per cent on small farms to 88.41 per cent on large farms. The value of non land assets varied from Rs.29, 008.89 on small farms to Rs.22,877.50 on large farms. The same for the sample as a whole was Rs.22, 425.97.

Table 4.3 : Investment pattern of sustainable and non-sustainable farms (Rs./ha)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land	175000 (87.35)	176425 (91.14)	176093.77 (90.24)	176223.00 (85.86)	174676 (88.41)	175066.65 (87.76)
2.	Wells	6944.11 (3.46)	5435.70 (2.80)	5786.30 (2.97)	11440.67 (5.57)	7889.6 (3.99)	8786.33 (4.41)
3.	Farm buildings	1332.68 (0.66)	1736.38 (0.89)	1642.54 (0.84)	1949.15 (0.94)	1623.35 (0.82)	1705.60 (0.86)
4.	Machinery and implements	9398.51 (4.69)	5646.2 (2.91)	6518.37 (3.34)	12841.30 (6.25)	8467.41 (4.28)	9571.93 (4.80)
5.	Livestock	7650.00 (3.81)	4813.02 (2.22)	5088.65 (2.61)	4777.37 (1.35)	4897.14 (2.48)	4361.9 (2.19)
6.	Values of assets						
	a) with land value	200325.3 (100.00)	193556.5 (100.00)	195129.65 (100.00)	205231.89 (100.00)	197553.50 (100.00)	199492.50 (100.00)
	b) without land value	25325.30	17131.3	19035.88	29008.89	22877.50	22425.97

(Figures in parentheses indicate percentages to respective totals)

From the analysis of results on pattern of assets, it can be concluded that land was the single most valuable asset on the sample farms. The value of land in absolute terms was higher on large farms but in relative terms the opposite is true. The results also showed that investment on productive assets viz., wells, machinery and implements and livestock showed inverse relationship with the size of land holding in the case of sustainable farms. The same trend is noticed in the case of non-sustainable farms except in case of livestock. The value of machinery and implements occupied first place on sustainable and non-sustainable pooled farms claiming 34.24 and 42.68 per cent of total value of assets excluding land value respectively. Next in order was value of wells which contributed 30.40 and 39.18 per cent followed by value of livestock accounting for 26.73 and 19.45 per cent respectively in the same order. This suggested that farmers gave high priority to working assets and for the development of irrigation sources that aid in increasing productivity. It is also interesting to note that the percentage investment on livestock was higher in both the sizes of sustainable farms compared to non-sustainable farms. The value of assets was marginally higher on both the size groups of non-sustainable than that of sustainable farms.

4.2 EXISTING CROPPING PATTERN

Cropping pattern is usually determined by many factors viz., climate, soil, topography, irrigation and drainage facilities, distance from the market etc. The cropping pattern of sustainable and non-sustainable farms is presented in Table 4.4.

Table 4.4: Cropping pattern of sustainable and non-sustainable farms (area in ha)

Crop	Sustainable			Non-sustainable		
	Small	Large	Pooled	Small	Large	Pooled
1. Kharif dryland						
Groundnut	0.80 (57.14)	7.80 (86.18)	3.95 (81.61)	0.70 (100.00)	6.16 (81.91)	2.74 (84.30)
Jowar	0.20 (14.28)	--	0.11 (2.27)	--	0.05 (0.66)	0.01 (0.30)
Fallow	0.40 (28.57)	1.25 (13.82)	0.78 (16.11)	--	1.31 (17.42)	0.50 (15.38)
Total	1.40 (100.00)	9.05 (100.00)	4.84 (100.00)	0.70 (100.00)	7.52 (100.00)	3.25 (100.00)
2. Kharif irrigated						
Mulberry	1.20 (54.54)	2.12 (38.68)	1.61 (43.86)	0.25 (20.00)	0.75 (34.88)	0.43 (27.21)
Mango	--	0.68 (12.40)	0.30 (8.17)	0.13 (10.40)	0.05 (2.32)	0.10 (6.32)
Paddy	0.30 (13.63)	0.55 (10.30)	0.41 (11.17)	0.40 (32.00)	0.30 (13.95)	0.36 (22.78)
Vegetables	0.11 (5.00)	0.23 (4.19)	0.16 (4.35)	--	0.15 (6.97)	0.05 (3.16)
Ragi	0.07 (3.18)	0.05 (0.91)	0.06 (1.63)	0.01 (0.80)	0.02 (0.93)	0.01 (0.63)
Fallow	0.52 (23.63)	1.85 (33.75)	1.13 (30.79)	0.46 (36.80)	0.88 (40.93)	0.63 (39.87)
Total	2.20 (100.00)	5.48 (100.00)	3.67 (100.00)	1.25 (100.00)	2.15 (100.00)	1.58 (100.00)
3. Rabi dryland						
4. Rabi irrigated						
Mulberry	1.20 (54.54)	2.12 (38.68)	1.61 (43.86)	0.25 (20.00)	0.75 (34.88)	0.43 (27.21)
Mango	--	0.68 (12.4)	0.30 (8.17)	0.13 (10.40)	0.05 (2.32)	0.10 (6.32)
Paddy	0.90 (40.90)	1.50 (27.37)	1.17 (31.88)	0.77 (61.60)	1.25 (58.13)	0.95 (60.12)
Vegetables	0.05 (2.27)	0.30 (5.47)	0.16 (4.35)	0.01 (0.80)	--	0.0063 (0.39)
Sunflower	0.07 (3.18)	0.20 (3.64)	0.12 (3.26)	0.07 (5.60)	0.10 (4.65)	0.08 (5.06)
Fallow	--	0.68 (12.40)	0.30 (8.17)	0.02 (1.60)	--	0.01 (0.63)
Total	2.20 (100.00)	5.48 (100.00)	3.67 (100.00)	1.25 (100.00)	2.15 (100.00)	1.58 (100.00)
Cropping intensity	136.11	111.69	117.03	139.48	99.58	109.03

(Figures in parentheses indicate percentages to respective totals)

4.2.1 Cropping pattern of sustainable farms

On dry land, small and large farmers currently cultivated groundnut, which is the most important oilseed crop on 0.80 ha, and 7.80 ha accounting for 57.14 and 86.18 per cent of the total dry land respectively. Small farmers grew 0.20 ha (14.28 per cent) of jowar, 0.40 (28.57 per cent) and 1.25 ha (13.82 per cent) of dry land in *kharif* season was kept fallow by small and large farmers respectively. On dryland farmers grew crops only in *kharif* season while on irrigated land, crops were grown both in *kharif* and *rabi* season.

In *kharif*, on irrigated land of small farmers, mulberry occupied nearly 55 per cent of the total land followed by paddy 13.63 per cent (0.30 ha), vegetables 5 per cent (0.11 ha) and ragi 3.18 per cent (0.07 ha), 0.52 ha (23.63 per cent) of *kharif* irrigated land was kept idle. Among large farmers, mulberry occupied 38.68 per cent (2.12 ha) followed by mango orchard 12.40 per cent (0.68 ha), paddy 10.30 per cent (0.55 ha), vegetables 4.19 per cent (0.23 ha). Nearly, 34.00 per cent of total *kharif* irrigated land was kept fallow by the large farmers.

In *rabi* season, small farmers had grown paddy, vegetables and sunflower on 0.90 ha (40.90 per cent) 0.05 ha (2.27 per cent) and 0.07 ha (3.18 per cent) of irrigated land respectively. Large farmers cultivated paddy on 1.50 ha (27.37 per cent), followed by vegetables on 0.30 ha (5.47 per cent) and sunflower on 0.20 ha (3.64 per cent). Mulberry and Mango orchard occupied the same area as in *kharif*. The entire *rabi* irrigated land of small farmers was under cultivation whereas 0.68 ha was kept fallow on large farms. The cropping intensity among small, large and pooled farms was 136.11, 111.69 and 117.03 per cent respectively.

4.2.2. Cropping pattern of non-sustainable farms

Groundnut occupied the entire dry land in the existing plan of small farmers, whereas in case of large farms it occupied nearly 82 per cent of the dry land. Jowar was grown on 0.05 ha of dry land on large farms. The remaining dry land (17.42 per cent) was kept fallow.

In *kharif*, on irrigated lands paddy an important food crop in the study area occupied the highest area of 0.40 ha (32 per cent) on small farms. Mulberry which is the predominant commercial crop of the study area, occupied 0.25 ha/20 per cent) followed by mango orchard 0.13 ha (10.40 per cent) and ragi 0.01 ha (0.8 per cent) on small farms.

In *kharif*, on irrigated land of large farms, mulberry occupied 0.75 ha (34.88 per cent) followed by paddy 0.30 ha (13.95 per cent) and vegetables 0.15 ha (6.97 per cent). More than 36 per cent of the *kharif* irrigated land was kept fallow in small and large farms.

In *rabi* season, small and large farmers had grown paddy on 0.77 ha and 1.25 ha accounting for 61.60 and 58.13 per cent of the irrigated land respectively. More than 4 per cent of *rabi* irrigated land was occupied by sunflower. Mulberry and mango orchard continued to occupy the same area as in *kharif*. The cropping intensity among small farms was 139.48 per cent while it was 99.58 per cent on large farms.

4.3 SUSTAINABLE AGRICULTURE

Sustainable agriculture should involve the successful management of resources to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving the natural resources. Intercropping, crop rotation, agroforestry, integrated pest management and integrated nutrient management were identified as indicators of sustainability. A brief description of these indicators is presented here under.

1. **Intercropping** : Intercropping is a method of cropping in which there is greater utilization of inter spaced area, the spatial distribution of light, nutrients, moisture, air and microenvironment of both the rhizosphere and phyllosphere and the temporal use of resources during the slow growth phase of a crop by the subsidiary crop or crops or vice versa in mono cropping or intensive cropping systems. Intercropping not only provides greater guarantee and stability of higher yield over different seasons but also helps to restore soil fertility, when legumes are included as component crop. Hence, it was considered as an indicator of sustainability.
2. **Crop rotation**: It refers to recurrent succession of crops on the same piece of land either in a year or over a longer period of time. Component crops are so chosen so that soil health is not impaired.
3. **Agro-forestry**: It is a collective term for systems of land use in which woody plants are deliberately combined on the same land management unit with herbaceous crops and or animals, either in some form of spatial arrangement or in sequence. For a land use system to fall within the concept of agro-forestry, there should be both ecological and economic interactions between woody plants and other components of the system.

Multipurpose nature of trees along with their nitrogen fixing ability should be given due weightage while selecting trees for agro-forestry.

- 4. **Integrated pest management:** Pest management is the intelligent selection and use of pest control action (tactics) that will ensure favourable economic, ecological and sociological consequences. Integrated pest management is the optimization of pest control in an economically and ecologically sound manner. In agriculture, pest management should ensure strong agriculture and viable environment. Hence, it was regarded as an indicator of sustainability.
- 5. **Integrated nutrient management:** It is the nutrient scheduling model for maintaining soil productivity in the nutrient supply and demand in intensive agriculture. Farmyard manure, green manuring and bio-fertilizer cropping systems for particular land and irrigation scheduling are the components of integrated nutrient management system that help to achieve ecologically, economically and socially sound agriculture. Therefore, it was regarded as one of the best indicators of sustainability.

4.3.1 Indicators of sustainability.

The details on the indicators of sustainability of selected farms are presented in Table 4.5. It is found that half of the small and three fourths of large sustainable farms adopted intercropping as against 33.30 per cent and 62.50 per cent of small and large non-sustainable farms respectively.

All the small farmers and nearly 94 per cent of large farmers followed crop rotations on sustainable farms. On the other hand, only 16.67 per cent of small farmers and 56.25 per cent of large farmers were following crop rotation on non-sustainable farms.

Table 4.5: Indicators of sustainability (Values in percentages)

S.No.	Particulars	Sustainable		Non-sustainable	
		Small	Large	Small	Large
1.	Intercropping	50.00	75.00	33.30	62.50
2.	Crop rotation	100.00	93.75	16.67	56.25
3.	Agro-forestry	46.00	68.75	--	22.50
4.	IPM (chemical)	93.00	68.75	93.75	87.50
5.	Integrated Nutrient Management				
	a) Neem cake	-	50.00	16.67	12.50
	b) Cattle manure	100.00	81.25	83.34	93.75
	c) Green manure	-	12.50	-	-
6	Soil amendments	-	43.75	16.67	6.25

Agro-forestry an important component of sustainable agriculture was adopted by small (46 per cent) and large (68.75 per cent) sustainable farms. However on non-sustainable farms only 22.5 per cent large farmers followed agro-forestry. Integrated pest management that ensures ecologically, economically and socially sound agriculture was practiced by 93 per cent of small sustainable and non-sustainable. In case of sustainable and non-sustainable large farms, it ranged between 68.75 and 87.5 per cent. All the small farmers of sustainable farms and more than 81 per cent of large sustainable farms and applied cattle manure, which is the important component of integrated nutrient management. Neem cake was applied by 50 per cent of large farmers of sustainable farms while in case of non-sustainable small and large farms the share of neem cake in the integrated nutrient management was 16.67 per cent, 12.50 per cent respectively. It is interesting to observe that green manuring, a cost effective method of nutrient supply was not followed by the farming community in the study area with an exception of 12.5 per cent of large sustainable farms. Soil amendments were applied by 43.75 per cent of large farmers in case of sustainable farms. The practice varied from 16.67 per cent to on small 6.25 on large non-sustainable farms.

4.4 ECONOMIC ASPECTS OF CROP ENTERPRISES

In the study area, the larger proportion of dry land of sample cultivators was occupied by groundnut crop as shown in the existing cropping pattern. Mulberry and mango orchards, which are perennials, predominate on irrigated land. Next most important crop enterprise was paddy. Other enterprise viz., vegetables, and sunflower were of minor importance in the cropping programme. Hence, in this section economic aspects of groundnut and paddy were discussed.

4.4.1 Human labour utilization

Successful completion of every agricultural operation requires some amount of human resource. The human labour absorption depends on the nature and size of the crop or livestock enterprise. Labour is an important item of cost of cultivation and affects the profitability of the farm business. Keeping this in mind, an attempt has been made to analyze the magnitude and pattern of labour employment in the production of groundnut and paddy. The operation wise human labour employment per hectare on different size groups of sustainable and non-sustainable farms is presented in Tables 4.6 and 4.7.

4.4.1.1 Human labour utilization in groundnut cultivation

In the study area, groundnut was grown in dry land during *kharif* season. A close perusal of Table 4.6 shows that on an average 65.94 mandays per hectare were used in groundnut cultivation on pooled sustainable farms. The same on small and large farms was 66.18 and 65.87 mandays respectively.

It is noted that the major labour absorbing operations were weeding, harvesting, stripping and drying sowing and land preparation as more than 90 per cent. (ranging from 91.92 on small farms to 92.85 per cent on large farms) of the total labour was used in these operations. It is further observed that maximum labour employment was in weeding (33.2 mandays) followed by harvesting (13.4 mandays) stripping and drying (5.38 mandays), sowing (4.79 mandays) and land preparation (4.32 mandays) on pooled sustainable farms. More or less same trend is noticed in both the size groups with regard to labour use.

Table 4.6 : Human labour utilisation-operation wise in groundnut cultivation (in mandays per hectare)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land preparation	3.43 (5.18)	4.55 (6.91)	4.32 (6.55)	6.11 (10.39)	1.43 (2.36)	2.40 (3.99)
2.	FYM application	3.91 (5.91)	3.25 (4.93)	3.39 (5.14)	5.00 (8.50)	2.91 (4.79)	3.34 (5.55)
3.	Sowing	4.13 (6.24)	4.96 (7.53)	4.79 (7.26)	7.48 (12.72)	5.41 (8.92)	5.83 (9.69)
4.	Fertilizer application	1.43 (2.16)	0.93 (1.4)	1.03 (1.56)	0.95 (1.62)	1.40 (2.31)	1.31 (2.18)
5.	Weeding	31.5 (47.59)	33.66 (51.10)	33.21 (50.36)	21.54 (36.64)	28.45 (46.99)	27.03 (44.92)
6.	Plant protection	-	0.53 (0.8)	0.42 (0.64)	-	4.20 (6.94)	3.34 (5.55)
7.	Harvesting	15.18 (22.94)	12.93 (19.63)	13.4 (20.32)	12.01 (20.43)	11.30 (18.67)	11.45 (19.03)
8.	Stripping + transporting	6.60 (9.97)	5.06 (7.68)	5.38 (8.16)	5.70 (9.69)	5.45 (9.00)	5.50 (9.14)
	Total	66.18 (100.00)	65.87 (100.00)	65.94 (100.00)	58.79 (100.00)	60.54 (100.00)	60.18 (100.00)
	Owned labour	18.77 (28.36)	9.45 (14.34)	11.41 (17.30)	15.25 (25.94)	9.47 (15.65)	9.09 (15.28)
	Hired labour	47.41 (71.64)	56.42 (85.66)	54.53 (82.70)	43.54 (74.06)	51.07 (84.34)	50.99 (84.72)

(Figures in parentheses indicate percentages to respective totals)

It is also found that family labour use was maximum (18.77 mandays) on small farms and minimum on large farms (9.45 mandays). The involvement of family members in the cultivation of groundnut on pooled farms was to the extent of 11.41 mandays per hectare accounting for 17.30 per cent of the total labour employment.

The total labour requirement for groundnut was 60.18 mandays per hectare on pooled non-sustainable farms. It varied from 58.79 mandays on small farms to 60.54 mandays on large farms. Maximum number of 27.03 mandays was required for weeding on pooled farms accounting for 44.92 per cent of the total labour requirement. The labour use for weeding increased from 21.54 mandays (36.64 per cent) on small farms to 28.45 mandays (46.99 per cent) on large farms. The employment of human labour for harvesting which was the next important operation on small, large and pooled farms was 12.2 mandays (20.43 per cent), 11.30 mandays (18.67 per cent) and 11.45 mandays (19.03 per cent) respectively. The other important operation of labour absorption was sowing where its use declined from 7.48 mandays (12.72 per cent) on small farms to 5.41 mandays (8.92 per cent) on large farms and the same on pooled farms was 5.83 mandays (9.69 per cent).

The results also revealed that the share of hired labour was more than that of family labour on both the size groups of non-sustainable farms and it varied from 74.06 per cent on small farms to 84.34 per cent on large farms. The family labour use was 9.09 mandays per hectare on pooled farms and declined from 15.25 mandays on small farms to 9.47 mandays on large farms.

4.4.1.2 Human labour utilisation in paddy cultivation

On an average, 172.99 mandays per hectare were used in paddy cultivation on pooled sustainable farms. The same ranged between 171.62 mandays and 173.83 mandays among small and large farms (Table 4.7). The maximum human labour was needed for weeding followed by harvesting, irrigation and transplanting. Of the total labour utilized 35.61 mandays (20.59 per cent) on pooled farms, 36.20 mandays (21.09 per cent) on small farms, 35.25 mandays (20.25 per cent) on large farms were used for weeding operation. Harvesting utilised 20.2 per cent (35.10 mandays), 19.23 per cent (33 mandays) and 20.93 per cent (36.39 mandays) of the total labour on pooled, small and large farms respectively. About 30.10 mandays (small) 35.41 mandays (large) and 33.40 mandays (pooled) were consumed for irrigation. Transplanting which was another important operation in paddy cultivation required 32.56 mandays (18.82 per cent) for the sample as a whole and varied from 33.82 mandays (19.71 per cent) on small farms to 31.79 mandays (18.29 per cent) in large farms. Apart from these operations, labour was also employed for threshing, land preparation and application of manures and fertilizers accounting for 7.72 per cent, 5.25 per cent and 5.45 per cent respectively on pooled farms. Family labour employment declined from 72.01 mandays per hectare on small farms to 41.65 mandays on large farms with an overall average of 53.16 mandays on pooled farms. The share of hired labour increased with the size of the farm and it varied from 58.03 per cent on small farms to 76.03 per cent on large farms.

It is observed from Table 4.7 that the total human labour engaged in the cultivation of paddy was 168.07, 174.03 and 170.31 mandays per hectare on small, large and pooled non-sustainable farms respectively. The family labour contribution on non-sustainable farms also declined with the size of the farm. It was 60.72 mandays on small farms and

Table 4.7 : Human labour utilisation-operation wise in paddy cultivation (in mandays per hectare)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land preparation	9.01 (5.25)	9.13 (5.25)	9.08 (5.25)	7.15 (4.25)	8.97 (5.15)	7.83 (4.59)
2.	FYM application	8.00 (4.66)	6.92 (3.98)	7.33 (4.24)	8.75 (5.21)	9.09 (5.22)	8.88 (5.21)
3.	Transplanting	33.82 (19.71)	31.79 (18.29)	32.56 (18.82)	31.25 (18.59)	33.74 (19.39)	32.18 (18.89)
4.	Fertilizer application	2.50 (1.46)	1.86 (1.07)	2.10 (1.21)	2.50 (1.49)	2.81 (1.61)	2.62 (1.54)
5.	Weeding	36.20 (21.09)	35.25 (20.28)	35.61 (20.59)	33.51 (19.94)	33.89 (19.47)	33.65 (19.76)
6.	Plant protection	1.25 (0.73)	4.59 (2.64)	3.32 (1.92)	3.51 (3.28)	2.81 (1.61)	4.49 (2.64)
7.	Irrigation	30.10 (17.54)	35.41 (20.37)	33.40 (19.31)	32.92 (19.59)	34.25 (19.68)	33.42 (19.62)
8.	Harvesting	33.00 (19.23)	36.39 (20.93)	35.10 (20.29)	30.97 (18.43)	33.53 (19.27)	31.94 (18.75)
9.	Threshing + transporting	14.75 (8.59)	12.49 (7.19)	13.35 (7.72)	15.51 (9.23)	14.94 (8.58)	15.29 (8.98)
	Total	171.62 (100.00)	173.83 (100.00)	172.99 (100.00)	168.07 (100.00)	174.03 (100.00)	170.31 (100.00)
	Owned labour	72.01 (41.96)	41.65 (23.96)	53.16 (30.73)	60.72 (36.13)	35.15 (20.20)	51.14 (30.03)
	Hired labour	99.61 (58.03)	132.18 (76.03)	119.83 (69.25)	107.35 (63.86)	138.88 (79.79)	119.17 (69.96)

(Figures in parentheses indicate percentages to respective totals)

35.15 mandays on large farms. Among all the operations performed, 19.76 per cent of the total labour employed was for weeding followed by irrigation (19.62 per cent), transplanting (18.89 per cent), harvesting (18.75 per cent) and threshing (8.98 per cent) on pooled farms. It is interesting to note that 85 per cent (ranging from 85.78 per cent on small farms to 86.39 per cent on large farms) of the total labour use was in these operations.

It is evident from the above analysis that labour absorption in the production of paddy was higher than that of groundnut cultivation. The labour utilisation in both the crops was marginally higher on sustainable farms compared to non-sustainable farms. However, there was no distinct difference in the human labour employment between the size groups. Out of all the operations weeding, harvesting, sowing or transplanting, threshing or stripping and irrigation (paddy) turned out to be the major operations that consumed 85 per cent of the total labour. The family labour contribution was less in groundnut cultivation both in absolute and relative terms compared to paddy cultivation. The percentage of hired labour employment in both the crops of different size groups on sustainable and non-sustainable farms was more than the percentage family labour use. There existed inverse relationship between family labour use and size of the farm.

4.4.2 Utilisation of bullock and tractor services.

Bullock and tractors were employed for land preparation and transportation of inputs and products. The operation wise bullock and tractor use for groundnut and paddy crops is presented in Tables from 4.8 to 4.11.

4.4.2.1 Bullock and tractor services in groundnut cultivation.

It is evident from Table 4.8 that the total bullock labour used on sustainable farms varied from 6.34 cattle pair days on small farms to 1.86 cattle pair days on large farms while the same on pooled farm was 2.8 cattle pair days. Much of the bullock labour required was met by owned bullocks which accounted for 94.47 per cent on small farms, 55.37 per cent on large farms and 73.95 per cent on pooled farms. Maximum bullock labour use was for land preparation followed by sowing and transportation accounting for 40.36, 30.00 and 29.64 per cent respectively on pooled farms. The same trend was noticed on large farms. However, on small farms the first, second, and third place occupied by land preparation (49.37 per cent), transportation (28.08 per cent) and sowing (22.56 per cent).

On non-sustainable farms, the total bullock labour use was 6.62, 2.09, and 3.02 cattle pair days per hectare on small, large and pooled farms respectively. Land preparation (50 per cent), sowing (26.82 per cent) and transportation (23.18 per cent) were the major bullock labour absorbing operations in the order of importance on pooled farms. The same pattern was observed on both the size groups of non-sustainable farms. More than 50 per cent of total bullock labour requirement was contributed by owned cattle on the size groups.

Machinery use increased from 0.73 hours per hectare on small sustainable farms to 2.76 hours on large farms. The same on pooled farms was 2.34 hours per hectare. On non-sustainable farms its use ranged from 0.95 hours on small farms to 1.38 hours on large farms with an average of 1.29 hours on pooled farms (Table 4.10) 100 per cent on small farms and more than 93 per cent of the total machinery use on large farms was for land preparation. Transportation utilised the remaining proportion of machinery services.

Table 4.8 : Cattle labour utilisation-operation wise in groundnut cultivation (cattle pair days per hectare)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land preparation	3.13 (49.37)	0.60 (32.26)	1.13 (40.36)	4.26 (64.35)	0.80 (38.28)	1.51 (50.00)
2.	Transportation	1.78 (28.08)	0.58 (31.18)	0.83 (29.64)	1.18 (17.82)	0.58 (27.75)	0.07 (23.18)
3.	Sowing	1.43 (22.56)	0.68 (36.56)	0.84 (30.00)	1.18 (17.82)	0.71 (33.97)	0.81 (26.82)
	Total	6.34 (100.00)	1.86 (100.00)	2.80 (100.00)	6.62 (100.00)	2.09 (100.00)	3.02 (100.00)
	Owned labour	5.99 (94.47)	1.03 (55.37)	2.07 (73.95)	3.55 (53.62)	1.11 (53.11)	1.61 (53.40)
	Hired labour	0.35 (5.52)	0.23 (44.62)	0.73 (26.04)	3.07 (46.37)	0.98 (46.88)	1.41 (46.60)

(Figures in parentheses indicate percentages to respective totals)

4.4.2.2 Bullock and tractor services in paddy cultivation.

It is discernible from the particulars furnished in Table 4.9 that the cattle labour requirement per hectare of paddy cultivation on sustainable farms was 15.19 cattle pair days for the sample as a whole and it declined from 19.07 on small farms to 10.45 cattle pair days on large farms. Out of the total cattle labour use 76.03, 30.62 and 62.01 per cent was contributed by owned cattle and the remaining through hired bullock labour on small, large and pooled farms respectively. Land preparation was the major cattle labour absorbing operation accounting for more than 80 per cent on all size groups. Transportation is the other item that utilised cattle labour to the extent of 18.72, 11.96 and 16.65 % of the total cattle labour employed on small, large and pooled farms respectively.

On non-sustainable farms, small, large and pooled farms utilised 17, 11.59 and 14.97 cattle pair days respectively. Analogous to sustainable farms, land preparation turned out to be the important operation of cattle labour use as it accounted for 83.82 per cent on small farms, 87.14 per cent on large farms and 84.76 per cent on pooled farms. Cattle labour use for the transportation of inputs was 2.75, 1.49 and 2.27 cattle pair days on small, large and pooled farms respectively.

It is interesting to observe that small farmers of sustainable and non-sustainable farms did not hire tractors for ploughing and transportation. On an average the machinery use was 4.36 hours on sustainable large farms and 4.25 hours per hectare on non-sustainable large farms (Table 4.11). The same was 1.96 and 1.59 hours on pooled sustainable and non-sustainable farms. More than 76 per cent of the total machinery use was for the purpose of land preparation on sustainable and non-sustainable farms. Transportation of FYM accounted for 19.03 and 23.52 per cent of the total machinery use on sustainable and non-sustainable large farms.

Table 4.9 : Cattle labour utilisation-operation wise in paddy cultivation (cattle pair days per hectare)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land preparation	15.50 (81.27)	9.20 (88.03)	12.66 (83.34)	14.25 (83.82)	10.10 (87.14)	12.69 (84.76)
2.	Transportation	3.57 (18.72)	1.25 (11.96)	2.53 (16.65)	2.75 (16.17)	1.49 (12.85)	2.27 (15.16)
	Total	19.07 (100.00)	10.45 (100.00)	15.19 (100.00)	17.00 (100.00)	11.59 (100.00)	14.97 (100.00)
	Owned labour	14.50 (76.03)	3.20 (30.62)	9.42 (62.01)	9.90 (58.23)	5.63 (48.57)	8.29 (55.37)
	Hired labour	4.57 (23.96)	7.25 (69.38)	5.77 (37.98)	7.10 (41.76)	5.96 (51.42)	6.67 (44.65)

(Figures in parentheses indicate percentages to respective totals)

Table 4.10: Tractor power utilisation in groundnut cultivation (hrs/ha)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land preparation	0.73 (100.00)	2.58 (93.48)	2.19 (93.59)	0.95 (100.00)	1.30 (94.55)	1.23 (95.53)
2.	Transportation	--	0.18 (6.52)	0.14 (5.98)	--	0.08 (5.45)	0.06 (4.66)
	Total	0.73 (100.00)	2.76 (100.00)	2.34 (100.00)	0.95 (100.00)	1.38 (100.00)	1.29 (100.00)
	Owned labour	--	0.95 (34.42)	0.76 (32.33)	--	--	--
	Hired labour	0.73 (100.00)	1.81 (65.57)	1.58 (67.67)	0.95 (100.00)	1.38 (100.00)	1.29 (100.00)

(Figures in parentheses indicate percentages to respective totals)

Table 4.11: Tractor power utilisation in paddy cultivation (hrs/ha)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Land preparation	--	3.53 (80.96)	1.59 (81.12)	--	3.25 (76.47)	1.22 (76.72)
2.	Transportation	--	0.83 (19.03)	0.37 (18.87)	--	1.00 (23.52)	0.37 (23.27)
	Total	--	4.36 (100.00)	1.96 (100.00)	--	4.25 (100.00)	1.59 (100.00)
	Owned labour	--	2.28 (52.29)	1.03 (52.55)	--	3.25 (76.47)	1.22 (76.72)
	Hired labour	--	2.08 (47.70)	0.94 (47.95)	--	1.00 (23.52)	0.37 (23.27)

(Figures in parentheses indicate percentages to respective totals)

It is clear from the above analysis that cattle labour use exhibited inverse relationship with the farm size in both the selected enterprises. On the other hand machinery use showed direct relationship with the size of the holding reflecting mechanization of farm operations on large farms.

It was further observed that larger proportion of the total cattle and machinery services were contributed by owned cattle and machinery. Ploughing and transportation were the major operations that require cattle and machinery services on different size groups of sustainable and non-sustainable farms. Small sustainable and non-sustainable farms used more cattle labour than large sustainable and non-sustainable farms. The opposite was true in case of machinery use. The bullock labour requirement was more in case of paddy cultivation compared to groundnut production.

4.4.3 Material inputs

Production of a farm commodity not only requires input services viz., human labour, bullock labour, machinery but also material inputs like seeds, fertilizers, farm yard manure, chemicals etc, that form an important cost component. The details of various material inputs used in the selected crop enterprises on different size groups of sustainable and non-sustainable farms are presented in Tables 4.12 and 4.13.

4.4.3.1 Material input utilisation in the cultivation of groundnut crop.

It is evident from Table 4.12 that on sustainable farms small, large and pooled farms used 105.50 kg, 102.80 kg and 103.40 kg of seeds per hectare respectively. On average 22.33 tonnes of FYM per hectare was used on pooled farms. This input

Table 4.12 : Material input utilisation in the cultivation of groundnut (per hectare)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Seed (kg)	105.50	102.80	103.4	109.60	112.10	111.59
2.	FYM (t)	23.20	22.10	22.33	15.55	14.40	14.64
3.	N (kg)	35.01	40.35	39.22	40.20	44.00	43.21
4.	P (kg)	42.00	45.10	44.50	39.23	41.90	41.35
5.	K (kg)	40.00	42.10	41.66	46.55	48.20	47.86
6.	Gypsum (kg)	--	2.35	1.86	--	--	--
7.	Plant protection chemicals (l)	0.48	0.67	0.63	0.93	1.10	1.06

application declined from 23.20 tonnes on small farms to 22.10 tonnes on large farms. Inorganic fertilizers were also applied in the cultivation of groundnut on sustainable farms and the break up of the same into N, P, K resulted in 35.01 kg, 42 kg and 40 kg per hectare on small farms, 40.35 kg, 45.10 kg and 42.10 kg per hectare on large farms, 39.22 kg, 44.50kg and 41.66 kg per hectare on pooled farms respectively. Gypsum was applied to the extent of 2.35 kg and 1.86 kg per hectare on large and pooled farms respectively. Small farmers did not apply gypsum. The respondents as a whole used 0.63 litres of plant protection chemicals per hectare to control pests and diseases and this varied from 0.48 kg on small farms to 0.67 kg on large farms.

On non-sustainable farms, the seed rate was 111.59 kg per hectare for the sample as a whole and it increased from 109.60 kg on small farms to 112.10 kg on large farms. Large farmers of non-sustainable farms applied less (14.40 tonnes) quantity of FYM per hectare than small farmers (15.55 tonnes), in the production of groundnut. The application of chemical fertilizers in terms of N, P, K worked out to 43.21 kg, 41.35 kg, and 47.86 kg per hectare respectively for the sample as a whole. The same was 40.20 kg, 39.23 kg, and 46.55 kg per hectare on small farms and 44 kg, 41.90 kg, and 48.20 kg per hectare on large farms. The use of plant protection chemicals ranged from 0.93 kg per hectare on small farms to 1.10 kg on large farms with an overall average of 1.06 kg. It is interesting to note that gypsum was not applied on non-sustainable farms.

4.4.3.2 Material input use in the cultivation of paddy.

It is evident from Table 4.13 that small, large and pooled sustainable farms used seed at the rate of 93.75 kg, 81.95 kg and 86.43 kg per hectare respectively. As against this, non-sustainable, small, large, pooled farms used 95.02 kg, 85.37 kg and 91.40 kg of

Table 4.13 : Material input utilisation in the cultivation of paddy (per hectare)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Seed (kg)	93.75	81.95	86.43	95.02	85.37	91.40
2.	FYM (t)	24.50	20.78	22.19	20.10	18.31	19.43
3.	N (kg)	77.50	85.43	82.42	79.13	71.56	76.29
4.	P (kg)	--	57.70	35.81	61.13	52.19	57.78
5.	K (kg)	47.50	38.95	32.19	41.50	34.04	38.71
6.	ZnSo ₄ (kg)	32.50	--	12.33	--	21.20	7.95
7.	Plant protection chemicals						
	a) dusts (kg)	0.50	1.01	0.82	0.90	1.10	0.96
	b) liquids (l)	2.01	2.51	2.32	2.42	2.52	2.46

seed per hectare in the cultivation of paddy. On an average, 22.19 tonnes of organic manure was applied on sustainable farms compared to 19.43 tonnes per hectare on non-sustainable farms. The same trend persisted in the application of FYM between size groups of sustainable and non-sustainable farms. The application of N,P,K per hectare for the sample as a whole on sustainable farms worked out 82.42 kg, 35.81 kg and 32.19 kg respectively whereas on non-sustainable pooled farms the same was 76.29 kg, 57.78 kg and 38.71 kg respectively. There was no definite trend between small and large sustainable and non-sustainable farms in the use of N, P, K. More quantity of gypsum was used on sustainable-pooled farms (12.33 kg) compared to non-sustainable pooled farms (7.95 kg). The same trend was observed on small farms of sustainable and non-sustainable agriculture. On an average, sustainable farms applied 0.82 kg and 2.32 litres of pest protection chemicals per hectare as a preventive and remedial measure against the attack of pests and diseases compared to 0.96 kg of dusts and 2.46 litres of liquids on non-sustainable farms.

4.4.4 Cost of cultivation of selected crops on sample farms.

Generally in any economic study total costs are discussed under two categories viz., variable costs and fixed costs, the widely accepted norm. In general, variable costs alone are reckoned to be the cost of cultivation by the farming community ignoring overhead costs and the profit and loss to are computed accordingly. However, in an economic analysis of business enterprises, the overhead costs are also taken into account to arrive at total costs and thereby to workout farm income.

Variable or working costs include expenses on labour employed to perform different farm operations and expenses incurred on material inputs viz., seeds, FYM, Fertilizers, plant protection chemicals, fuel charges etc. The fixed costs are depreciation on working assets, interest on fixed capital rent on land and land revenue. The particulars of cost of cultivation of groundnut and paddy according to size groups of sustainable and non-sustainable farms are presented in Tables 4.14 and 4.15 respectively.

4.4.4.1 Cost of cultivation of groundnut.

On an average, cost of cultivation of groundnut was estimated at Rs.12,735.27 per hectare on pooled sustainable farms (Table 4.14). The cost of cultivation decreased with the size of the holding from Rs.12,735.27 on small farms to Rs.12,378.02 on large farms. It was observed that operational costs accounted for major share in the total costs on all categories of farms. The total operational costs per hectare ranged from Rs.8,422.54 on small farms to Rs.8,153.09 on large farms with an overall average of Rs.8,209.62 for the sample as a whole. The variable costs accounted for 66.13, 65.86 and 65.93 per cent of the total costs on small, large and pooled sustainable farms respectively (Table 4.14).

Among the working costs, cost of seed was higher than that of other inputs amounting to Rs. 2,215.50, Rs.2,158.80 and Rs.2,170.69 on small, large and pooled farms respectively accounting for 17.39, 17.44 and 17.43 per cent in that order. Expenditure on human labour was the next important item of cost on all size groups of farms. It varied from Rs.2,117.76 (16.62 per cent) on small farms to Rs.2,107.68 (17.02 per cent) on large farms. The same was Rs.2,109.78 (16.94 per cent) on pooled farms. The other items of expenditure in the order of importance were manures and fertilizers accounting for 10.93 and 9.32, 10.71 and 9.73 and 10.76 and 9.72 per cent of the total costs on small, large and pooled farms respectively. The items of cost of minor importance were bullock labour

(3.37 per cent), tractor power (3.75 per cent), interest on working capital (1.92 per cent) and plant protection chemicals (1.79 per cent) on pooled farms. More or less the same trend was noticed on small and large farms.

The results presented in Table 4.14 also revealed that fixed costs per hectare worked out to Rs.4,312.73, Rs.4,224.93 and Rs.4,243.19 on small, large and pooled farms respectively. The share of fixed costs in the total costs was more than 33 per cent on both the size groups. Further, it was found that rental value of owned land was high at Rs.3,133.00 (24.60 per cent) on small farms as against Rs.3,099.90 (25.04 per cent) on large farms. It was Rs. 3,106.84(24.95 per cent) on pooled farms. The other major items of fixed costs were depreciation and interest on fixed capital accounting for 3.69 and 3.51 per cent of the total costs on pooled farms respectively.

On non-sustainable farms, the per hectare cost of cultivation of groundnut worked out to be Rs.12,485.46 on small farms, Rs.11,909.57 on large farms and Rs.12,228.14 on pooled farms. The break up of costs showed that 64.29 per cent was accounted for operational costs and 35.71 per cent by fixed costs on pooled farms. More or less the same trend was noticed on small and large farms with regard to breakup of costs. Like on sustainable farms, cost of seed constituted the most important item of expenditure accounting for 18.43, 19.76 and 19.48 per cent on small, large and pooled farms respectively. As high as Rs.2,354.10 on large farms, Rs.2,301.60 on small arms and Rs.2,343.29 on pooled farms was spent on seed. The human labour cost amounted to Rs.1,925.75 for the sample as a whole and declined from Rs.1,937.28 on large farms to Rs.1,881.28 on small farms. This cost accounted for 15.06, 16.26 and 16.09 per cent of the total cost on small, large and pooled farms respectively.

The interest of farmers to earn more income from farm business through better management practices was quite evident as an amount of Rs.1,307.40 on large farms followed by pooled farms (Rs. 1,289.87) and small farms (Rs. 1,222.23) was spent on fertilizers and this item of cost accounted for 9.78, 10.97 and 10.72 per cent on small, large and pooled farms respectively. Cost of manure succeeded as the next important cost component with an expenditure of Rs.933, Rs.864 and Rs.878.20 on small, large and pooled farms respectively and this item of cost accounted for 7.47,7.25 and 7.30 per cent in that order. Bullock labour and tractor power followed as other items of cost claiming an expenditure of Rs.441.18 and Rs.257.50 respectively on pooled farms. The share of these items of cost on small and large farms was 7.95 and 1.52 and 2.50 and 2.30 per cent respectively.

The fixed costs per hectare on non-sustainable farms decreased with the size of holding from Rs.4,401.89 on small farms to Rs.4,266.08 on large farms whereas it was Rs.4,294.09 for the sample as a whole. As in case of sustainable farms, rental value of owned land had the major share in the fixed costs and accounted for more than 24 per cent of the total costs on all size groups. Interest on fixed capital and depreciation were other components of fixed costs accounting for 4.30 and 3.57 per cent respectively on pooled farms. The production costs of groundnut were graphically represented in Fig.1.

4.4.4.2 Cost of cultivation of paddy

The cost of cultivation of paddy on sustainable farms as presented in Table 4.15 stood at Rs.21,267.40 per hectare on sample farms and it increased from Rs.21,134.68 on small farms to Rs.21,350.46 on large farms. The total cost was the sum of operating costs

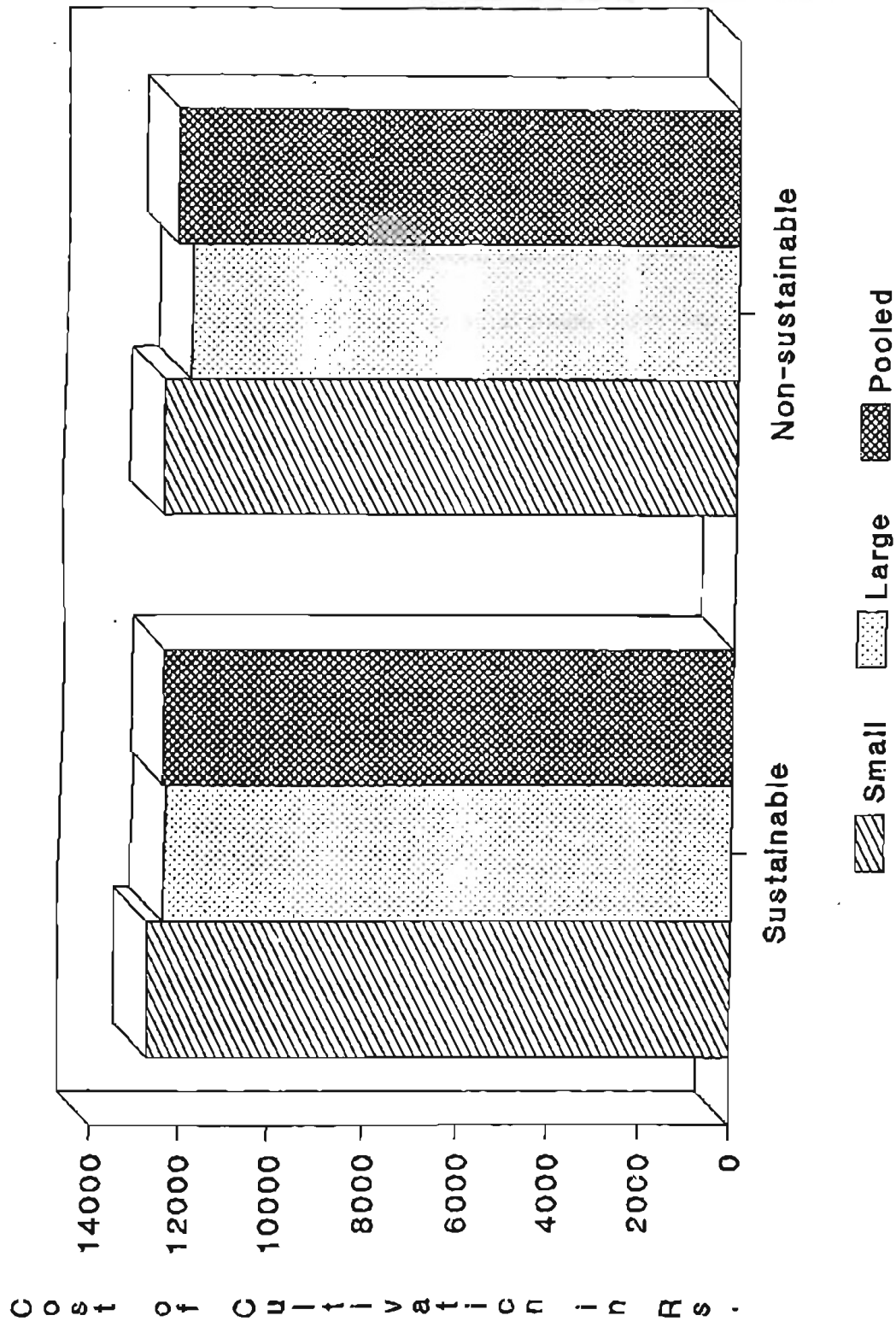
Table 4.14: Cost of cultivation of groundnuts (₹/ha/annum)

Particulars	Sustainable			Non-sustainable		
	Small	Large	Pooled	Small	Large	Pooled
A. OPERATIONAL COSTS						
Human labour	2117.76 (16.62)	2107.68 (17.02)	2109.78 (16.94)	1881.28 (15.06)	1937.28 (16.26)	1925.75 (16.09)
Owned	600.64 (4.71)	302.24 (2.44)	467.79 (3.76)	259.20 (2.07)	303.36 (2.55)	294.27 (2.45)
Hired	1517.12 (11.91)	1805.44 (14.58)	1744.95 (14.01)	1622.08 (12.99)	1633.92 (13.71)	1631.48 (13.56)
Bullock labour	951.00 (7.46)	279.00 (2.25)	419.99 (3.37)	993.00 (7.95)	298.11 (2.50)	441.18 (3.67)
Owned	898.50 (7.05)	154.50 (1.24)	310.59 (2.49)	532.50 (4.26)	151.11 (1.27)	229.63 (1.91)
Hired	52.50 (0.4)	124.50 (1.00)	109.39 (0.88)	460.50 (3.68)	147.00 (1.23)	211.54 (1.76)
Tractor power	146.00 (1.14)	552.00 (4.45)	466.82 (3.75)	190.00 (1.52)	275.00 (2.30)	257.50 (2.14)
Owned	--	190.00 (1.53)	150.14 (1.21)	--	--	--
Hired	146.00 (1.14)	362.00 (2.92)	316.68 (2.54)	190.00 (1.52)	275.00 (2.30)	257.50 (2.14)
Seed	2215.50 (17.39)	2158.80 (17.44)	2170.69 (17.43)	2301.60 (18.43)	2354.10 (19.76)	2343.29 (19.48)
FYM	1392.00 (10.93)	1326.00 (10.71)	1339.85 (10.76)	933.00 (7.47)	864.00 (7.25)	878.20 (7.30)
Fertilizers	1187.00 (9.32)	1204.81 (9.73)	1201.07 (9.72)	1222.23 (9.78)	1307.40 (10.97)	1289.87 (10.72)
Soil amendments	--	50.38 (0.4)	39.81 (0.32)	--	--	--

Particulars	Sustainable			Non-sustainable		
	Small	Large	Pooled	Small	Large	Pooled
Plant protection chemicals	168.00 (1.31)	237.00 (1.91)	222.52 (1.79)	327.00 (2.61)	385.00 (3.23)	373.06 (3.10)
Interest on working capital	248.28 (1.93)	237.42 (1.92)	239.07 (1.92)	235.46 (1.88)	222.60 (1.86)	225.25 (1.87)
Total variable costs	8422.54 (66.13)	8153.09 (65.86)	8209.62 (65.93)	8083.57 (64.74)	7643.49 (64.17)	7734.09 (64.29)
B. FIXED COSTS						
Depreciation	335.50 (2.63)	492.00 (3.97)	459.17 (3.69)	410.50 (3.28)	435.01 (3.65)	429.96 (3.57)
Repairs	221.53 (1.73)	233.17 (1.88)	230.73 (1.85)	299.06 (2.39)	213.89 (1.79)	231.43 (1.92)
Land revenue	10.00 (0.07)	10.00 (0.08)	10.00 (0.08)	10.00 (0.08)	10.00 (0.08)	10.00 (0.08)
Rental value of owned land	3133.00 (24.60)	3099.90 (25.04)	3106.84 (24.95)	3096.73 (24.80)	3107.59 (26.09)	3105.35 (25.82)
Interest on fixed capital	612.70 (4.81)	389.85 (3.15)	436.61 (3.51)	585.60 (4.69)	499.59 (4.19)	517.29 (4.30)
Total fixed costs	4312.73 (33.86)	4224.93 (34.13)	4243.19 (34.07)	4401.89 (35.25)	4266.08 (35.82)	4294.04 (35.71)
Total costs	12735.27 (100.00)	12378.02 (100.00)	12452.97 (100.00)	12485.46 (100.00)	11909.57 (100.00)	12228.14 (100.00)

(Figures in parentheses indicate percentages to respective totals)

Fig.1 Cost of Cultivation of Groundnut in sustainable and non-sustainable farms



and fixed costs amounting to Rs.12,685.45 (60.04 per cent) and Rs.8,449.23 (39.96 per cent) on small farms, Rs.12,943.46 (60.62 per cent) and Rs.8,407.00 (39.37 per cent) on large farms and Rs.12,844.40 (60.39 per cent) and Rs.8,423.00 (39.61 per cent) on pooled farms. The higher cost oriented input among operational costs in paddy cultivation was human labour on which the amount incurred was Rs.5,491.84, Rs.5,562.56 and Rs.5,535.74 on small, large and pooled farms respectively and its share accounted for 25.98, 26.05 and 26.02 per cent of the total cost in that order. Next important operational cost was expenditure on fertilizers. On an average, expenditure on this item of cost was Rs.1,585.00 (7.49 per cent) Rs.1,886.82 (8.84 per cent) and Rs.1,772.30 (8.33 per cent) on small, large and pooled farms respectively. Bullock labour cost was highest (Rs.1,907) on small farms followed by pooled farms (Rs.1,519) and large farm (Rs.1,045). Cost of manure which was another important item of operational cost amounting to Rs.1,225 on small farms, Rs.1,039 on large farms and Rs.1,109.55 on pooled farms accounting for 5.79, 4.86 and 5.21 per cent in the same order. The cost of plant protection chemicals worked out to Rs.1,010.90 (4.78 per cent), 1,201.10 (5.62 per cent) and 1,129.60 (5.31 per cent) on small, large and pooled farms respectively.

The other important category of the total cost was fixed cost. Under these costs rental value of owned land was estimated at Rs.6,956.43 for the sample as a whole accounting for 32.70 per cent of the total cost. The same decreased from Rs.7,017 on small farms to Rs.6,919.43 on large farms. An amount of Rs.480.03 (2.26 per cent) was found under interest on fixed capital followed by depreciation (Rs.432.60) on pooled farms.

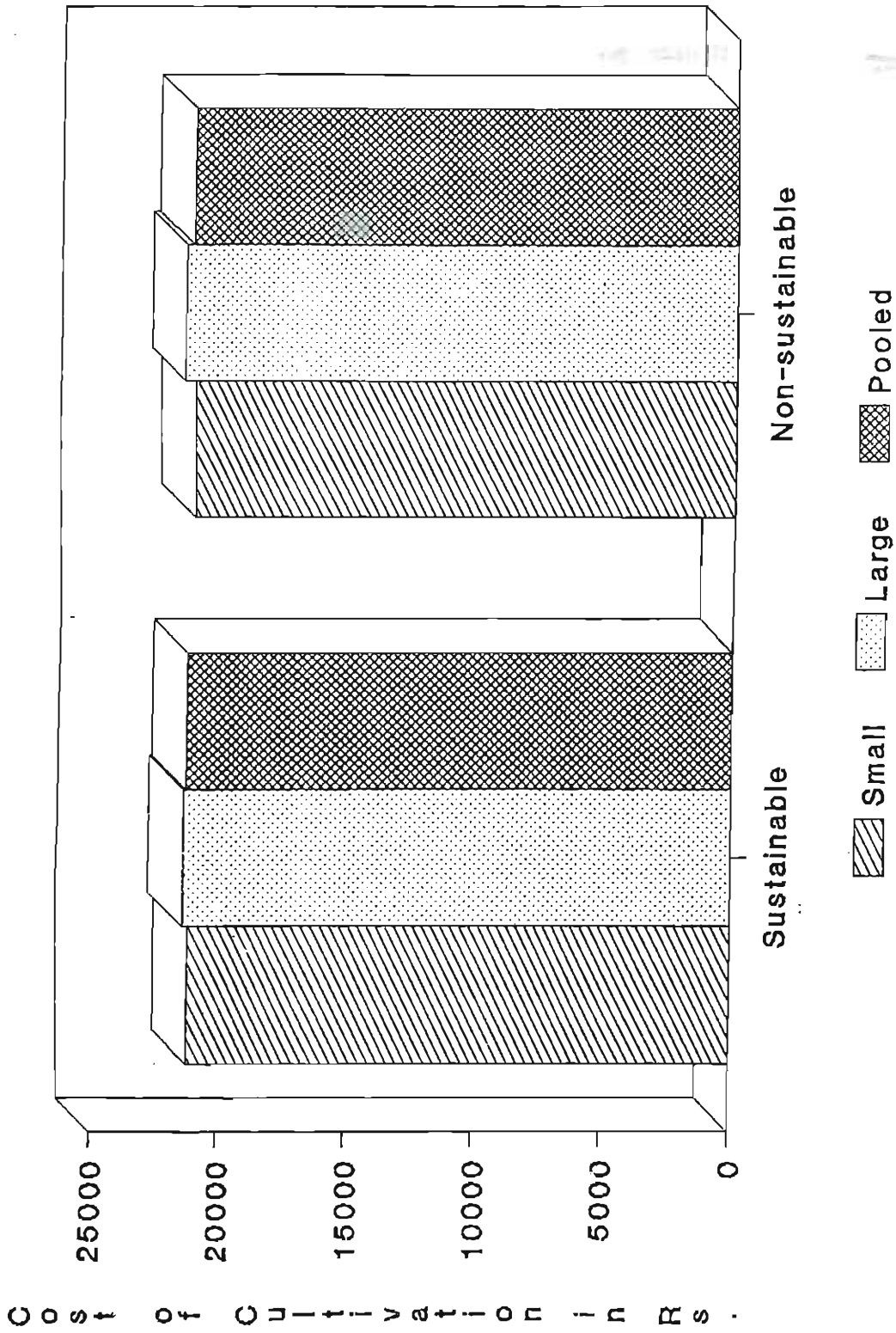
Table 4.15: Cost of cultivation of paddy (Rs/ha)

Particulars	Sustainable			Non-sustainable		
	Small	Large	Pooled	Small	Large	Pooled
A. OPERATIONAL COSTS						
Human labour						
Owned	5491.84 (25.98)	5562.56 (26.05)	5535.74 (26.02)	5378.24 (25.57)	5568.96 (26.00)	5449.76 (25.74)
Hired	2304.064 (10.90)	1333.12 (6.24)	1701.60 (8.00)	1943.68 (9.24)	1125.44 (5.25)	1636.84 (7.73)
Bullock labour						
Owned	3187.20 (15.08)	4229.44 (19.80)	3834.10 (18.02)	3434.56 (16.33)	4443.52 (20.74)	3812.92 (18.01)
Hired	1907.00 (9.02)	1045.00 (4.89)	1519.00 (7.14)	1700.00 (8.08)	1159.00 (5.41)	1497.00 (7.07)
Tractor power						
Owned	1450.00 (6.85)	320.00 (1.49)	941.50 (4.43)	990.00 (4.70)	563.00 (2.63)	829.87 (3.91)
Hired	457.00 (2.16)	725.00 (3.39)	577.40 (2.71)	710.00 (3.37)	596.00 (2.78)	667.25 (3.15)
Fertilizers						
Owned	--	872.00 (4.08)	392.40 (1.84)	--	850.00 (3.96)	318.75 (1.50)
Hired	--	456.00 (2.13)	205.20 (0.96)	--	650.00 (3.03)	243.75 (1.15)
Seed						
Owned	937.50 (4.43)	819.50 (3.83)	864.26 (4.06)	950.20 (4.51)	853.70 (3.98)	914.00 (4.32)
Hired	1225.00 (5.79)	1.09 (4.86)	1109.55 (5.21)	1005.00 (4.78)	915.5 (4.27)	971.43 (4.58)
Plant protection chemicals						
Owned	1585.00 (7.49)	1886.82 (8.84)	1772.30 (8.33)	1897.75 (9.03)	1913.00 (8.93)	1903.50 (8.99)
Hired	1010.90 (4.78)	1201.10 (5.62)	1129.60 (5.31)	1141.80 (5.43)	1224.80 (5.72)	1172.90 (5.54)

Particulars	Sustainable			Non-sustainable		
	Small	Large	Pooled	Small	Large	Pooled
Electricity	114.28 (0.54)	81.05 (0.38)	93.65 (0.44)	122.01 (0.58)	92.13 (0.43)	110.78 (0.52)
Interest on working capital	413.93 (1.95)	436.43 (2.04)	427.90 (2.01)	423.08 (2.01)	434.63 (2.02)	427.86 (2.02)
Total variable costs	12685.45 (60.04)	12943.46 (60.62)	12844.40 (60.39)	12618.08 (60.01)	13011.72 (60.76)	12765.38 (60.29)
B. FIXED COSTS						
Depreciation	335.50 (1.58)	492.01 (2.30)	432.60 (2.03)	410.50 (1.95)	435.01 (2.03)	419.70 (1.98)
Repairs	421.53 (1.99)	533.17 (2.49)	490.80 (2.30)	409.06 (1.94)	513.89 (2.39)	449.30 (2.12)
Land revenue	62.50 (0.29)	63.54 (0.29)	63.15 (0.29)	64.01 (0.30)	63.06 (0.29)	63.65 (0.30)
Rental value of owned land	7017.00 (33.18)	6919.43 (32.40)	6956.43 (32.70)	6937.98 (32.99)	6890.63 (32.17)	6920.22 (32.68)
Interest on fixed capital	612.70 (2.89)	398.85 (1.86)	480.03 (2.26)	585.90 (2.78)	499.59 (2.33)	553.50 (2.61)
Total fixed costs	8449.23 (39.96)	8407.00 (39.37)	8423.00 (39.61)	8407.45 (39.98)	8402.18 (39.23)	8405.50 (39.70)
Total costs	21134.68 (100.00)	21350.46 (100.00)	21267.50 (100.00)	21025.53 (100.00)	21414.80 (100.00)	21171.50 (100.00)

(Figures in parentheses indicate percentages to respective totals)

Fig.2 Cost of Cultivation of Paddy in sustainable and non-sustainable farms



On non-sustainable farms, the total cost of cultivation per hectare amounted to Rs.21,171.50 for the sample as a whole. Size wise analysis indicated direct relationship with the farm size. It increased from Rs.21,025.53 on small farms to Rs. 21,414.80 on large farms. On both the size groups, it was observed that operational costs accounted for major share in the total costs. The total variable costs ranged from Rs.12,618.08 on small farms to Rs.13,011.72 on large farms accounting for 60.01 and 60.76 per cent respectively.

The major item in operational cost was human labour in both the size groups. The percentage was 25.57, 26.00 and 25.74 on small, large and pooled farms respectively. About Rs.1,897.75 (9.03 per cent), Rs.1,913 (8.93 per cent) and Rs.1,903.50 (8.99 per cent) was spent on fertilizers by small, large and pooled farmers respectively. Expenditure on bullock labour was found to be Rs.1,700 on small farms, Rs.1,159 on large farms and Rs.1,497 on pooled farms claiming 8.08, 5.41 and 7.07 per cent respectively.

The expenditure on plant protection chemicals was more (Rs.1,224.80) on large farms compared to small farms (Rs.1,141.80), the same was Rs.1,172.90 on pooled farms. On the other hand, cost incurred on manures was more on small farms than on large farms. It was Rs.1,005, 915.50 and Rs.971.43 on small, large and pooled farms respectively and it accounted for 4.78, 4.27 and 4.58 per cent of the total cost in that order. About 4.51, 3.98 and 4.32 per cent of the total expenses were incurred on seed in small, large and pooled non-sustainable farms.

The results also revealed that fixed costs amounted to Rs. 8,407.45, 8,402.18 and Rs.8,405.50 accounting for 39.98, 39.23 and 39.70 per cent for the size groups of small, large and pooled farms respectively. The most important component of fixed cost was the rental value of owned land, which was 32.99 per cent on small farms, 32.17 per cent on large farms and 32.68 per cent on pooled farms. The other important item of fixed cost was interest on fixed capital accounting for more than 2 per cent on all size groups. The production costs of paddy were represented graphically in Fig.2.

The overall analysis of cost structure of paddy and groundnut production revealed inverse relationship between costs and size of the farm in the cultivation of groundnut which might be due to economies of scale and direct relationship in the production of paddy reflecting higher investment capacity of the large farmers. The difference in the per hectare cost of cultivation between the size groups was due to the differences in the magnitude of input and input services utilisation like human labour, seed, fertilizers, and manures and bullock labour etc.,

The share of operational and fixed costs was in the ratio of 66:34 in case of groundnut and 60:40 in paddy production. Among the operational costs seed, manures and fertilizers were the major items in groundnut production whereas human labour, fertilizers, bullock labour and plant protection chemicals were the important cost components of paddy cultivation. In both the crops rental value of owned land turned out to be the major component of fixed cost. The cost of cultivation of paddy was higher than that of groundnut. Another important observation was that total costs were higher on sustainable farms compared to non-sustainable farms.

4.4.5 Output and returns

The details of physical output and monetary returns per hectare from the production of groundnut and paddy on sustainable and non sustainable farms are presented in Tables 4.16 and 4.17.

4.4.5.1 Output and returns from groundnut cultivation

On an average, the yield per hectare was 12.00, 11.00 and 11.55 quintals on small, large and pooled sustainable farms. The yield of groundnut on non-sustainable farms was less than that of sustainable farms. Small and large farmers on non-sustainable farms realised an output of 10.75 and 10.25 quintals per hectare respectively whereas on pooled farms the same was 10.56 quintals (Table 4.16).

On sustainable farms the respondents obtained a gross income of Rs.15,631.63 as against Rs.14,218.13 realised by the farmers on non-sustainable pooled farms. The gross income varied from Rs.16,130 per hectare on small farms to Rs.15,022.50 on large sustainable farms whereas it declined from Rs.14,467.50 on small non-sustainable farms to Rs.13,802.50 on large farms. (Fig. 3)

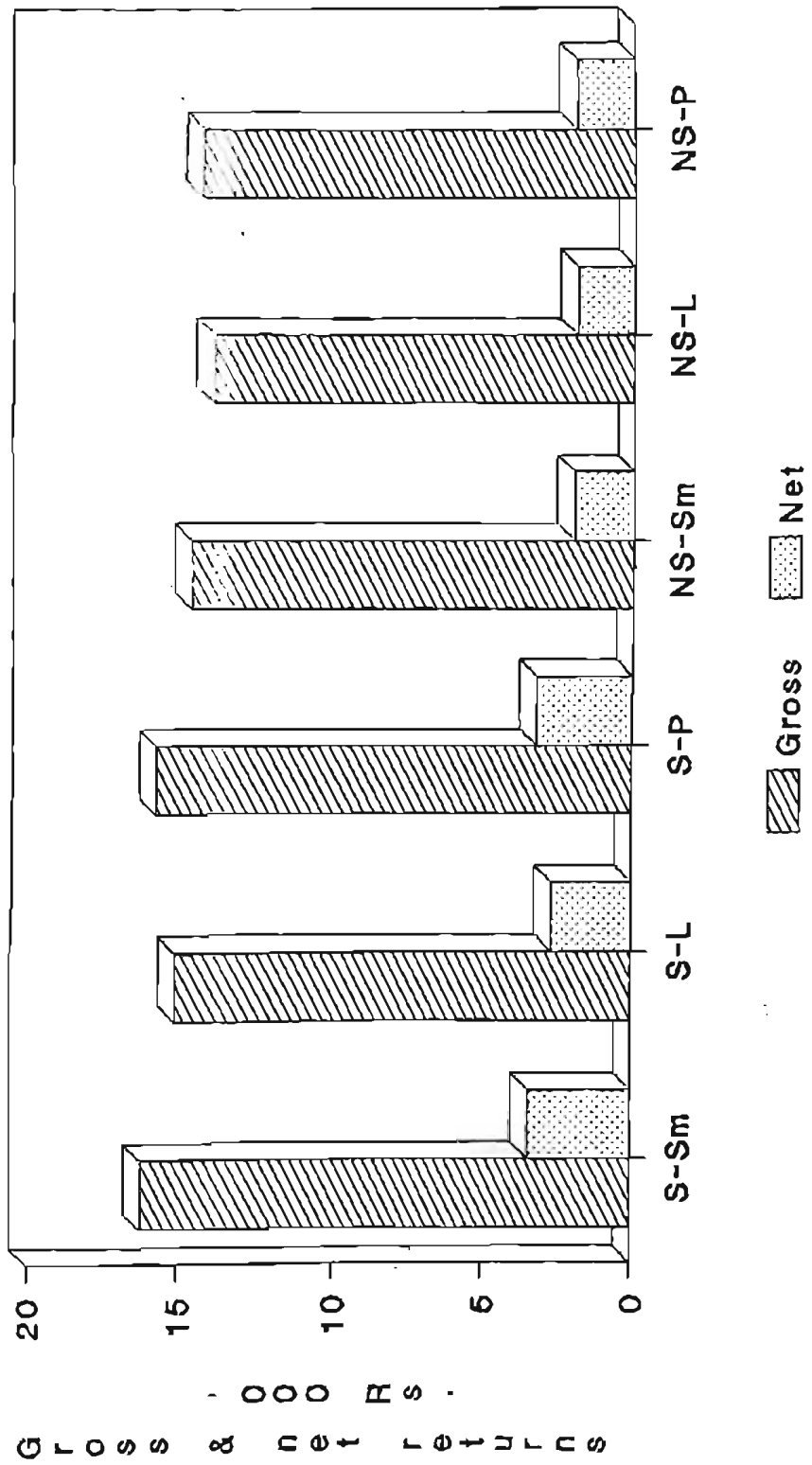
4.4.5.2 Output and returns from paddy cultivation

From Table 4.17, it is observed that the yield per hectare was 46.78 quintals on small farms as against the yield of 46.12 quintal on large sustainable farms. The average yield of paddy for the sample as a whole was 46.48 quintals on sustainable farms. Non-sustainable small, large and pooled farms yielded 45.50, 45.00, and 45.31 quintals respectively. The gross income was higher (Rs.29,165.50) on sustainable farms compared

Table 4.16: Output and returns per hectare of groundnut

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Yield in physical units						
	a) Main product (q)	12.00	11.00	11.55	10.75	10.25	10.56
	b) By product (cart loads)	2.60	2.45	2.53	2.40	2.32	2.37
2.	Yield in monetary units (Rs)						
	a) Main product	15480.00	14410.00	14998.50	13867.50	13222.50	13625.63
	b) By product	650.00	612.50	633.13	600.00	580.00	592.50
3.	Gross returns per ha (Rs)	16130.00	15022.50	15631.63	14467.50	13802.50	14218.13

Fig.3 Comparison of gross & net returns of sustainable and non-sustainable farms - Groundnut



S = Sustainable
 NS = Non-sustainable
 Sm = Small, L = Large, P = Pooled

to non-sustainable farms (Rs.28,243.00). Size wise analysis indicated that gross income declined from Rs.29,380.50 on small sustainable farms to Rs.28,904.00 on large farms. The same trend was observed in case of non-sustainable farms. The total revenue varied from Rs.28,367.50 on small non-sustainable farms to Rs.28,039.50 on large farms. (Fig 4).

From the above discussion, it is clear that productivity of both paddy and groundnut was inversely related with the size of holding on sustainable as well as non-sustainable farms. It is also clear that the productivity of both the crops was higher on sustainable than that of non-sustainable farms.

4.4.6 Costs and returns per quintal of paddy and groundnut

The particulars on costs and returns per quintal of groundnut and paddy production on sustainable and non-sustainable farms are presented in Tables 4.18 and 4.19.

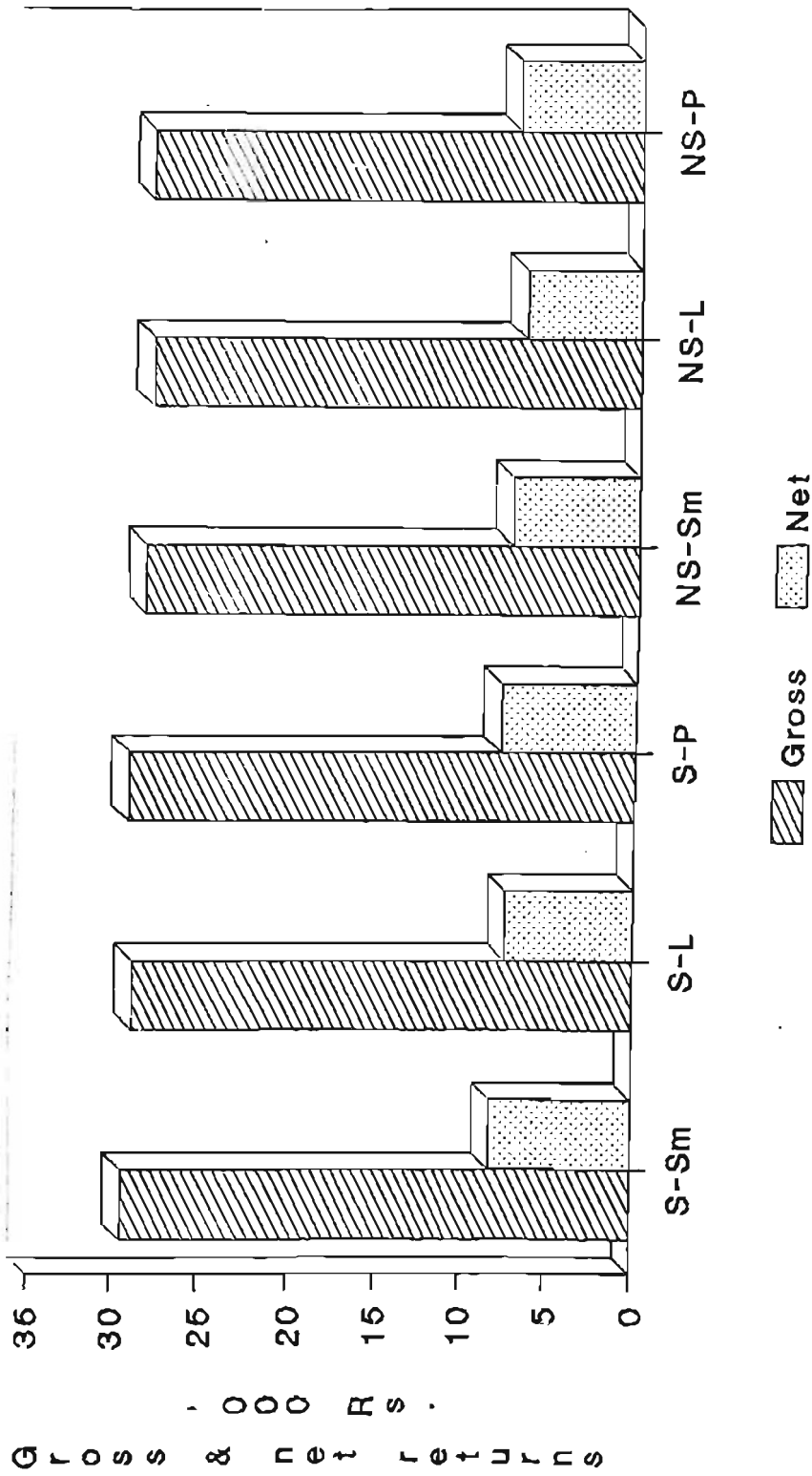
4.4.6.1 Costs and returns per quintal of groundnut production

The contents of Table 4.18 reveal that the total cost per quintal increased from Rs.1,061.27 on small sustainable farms to Rs.1,125.27 on large farms. The same was Rs.1,078.15 for the sample as a whole. On non-sustainable the unit cost of production was almost the same for small and large farms (Rs.1,161). The net income was more on sustainable small farms compared to large farms. It was Rs.282.89 per quintal on small farms, Rs.240.40 on large farms and Rs.275.20 on pooled farms. On non-sustainable farms there is no variation in the net income between the size groups.

Table 4.17: Output and returns per hectare of paddy

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Yield in physical units						
	a) Main product (q)	46.78	46.12	46.48	45.50	45.00	45.31
	b) By product (cart loads)	3.75	3.52	3.65	3.05	2.97	3.02
2.	Yield in monetary units (Rs)						
	a) Main product	28068.00	27672.00	27888.00	27300.00	27000.00	27186.00
	b) By product	1312.50	1232.00	1277.50	1067.50	1039.50	1057.00
3.	Gross returns per ha (Rs)	29380.50	28904.00	29165.50	28367.50	28039.50	28243.00

Fig.4 Comparison of gross & net returns
of sustainable and non-sustainable farms
- Paddy



S = Sustainable,
NS = Non-sustainable
Sm = Small, L = Large, P = Pooled

Table 4.18 : Costs and returns per quintal of groundnut production (Rs./ha)

Sl. No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Total variable costs	701.87	741.18	710.78	751.96	745.71	749.39
2.	Total fixed costs	359.39	384.08	367.37	409.47	416.20	411.62
3.	Total costs	1061.27	1125.27	1078.15	1161.44	1161.91	1161.61
4.	Gross income	1344.16	1365.68	1353.38	1345.81	1346.58	1346.09
5.	Net income	282.89	240.40	275.20	184.37	184.67	184.48

Table 4.19 : Costs and returns per quintal of paddy production (Rs./ha)

Sl. No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Total variable costs	271.17	280.64	276.34	277.32	289.14	281.73
2.	Total fixed costs	180.61	182.28	181.22	184.78	186.71	185.51
3.	Total costs	451.78	462.92	457.56	462.10	475.85	467.24
4.	Gross income	628.05	626.71	627.48	623.46	623.10	623.33
5.	Net income	176.27	163.78	169.92	161.36	147.21	156.07

Table 4.19 : Costs and returns per quintal of paddy production (Rs./ha)

Sl. No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Total variable costs	271.17	280.64	276.34	277.32	289.14	281.73
2.	Total fixed costs	180.61	182.28	181.22	184.78	186.71	185.51
3.	Total costs	451.78	462.92	457.56	462.10	475.85	467.24
4.	Gross income	628.05	626.71	627.48	623.46	623.10	623.33
5.	Net income	176.27	163.78	169.92	161.36	147.21	156.07

4.4.6.2 Costs and returns per quintal of paddy production.

The cost of production had direct relationship with the farm size in the production of paddy, as it was Rs.451.78 on small sustainable farms and Rs.462.92 on large farms. The same for the sample as a whole was Rs.457.56 per quintal. In case of non-sustainable farms, the costs per quintal increased from Rs.462.10 on small farms to Rs.475.85 on large farms with an average of Rs.467.24 on pooled farms. The net returns per quintal were higher on small sustainable farms (Rs.176.27) compared to large farms (Rs.163.78) and pooled farms (169.92). The same on small, large and pooled non-sustainable farms was Rs.161.36, Rs.147.21 and Rs.156.07 respectively.

From the preceding discussion, it can be concluded that cost of producing a quintal of paddy was higher on large farms than on small sustainable and non-sustainable farms. The same was true in case of groundnut on sustainable farms. The unit cost of production of groundnut was the same on both the size groups of non-sustainable farms. The cost of production of both the crops was higher on non-sustainable farms compared to sustainable farms.

4.4.7 Cost concepts

The cultivation of crops is also dealt by adopting the cost concepts used in farm management studies. Cost A₁, A₂, Cost B and Cost C were adopted in the present study. The concept of cost C is the most comprehensive one. It included both fixed and variable costs and hence provides basis for comparison between different types of operational holdings. The cost of cultivation of groundnut and paddy according to cost concepts were worked out and presented in Tables 4.20 and 4.21 respectively.

4.4.7.1 Cost concepts in groundnut cultivation

It is clear from the details of Table 4.20 that there was no leasing activity among the sample farmers and hence cost A_1 and Cost A_2 remained the same.

It is found that the cost of cultivation (Cost C) was maximum (Rs.12,735.27) on small farms and minimum on large farms (Rs.12,378.02) exhibiting negative relationship with the farm size. Cost A_1/A_2 was higher (Rs.8,586.03) on large farms than on small farms (Rs.8,388.73). The plausible reason was that large farmers engaged more hired labour and small farms used more family labour. But the cost B exhibited the same trend as that of cost C. For the sample as a whole cost A_1 , Cost A_2 cost B and Cost C were Rs.8,544.68, Rs.12,088.13 and Rs.12,452.97 respectively on sustainable farms. On non-sustainable farms cost A_1, B and Cost C showed inverse relationship with the size of holding whereas cost A_1/A_2 exhibited inverse relationship.

4.4.7.2 Cost concepts in paddy cultivation

The particulars furnished in Table 4.21 reveal that cost C was Rs.21,025.50, Rs.21,414.90 and Rs.21,171.75 on small, large and pooled non-sustainable farms. Unlike in case of groundnut, paddy production exhibited direct relationship with the size of holding. The cost C was Rs.21,134.68, Rs.21,350.46 and Rs.21,267.41 on small, large and pooled sustainable farms. Cost A_1/A_2 and Cost B also had exhibited direct relationship with the farm size.

Table 4.20 : cost concepts-groundnut production (Rs./ha)

Sl. No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Cost A ₁ /A ₂	8388.93	8586.03	8544.66	8543.93	7999.03	8111.22
2.	Cost B	12134.63	12075.18	12088.13	12226.26	11606.21	11733.87
3.	Cost C	12735.27	12378.02	12452.97	12485.46	11909.57	12028.14

Table 4.21: cost concepts-paddy production (Rs./ha)

Sl.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	Pooled
1.	Cost A ₁ /A ₂	11200.34	12699.06	12129.35	11557.97	12898.24	12061.19
2.	Cost B	18830.04	20017.34	19565.81	19081.85	20288.46	19534.91
3.	Cost C	21134.68	21350.46	21267.41	21025.50	21414.90	21171.75

From the above discussion, it can be inferred that cost C showed inverse relationship on both sustainable and non-sustainable farms with the size of the holding in groundnut production. The opposite trend was noticed in case of paddy production. It was also observed that the variation from cost B to cost C was higher on small farms compared to large farms. This might be due to the fact that in general, family labour contribution was more on small farms and this phenomenon accounted for higher imputed value of family labour in the total cost.

4.4.8 Measures of farm income

Costs and returns are the two elements of any business enterprise. Cost represents the value of inputs used in the production process whereas returns present the value of the output achieved. The relative magnitude of the costs and returns from the enterprise indicates the success of the farm business keeping this in view, various farm efficiency measures viz., gross income, farm business income, net income, farm investment income, family labour income were computed. In addition benefit cost ratio was worked out and presented in Tables 4.22 and 4.23.

4.4.8.1 Measures of farm income in groundnut cultivation.

It is clear from the details of Table 4.22 that gross income decreased with the size of the farm both in sustainable and non-sustainable farms. Per hectare gross income was Rs.16,130.00, Rs.15,022.50 and Rs.15,631.63 on small, large and pooled sustainable farms respectively as against Rs.14,467.50, Rs.13,802.50 and Rs.14,218.13 in the same order on non-sustainable farms.

Table 4.22 : Measures of farm income-groundnut production (Rs./ha)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	pooled
1.	Gross income	16130.00	15022.50	15631.63	14467.50	13802.50	14218.13
2.	Farm business income	7741.07	6436.47	7086.95	5923.57	5803.47	6106.91
3.	Family labour income	3995.37	2946.72	3543.50	2241.24	2196.29	2484.26
4.	Net income	3394.73	2644.48	3178.66	1982.04	1892.93	1948.62
5.	Farm investment income	7140.43	6134.24	6722.11	5664.37	5500.11	5812.64
6.	Benefit-cost ratio	0.27	0.21	0.26	0.16	0.16	0.16

Table 4.22 : Measures of farm income-groundnut production (Rs./ha)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	pooled
1.	Gross income	16130.00	15022.50	15631.63	14467.50	13802.50	14218.13
2.	Farm business income	7741.07	6436.47	7086.95	5923.57	5803.47	6106.91
3.	Family labour income	3995.37	2946.72	3543.50	2241.24	2196.29	2484.26
4.	Net income	3394.73	2644.48	3178.66	1982.04	1892.93	1948.62
5.	Farm investment income	7140.43	6134.24	6722.11	5664.37	5500.11	5812.64
6.	Benefit-cost ratio	0.27	0.21	0.26	0.16	0.16	0.16

Fig.5a Measures of farm income-Groundnut Sustainable

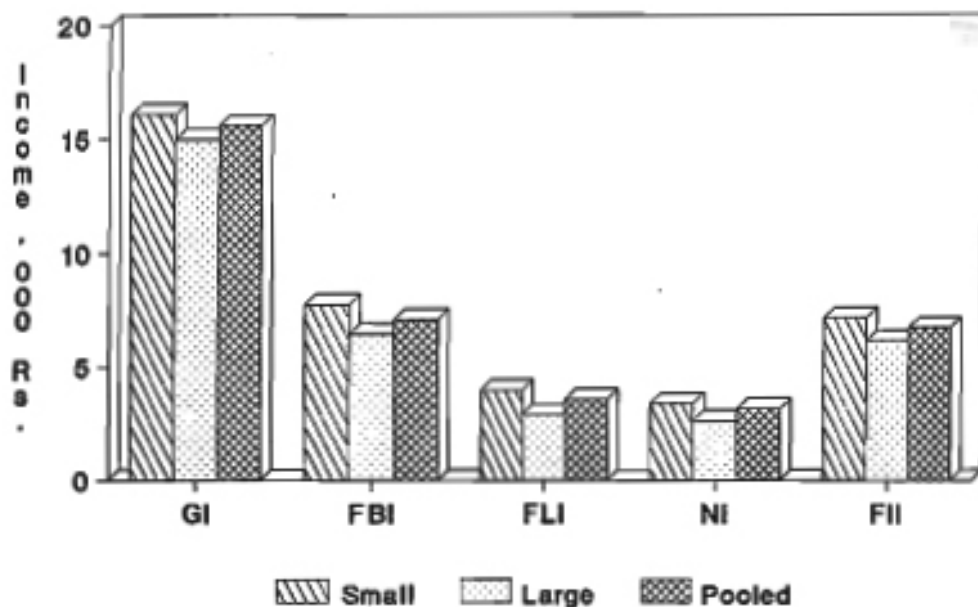
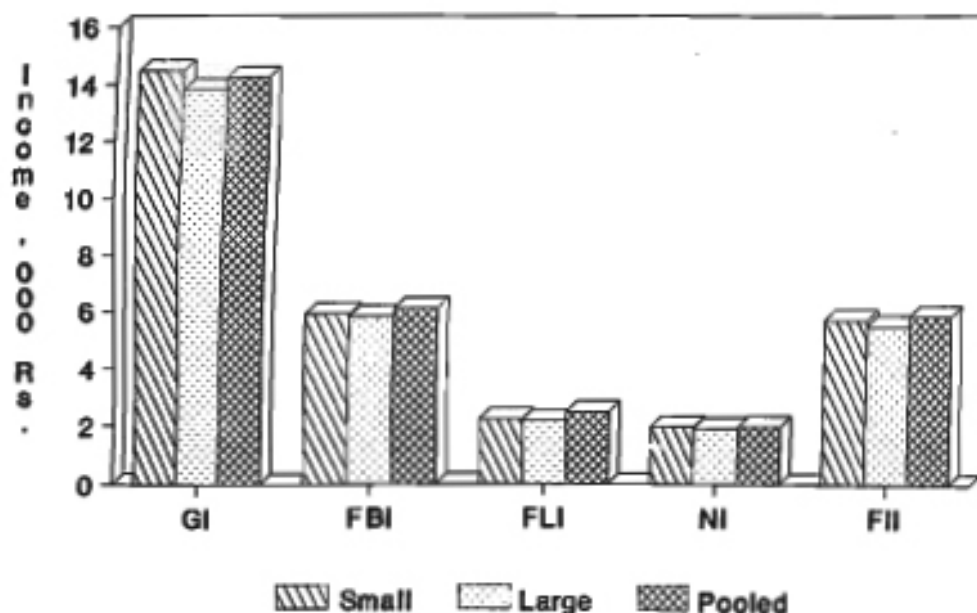


Fig.5b Measures of farm income-Groundnut Non-sustainable



GI = Gross Income FBI = Farm Business Income
 FLI = Family labour income NI = Net income FII : Farm Investment Income

Farm business income, the income over variable costs on the sample farms was Rs.7,086.95 per hectare. The same ranged from Rs.7,741.07 on small sustainable farms to Rs.6436.47 on large farms. Small, large and pooled farmers of non-sustainable farms realised a farm business income of Rs.5,923.57, Rs.5,803.47 and Rs.6,106.91 respectively.

Net income which is one of the important observable indicators of sustainability (Gordon Conway) exhibited inverse relationship with the size of the farm. Net income on sustainable farms declined from Rs.3,394.73 per hectare on small farms to Rs.2,644.48 on large farms and the same was 3,178.60 for the sample as a whole. On non-sustainable farms too, the net income decreased from Rs.1,982.04 on small farms to Rs.1,892.93 on large farms with an overall average of Rs.1,948.62 for the sample as a whole.

Family labour income was Rs.3,995.37, Rs. 2,946.72, and Rs.3,543.50 and Rs.2,241.24, Rs.2,196.29 and Rs.2,484.26 on sustainable and non-sustainable small, large and pooled farms respectively.

Farm investment income was Rs.7,140.43, Rs.6,134.24 and Rs.6,722.11 on sustainable small, large and pooled farms respectively as against Rs.5,664.37, Rs.5,500.11 and Rs.5,812.64 in the same order on non-sustainable farms.

The benefit cost ratio was found to be higher on sustainable small farms (0.27) than on large farms (0.21). It was 0.26 on pooled farms. The benefit-cost ratio was the same (0.16) on non-sustainable small, large and pooled farms. The measures of farm income of groundnut in sustainable and non-sustainable farms were graphically represented in Fig.5a, 5b.

4.4.8.2 Measures of farm income in paddy cultivation.

It is observed from Table 4.23 that on an average the selected paddy cultivators on sustainable farms realised gross income of Rs. 29,165.50 per hectare. Size wise analysis revealed that the gross income decreased with the farm size. This ranged from Rs. 29,380.50 on small farms to Rs. 28,904 on large farms. In case of non-sustainable farms the gross income was Rs. 28,367.50 on small farms, Rs.28,039.50 on large farms and Rs.28,243 for the sample as a whole.

Although gross income is a good measure to gauge the productivity and efficiency of the farm but it alone does not tell the success of the farm business. Hence net income was worked out to make the comparison among different farms. Higher the net income more success is the business and vice-versa. On an average, the net income was Rs.7,898.10 for the sample as a whole on sustainable farms. It was found that the sustainable small farmers obtained more net income(Rs.8,245.82) than large farms (Rs.7,553.54). The same trend persisted on non-sustainable farms. The net income declined from Rs.7,341.97 on small farms to Rs.6,624.70 on large farms and the same for the sample farms was 7,071.50.

Small farmers of sustainable farming realised a farm business income of Rs.18,180.16 per hectare followed by large farms with Rs.16,204.94 establishing an inverse relationship with the farm size. The same was Rs.17,036.15 on pooled farms.

The farm business income was Rs.16,809.63, Rs.15,141.26, and Rs.16,181.81 on non-sustainable small, large and pooled farms respectively.

Table 4.23 : Measures of farm income-paddy production (Rs./ha)

S.No.	Particulars	Sustainable			Non-sustainable		
		Small	Large	Pooled	Small	Large	pooled
1.	Gross income	29380.50	28904.00	29165.50	28367.50	28039.50	28243.00
2.	Farm business income	18180.16	16204.94	17036.15	16809.53	15141.26	16181.81
3.	Family labour income	10550.46	8886.56	9599.69	9285.65	7751.04	8708.09
4.	Net income	8245.82	7553.54	7898.10	7341.97	6624.70	7071.50
5.	Farm investment income	15875.52	14871.82	15334.56	14865.85	14014.92	14545.22
6.	Benefit-cost ratio	0.39	0.35	0.37	0.34	0.30	0.33

Fig.6a Measures of farm income-Paddy Sustainable

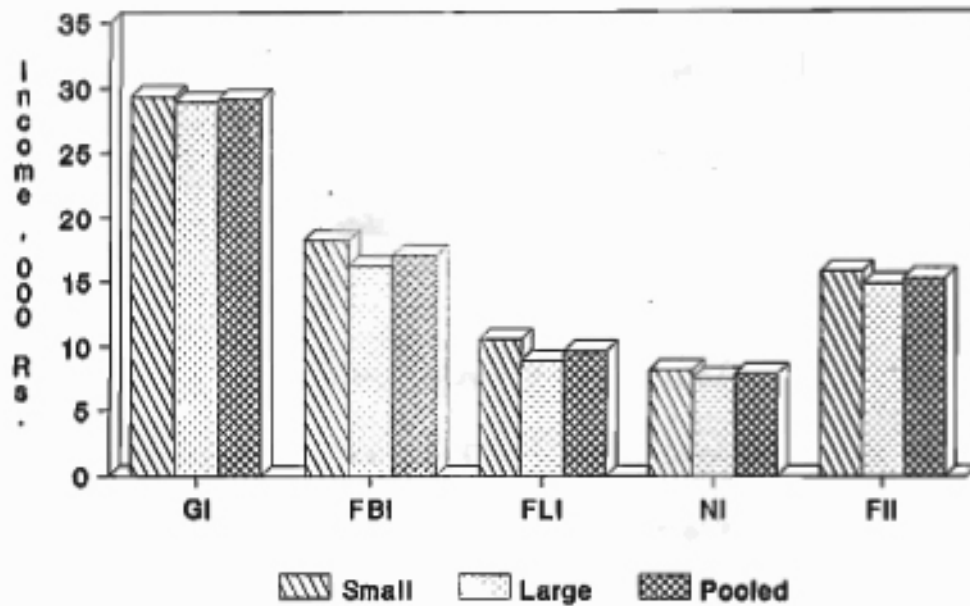
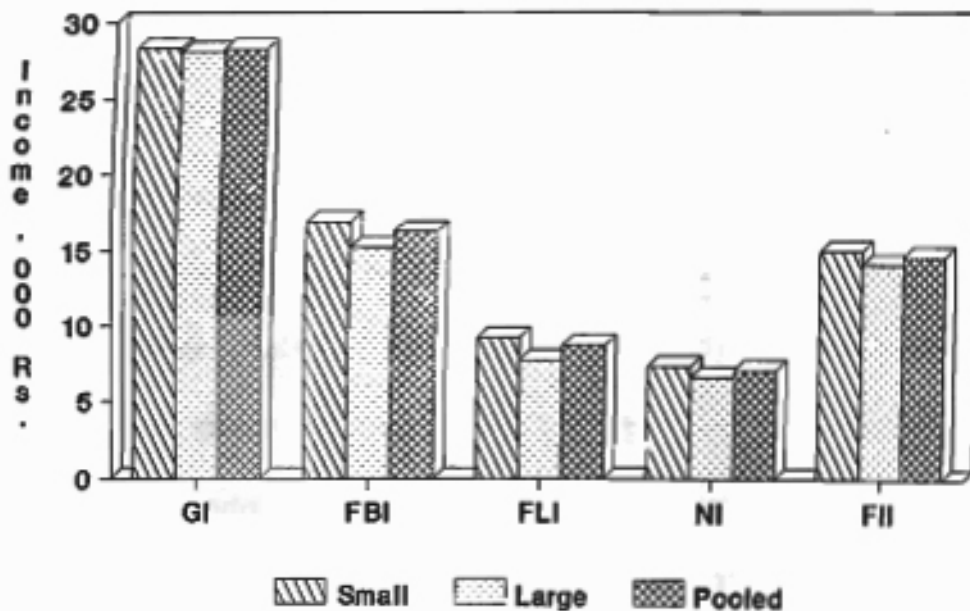


Fig.6b Measures of farm income-Paddy Non-sustainable



GI = Gross Income FBI = Farm Business Income
 FLI = Family labour income NI = Net income FII : Farm Investment Income

The family labour income received by small and large farmers of sustainable and non-sustainable farms was Rs.10,550.46 and Rs. 8,886.66 and Rs.9,285.65 and Rs.7,751.04 respectively establishing negative relationship with the farm size.

Farm invest income per hectare was of the order of Rs.15,875.52, Rs.14,871.82 and Rs.15,334.56 and Rs.14,865.85, Rs.14,014.92 and Rs.14,545.22 on small, large and pooled sustainable and non-sustainable farms.

Benefit-cost ratio indicates the returns for every rupee of investment and it was computed by dividing the net returns with Cost C. It is found that the benefit-cost ratio was negatively correlated with the farm size on sustainable and non-sustainable farms. It varied from 0.39 on sustainable small farms to 0.35 on large farms. For the sample as a whole, it was 0.37. On non-sustainable farms it was 0.34, 0.30 and 0.33 on small, large and pooled farms respectively. The measures of farm income of groundnut in sustainable and non-sustainable farms were graphically represented in Fig.6a,6b

An over view of the above analysis indicates that all income measures viz., gross income, net income, farm business income, family labour income and farm investment income exhibited inverse relationship with farm size on sustainable as well as non-sustainable farms in the production of groundnut and paddy. This implies that small farmers realised more returns for their overall investment, family labour use and fixed resources in the farm business. The returns per rupee of investment was higher on small farms than on large farms. All the income measures were higher on sustainable farms compared to non-sustainable farms.

4.5 RESOURCE PRODUCTIVITY

The goal of farmers in the organization of farm business is to maximise farm returns from the resources available with them. They make some adjustments in the allocation of their resources in order to operate the farm business at economic optimum level. The question that arises is whether the farmers belonging to different size groups respond equally to economic opportunities and make rational use of resources. Keeping this in view an attempt is made here to examine the factor product relationship and resource use efficiency in the production of groundnut and paddy. The multiple linear production function which gave the best fit was selected to establish the input output relationship. The regression coefficients of different inputs used in the production function were estimated separately for sustainable and non-sustainable farms and results are presented in Table 4.24.

4.5.1 Resource productivity in groundnut production

The results for sustainable farms revealed that out of the six independent variables included in the model, seeds (X_2) and machine labour (X_4) were positively significant at one per cent level whereas fertilizers (X_3), was positively significant at ten per cent level. On the other hand, the coefficients of variables like land (X_1), and manures (X_6) were positively related but found non-significant while human labour (X_5) had negative coefficient but non-significant. The regression coefficients of the production function indicate the response of output due to unit change in input. For example, one unit increase in seeds (X_2), fertilizers (X_3) and machine labour (X_4) would result in an increase of 0.0011, 0.00017 and 0.00016 units respectively in groundnut productivity. The coefficient

Table 4.24 : Regression coefficients of inputs of groundnut in sustainable and non-sustainable farms.

S.No.	Particulars	Variable	Regression coefficients	
			Sustainable	Non-sustainable
1.	Intercept		-0.0304	-0.0259
2.	Land in hectares	X ₁	0.27910	0.23401
3.	Expenditure on seeds (Rs.)	X ₂	0.00011**	0.00012**
4.	Expenditure on fertilizers (Rs.)	X ₃	0.00017*	0.00092*
5.	Expenditure on machine labour (Rs.)	X ₄	0.00016**	0.00017**
6.	Human labour per farm in mandays	X ₅	-0.0070	-0.0059
7.	Manures per farm in tonnes	X ₆	0.0034	0.0022
8.	Coefficient of multiple determination	R ²	0.9598	0.9399

* Significant at 10 per cent level

** Significant at 1 per cent level

of multiple determination (R^2) was 0.9598. This indicates that the variables included in the function explained about 95.98 per cent of variation in the production of groundnut.

In case of non-sustainable farms, the regression coefficients of seeds (X_2), machine labour (X_4) were positively significant at one per cent level whereas fertilizers (X_3), was positively significant at 10 per cent level. The results imply that one unit increase in seeds (X_2), fertilizers (X_3) and machine labour (X_4) above their respective mean levels would result in an increase of 0.00012, 0.00092 and 0.00017 units in the productivity when all other variables are kept constant. It was further found that the regression coefficient of land (X_1) was positively non-significant while the same in case of human labour was negatively non-significant and indicated that the change in the level of these inputs did not affect the production. The coefficient of multiple determination (R^2) was 0.9399. This would indicate good fit of multiple linear production function for the data and explained about 93.99 per cent of variation in the production of groundnut.

4.5.2 Resource productivity in paddy production.

It is apparent from Table 4.25 that the regression coefficients of bullock labour (X_4) and manures (X_6) were negatively significant at one per cent level whereas human labour (X_5) was negative and significant at 10 per cent level in sustainable farms. This means that one unit increase in the use of bullock labour (X_4), manures (X_6) and human labour (X_5) over their mean level, keeping others at constant, would be reducing yield by 0.0019, 0.0492 and 0.0328 units respectively. This suggested that the use of bullock labour, manures and human labour had to be reduced in order to overcome the negative effect. The coefficient of variables viz., land (X_1), seeds (X_2) and fertilizers (X_3) were positively

Table 4.25 : Regression coefficients of inputs of paddy in sustainable and non-sustainable farms.

S.No.	Particulars	Variable	Regression coefficients	
			Sustainable	Non-sustainable
1.	Intercept		-0.6309	-1.8261
2.	Land in hectares	X ₁	3.6312	-4.1036
3.	Expenditure on seeds (Rs.)	X ₂	0.0001	-0.0012
4.	Expenditure on fertilizers (Rs.)	X ₃	0.0071	0.0186
5.	Bullock labour in cattle pair days	X ₄	-0.0019**	-0.0018*
6.	Human labour per farm in mandays	X ₅	-0.0328*	-0.0021*
7.	Manures per farm in tonnes	X ₆	-0.0492**	-0.017*
8.	Coefficient of multiple determination	R ²	0.8607	0.9512

* Significant at 10 per cent level

** Significant at 1 per cent level

non-significant indicating that the change in the levels of these resources did not affect the productivity. The coefficient of multiple determination (R^2) was 0.8607 indicating that variables included in the function explained 86.07 per cent of variation in the yield of paddy on sustainable farms.

On non-sustainable farms too the production coefficients of bullock labour (X_4), human labour (X_5) and manures (X_6) were turned out to be negative and significant at 10 per cent level indicating that one unit increase in bullock labour (X_4), human labour (X_5) and manures (X_6) over their mean level would decrease yield by 0.0018 and 0.0021 and 0.0171 units respectively. The other variables land (X_1), seeds (X_2) and fertilizers (X_3) were positively related but found non-significant. The coefficient of multiple determination was 0.9512 indicating that variables included in the production functionaries explained 95.12 per cent of variation in the yields of paddy.

4.6 PATTERN OF INCOME DISTRIBUTION

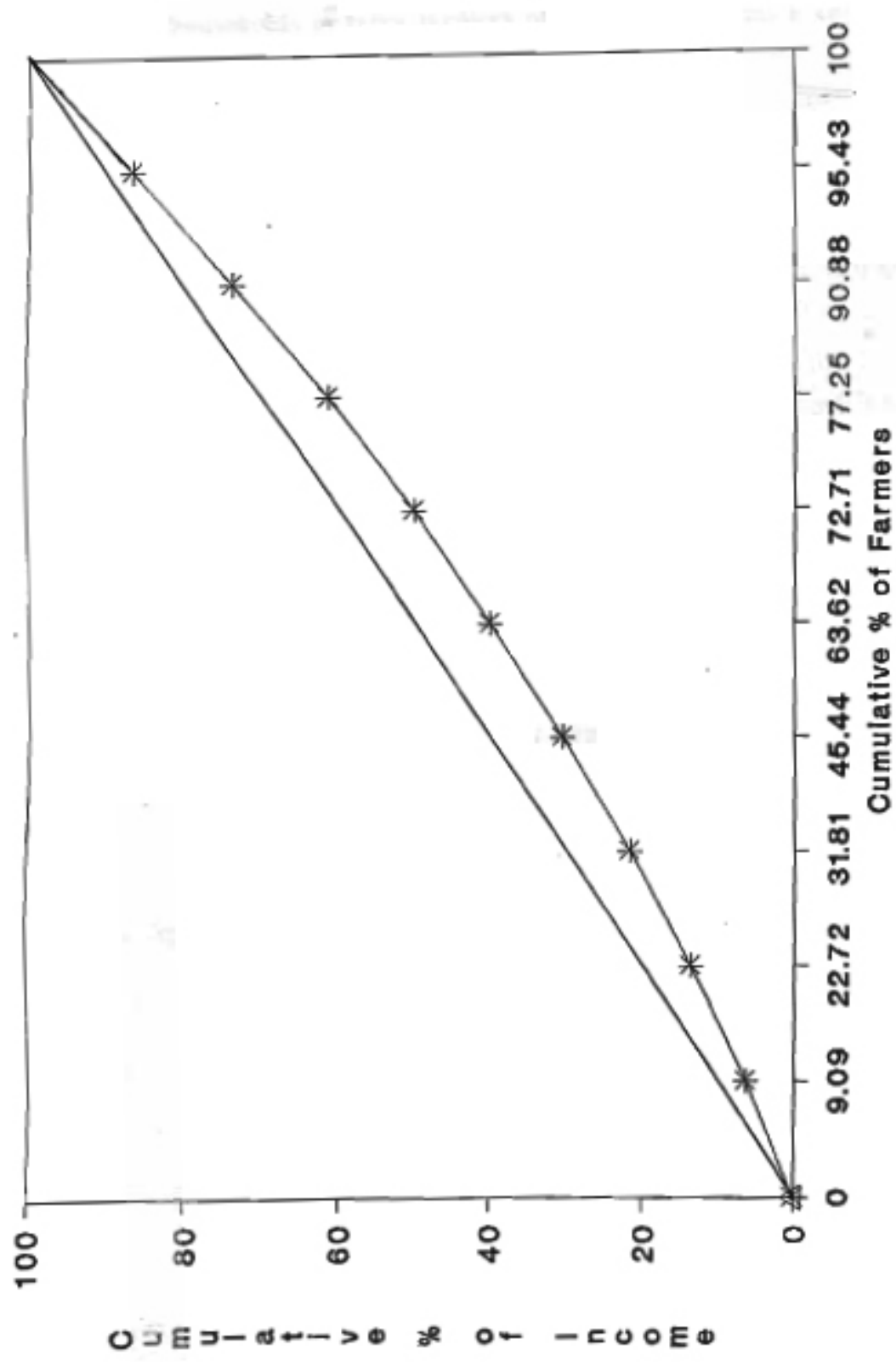
4.6.1 Distribution of households of small farmers of sustainable farms according to farm business income

Table 4.26 reveals that 45 per cent of household of small farmers accounted for an annual farm business income of less than Rs.20,000, shared 30.49 per cent of the total farm business income earned by the households. Similarly, on the highest side families earning between Rs.32,001 and Rs.34,000 accounted for by 4.6 per cent of the households and their share in the total income was 13.71 per cent. The maximum number of households had fallen in the income group of below Rs.24,000 with an average income of Rs.22,867.50 and their contribution to the total income was 9.5 per cent. The pattern of distribution of income is depicted through Lorenz curve (Fig. 7).

Table 4.26: Pattern of income distribution – Sustainable (small)

<i>Class interval</i>	Percentage of farmers	Percentage of aggregate income	Cumulative percentage of farmers	Cumulative percentage of income
14000-16000	9.09	6.19	9.09	6.19
16001-18000	13.64	7.30	22.72	13.49
18001-20000	9.09	8.10	31.81	21.59
20001-22000	13.64	8.90	45.44	30.49
22001-24000	18.18	9.50	63.62	39.99
24001-26000	9.09	10.08	72.71	50.07
26001-28000	4.54	11.19	77.25	61.25
28001-30000	13.64	12.03	90.88	73.28
30001-32000	4.55	12.99	95.43	86.27
32001-34000	4.55	13.71	100.00	100.00

Fig.7 Pattern of income distribution
- Sustainable (small)



4.6.2 Distribution of households of large farmers of sustainable farms according to farm business income.

The details of farm business income of the large farms are presented in (Table 4.27). Thirty three per cent of the households had an income of less than Rs.1,00,000 and their share in the income was 33 per cent. The maximum amount earned was in the range varying from Rs.1,00,000 – 1,10,000 and they claimed 14.62 per cent of the total income. The maximum number of households has fallen in Rs.1,00,000-1,10,000 and their share in the income being 14.62 per cent. The pattern of distribution of income is depicted through Lorenz curve (Fig.8).

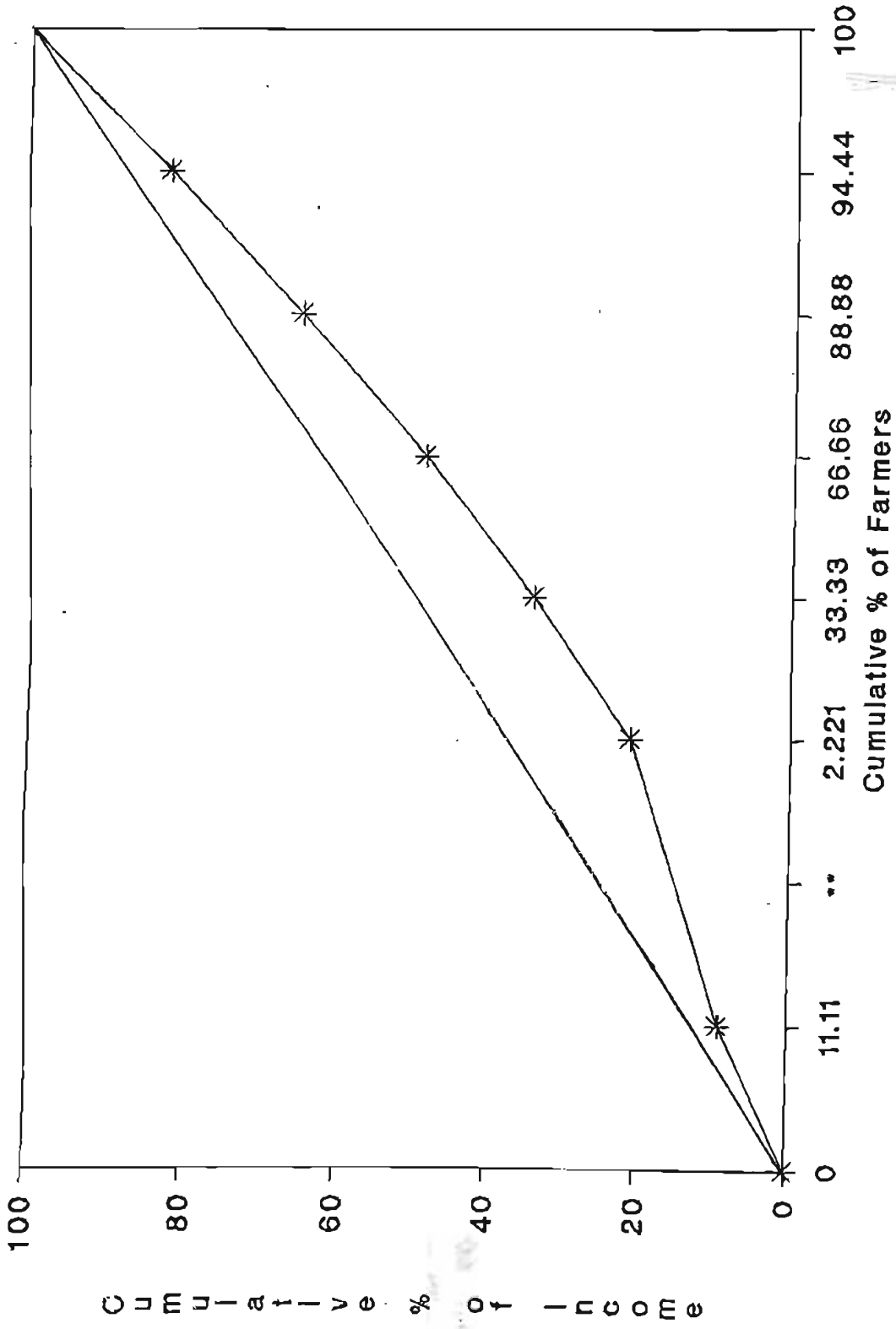
4.6.3 Distribution of households of small farmers of non-sustainable farms according to farm business income

The poorest among the small farmers' families, accounted for 4 per cent of the total household, and shared 4.64 per cent of the total income earned by the sample families (Table 4.28). Nearly 68 per cent of the households were within the income of Rs.21,000 and their share in the total income was 54.65 per cent. The maximum percentage of households had fallen in the income range of Rs.15,001-17,000 and their share in the total income earned was 9.96 per cent with an average income of Rs.16,107.48. The pattern of distribution of income is depicted through Lorenz curve (Fig.9).

Table 4.27 : Pattern of income distribution – Sustainable (large)

Class interval	Percentage of farmers	Percentage of aggregate income	Cumulative percentage of farmers	Cumulative percentage of income
60000-70000	11.11	9.07	11.11	9.07
70001-80000	0.00	0.00	0.00	0.00
80001-90000	11.11	12.02	22.22	21.09
90001-100000	11.11	13.08	33.33	34.17
100001-110000	33.33	14.62	66.66	48.79
110001-120000	22.22	15.88	88.88	64.67
120001-130000	5.56	16.97	94.44	81.64
130001-140000	5.56	18.35	100.00	100.00

Fig.8 Pattern of income distribution
- Sustainable (large)



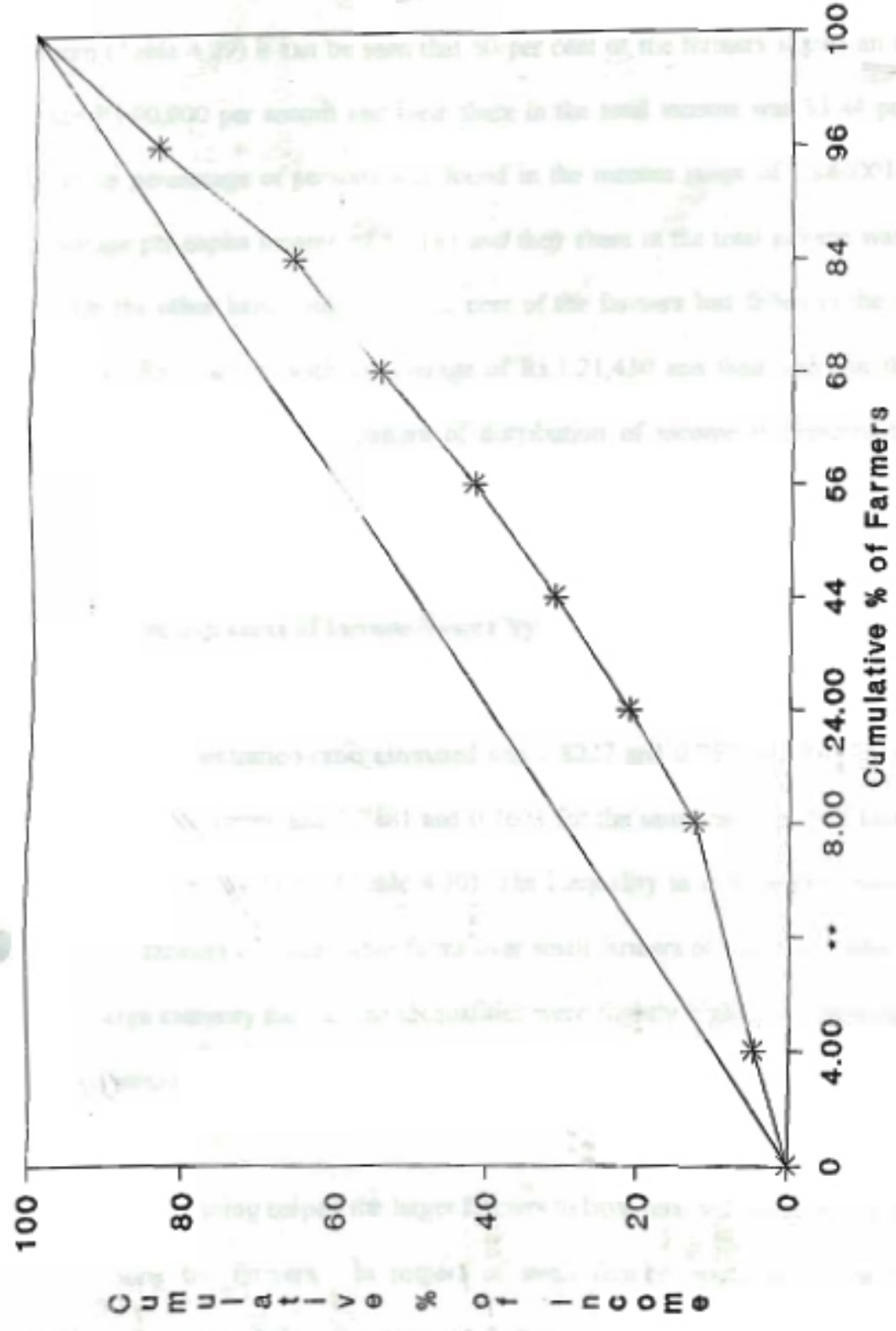
** 70001-80000 value = 0

Table 4.28: Pattern of income distribution – non-sustainable (small)

Class interval	Percentage of farmers	Percentage of aggregate income	Cumulative percentage of farmers	Cumulative percentage of income
7000-9000	4.00	4.64	4.00	4.64
9001-11000	0.00	0.00	0.00	0.00
11001-13000	4.00	7.79	8.00	12.43
13001-15000	16.00	8.84	24.00	21.27
15001-17000	20.00	9.96	44.00	31.23
17001-19000	12.00	10.90	56.00	42.13
19001-21000	12.00	12.52	68.00	54.65
21001-23000	16.00	13.82	84.00	65.47
23001-25000	12.00	15.23	96.00	83.70
25001-27000	4.00	16.27	100.00	100.00

number of households of large farmers of non-sustainable farms according to income.

Fig.9 Pattern of income distribution - non-sustainable (small)



-- 9001-11000 value = 0

4.6.4 Distribution of households of large farmers of non-sustainable farms according to farm business income.

From (Table 4.29) it can be seen that 60 per cent of the farmers shared an income of less than Rs.90,000 per annum and their share in the total income was 33.44 per cent. The maximum percentage of persons was found in the income range of Rs.80001-90000 with an average per capita income of 85,183 and their share in the total income was 13.03 per cent. On the other hand, only 6.67 per cent of the farmers had fallen in the income group of above Rs.1,20,000 with an average of Rs.1,21,430 and their share in the total income was 18.58 per cent. The pattern of distribution of income is depicted through Lorenz curve (Fig.10).

4.6.5 Quantitative measures of income inequality

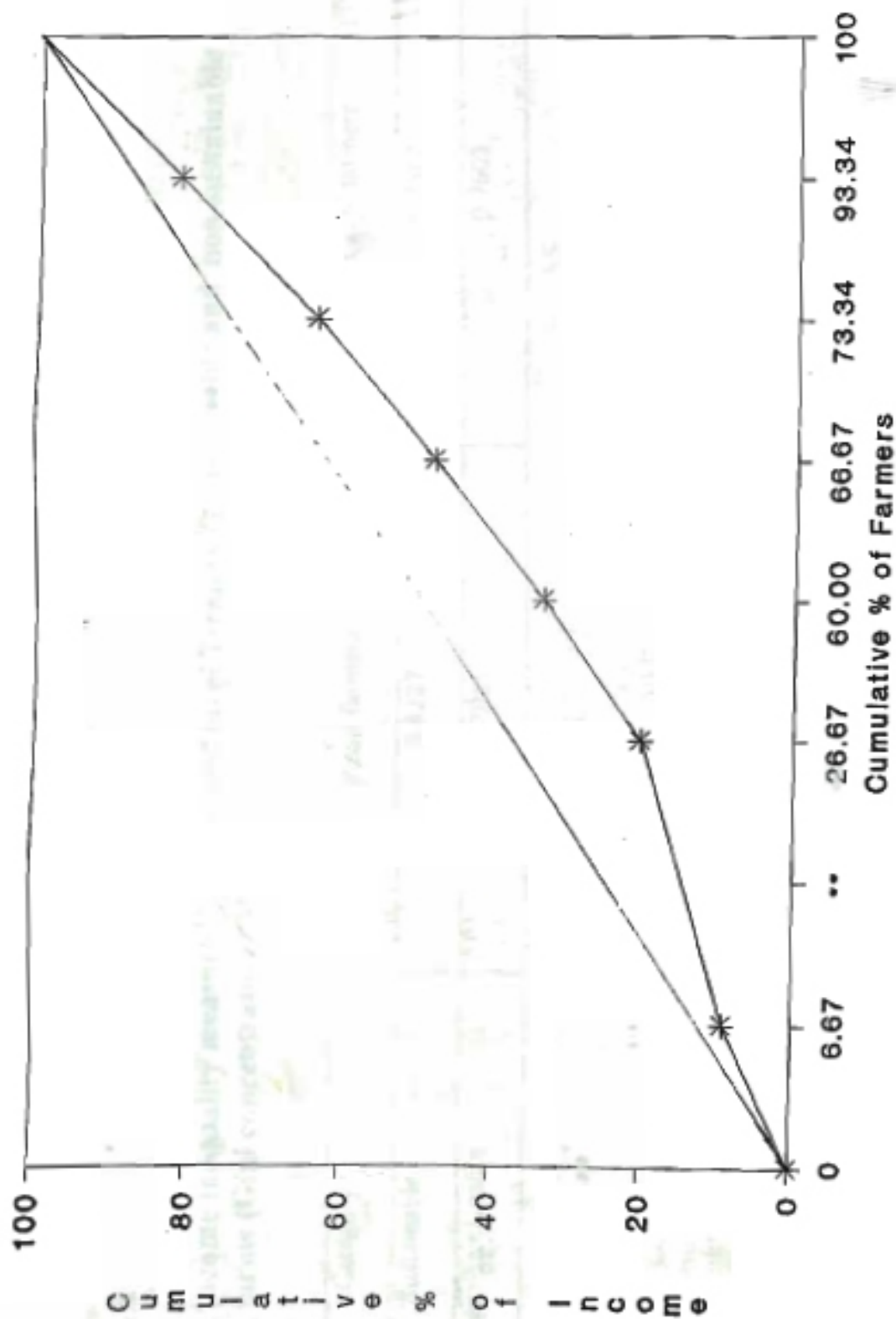
The Gini concentration ratio estimated was 0.8227 and 0.7507 for small and large farmers of sustainable farms and 0.7881 and 0.7603 for the same categories of farmers in respect of non-sustainable farms (Table 4.30). The inequality in income distribution was greater for small farmers of sustainable farms over small farmers of non-sustainable farms. In respect of large category the income inequalities were slightly higher on non-sustainable farms over sustainable farms.

Sustainable farming helped the larger farmers to have relatively reduced the income distribution among the farmers. In respect of small farmers sustainable farming had accentuated, the income imbalances among the farmers.

Table 4.29: Pattern of income distribution – non-sustainable (large)

Class interval	Percentage of farmers	Percentage of aggregate income	Cumulative percentage of farmers	Cumulative percentage of income
50000-60000	6.67	8.99	6.67	8.99
60001-70000	0.00	0.00	0.00	0.00
70001-80000	20.00	11.42	26.67	20.41
80001-90000	33.33	13.03	60.00	33.44
90001-100000	6.67	14.74	66.67	48.18
100001-110000	6.67	15.58	73.34	63.16
110001-120000	20.00	17.65	93.34	81.41
120001-130000	6.67	18.58	100.00	100.00

Fig.10 Pattern of income distribution
- non-sustainable (large)



** 60001-70000 value = 0

Table 4.30: Income inequality measure for small and large farmers of sustainable and non-sustainable farms (Gini concentration ratio)

Category	Small farmers	Large farmers
Sustainable	0.8227	0.7507
Non-sustainable	0.7881	0.7603

4.7 OPINION SURVEY

An opinion survey was carried out for the sample of 80 farmers regarding the adoption of methods of sustainable agriculture and problems associated with the sustainable agriculture. The details are presented in Table 4.31 and each item in the opinion survey is assessed in terms of the percentage to sample farmers.

About 83 per cent of the farmer opined that increased income was the main reason for adopting intercropping. Nearly 38 per cent of farmers felt that intercropping would result in higher production and stabilization of yields. Maintenance of soil fertility and additional employment were the main advantages of intercropping as expressed by 7.50 and 12.50 per cent of the sample farmers respectively. The most important problem in the adoption of intercropping was shortage of labour (50 per cent) followed by reduction in yields (35 per cent) and non-availability of seeds (17.50 per cent).

70 per cent of the respondents stated that the growing of trees on farms provide raw material for implements. About 53 per cent of the sample farmers felt that trees on farms provide fodder for livestock. Nearly 37 per cent of the respondents preferred to grow trees on their farms for green manuring. According to 15 per cent of the farmers growing of trees on farms add organic matter. Reduction in productivity was the main reason for not growing trees on farms as expressed by 42.50 per cent of the respondents. Bird menace and increased pest incidence were the other reasons expressed by 17.50 and 15 per cent of the farmers.

Table 4.31 : Opinion survey

S.No.	Particulars	Percentage to the total respondents
1.	Reasons for changes in intercropping	
	a. Increased income	82.50
	b. Higher production	37.50
	c. Maintenance of soil fertility	7.50
	d. Yield stabilization	37.50
	e. Additional employment	12.50
	Problems associated with intercropping	
	a. Shortage of labour	50.00
	b. Non-availability of seed material	17.50
	c. Reduction in yields	35.50
2.	Merits of growing trees on farms	
	a. Green leaf manure	37.50
	b. Fodder for livestock	52.50
	c. Raw material for implements	70.00
	d. Added organic matter	15.00
	Indicate reasons for not raising trees on farm	
	a. Reduction in productivity	42.50
	b. Increased pest incidence	15.00
	c. Possible bird menace	17.50
3.	Reason for increased use of pesticides	
	a. Increased awareness	17.50
	b. Quick response	32.50
	c. Labour saving	15.00
	d. Easy handling	55.50
	e. Easy availability	57.50
	f. Stabilizes income	10.00

Contd.. Table 4.31

4.	Reasons for decrease in the livestock population	
	a. High maintenance cost	80.50
	b. Shortage in the grazing lands	90.00
	c. Shortage of labour	65.50
	d. Slow turn over of important items of field work	22.50
5.	Reasons for decrease in the use of organic manure	
	a. Decline in cattle population	87.50
	b. Non-availability of labour in time	27.50
	c. Availability of chemical fertilizers	82.50
6.	Reasons for increase in the use of fertilizers	
	a. Higher productivity	35.00
	b. Non-availability of organic manures	85.00
	c. Government subsidies	15.00
7.	Reasons for non-adoption of practices of sustainable farming	
	a. Improved technology	32.50
	b. Increased income	10.00
	c. Labour shortage	25.00
	d. Difficulty in the availability of productive inputs	50.00
	e. Awareness of modern practices	32.50
8.	Long term process	22.50

About 68 per cent of the respondents pointed that the availability was the main reason for increased use of pesticides. In addition to this easy handling quick response and awareness were the other reasons for the increased use of pesticides as felt by 56 per cent, 33 per cent and 18 per cent of the respondents respectively.

90 per cent of the farmers expressed that shortage in the grazing lands was the most important reason for decrease in the livestock population. About 81 and 66 per cent of farmers felt that increased maintenance cost and shortage of labour respectively were main reasons for decline in the livestock population.

Decline in the cattle population, availability of chemical fertilizers and non availability of labour in time for transportation and application were the reasons for the decline in the use of organic manures as reported by 87.50, 82.50 and 27.50 per cent of the respondents respectively.

Non-availability of organic manure was the main reason for increased use of fertilizers according to 85 per cent of the respondents. Higher productivity was another reason cited, by 35 per cent of the respondents. About 15 per cent of the farmers felt that provision of subsidy was the reason for increased fertilizer use.

Inspite of many benefits from the adoption of methods of sustainable agriculture, farmers expressed some problems associated with sustainable agriculture. Half of the respondents felt that non-availability of productive input was the main reason for not adopting the practices that helps in sustainable farming. Awareness of modern practices

and improved technology were the other reason reported by 33 per cent of the farmers. Sustainability was a long term process for about 23 per cent of the respondents 25 per cent of the respondents reported that shortage of labour was a bottleneck in the practice of sustainable farming.

*Summary and
Conclusions*

CHAPTER-V

SUMMARY AND CONCLUSIONS

Land, water, climate, flora and fauna are the basic natural resources for agricultural development which are subject to various deteriorating influences. Since agricultural development cannot sustain on a deteriorating natural resource base, it is imperative to develop strategies for conservation and improvement of resources. The concept of sustainable resource management implies that the needs of the present can be met without compromising the ability of the resources to meet the needs of the future. In the past in view of the over riding concern for ensuring food security and meeting other vital requirements of the large and rapidly growing population, the pursuit of research was directed towards utilization of resources to derive maximum benefits. There is now recognition that truly productive agriculture must have long term sustainability by way of sustenance of natural resources, economic viability and social acceptability of production systems and protection of environment.

The present study entitled "An economic study of influencing factors of sustainable agriculture in rainfed area of Anantapur district was aimed at identifying the indicators of sustainability and comparing the costs and returns from sustainable and non-sustainable farms.

5.1 THE OBJECTIVES OF THE STUDY

1. To identify and evaluate the indicators of sustainability
2. To compare the costs and returns of sustainable and non-sustainable farms and
3. To identify constraints of adopting strategies of sustainability and suggest ameliorative measures.

The study was carried out in Anantapur district as it recorded first in the area under rainfed crops among the four districts of Rayalaseema region in Andhra Pradesh. Two mandals namely Kadiri and Tanakallu exhibiting greater variation in rainfall were selected. Two villages from each mandal were selected on the basis of rainfed area of important crops. Twenty farmers from each of the village were randomly selected thereby marking the size of the sample to 80. The sample farmers were stratified in to two categories viz., sustainable and non-sustainable and again into two size groups in each category i.e., small and large. The primary data were collected by survey method through well structured schedules for the agricultural year 1997-1998. The data were analysed by using conventional and functional analyses to fulfil the objectives of the study.

The average size of the holding for the sample as a whole in case of sustainable farms was 8.51 hectares as against 4.83 hectares of non-sustainable farms. The size of the farm was more on sustainable farms compared to non-sustainable farms. The irrigated land accounted for 43.13 and 32.71 per cent of the total land holding on sustainable and non-sustainable farms respectively. The average size of dry land was 4.84 hectares (57.87 per cent) on sustainable as against 3.25 hectares (67.29 per cent) on non-sustainable farms.

The family composition revealed that the average size of the family was 5.00, 6.55 and 5.69 members in the case of small, large and pooled sustainable farms respectively, while the same was 7.05, 5.83 and 6.79 members on non-sustainable farms in that order. The number of male, female and children was more in case of sustainable and non-sustainable large farms compared to small farms. The participation of family members in the farm work showed inverse relationship with the size of the land holding.

The per hectare value of assets was highest (Rs.2,00,325.30) on small farms and lowest (Rs.1,93,556.30) on large sustainable farms. The same ranged from Rs.2,05,231.89 on small non-sustainable farms to Rs.1,97,553.50 on large farms exhibiting inverse relationship between value of assets and the farm size. The results also showed that investment on productive assets viz., wells, machinery, implements and livestock showed negative relationship with the size of land holding.

The cropping pattern of sustainable and non-sustainable farms indicated that groundnut, the most of important crop in the study area occupied 57.14 and 86.18 per cent of the dry land on small and large sustainable farms as against 100 per cent and 82 per cent on small and large non-sustainable farms. Mulberry occupied 55 and 38.68 per cent followed by 13.63 and 10.30 per cent of total kharif irrigated land on small and large sustainable farms respectively. On non-sustainable farms, paddy and mulberry occupied 32 and 20 and 13.95 and 34.88 per cent of the total kharif irrigated land of small and large farms respectively.

Intercropping, crop rotation, agro-forestry, integrated pest management and integrated nutrient management were identified as indicators of sustainability.

Groundnut cultivation required 65.94 and 60.18 mandays per hectare on sustainable and non-sustainable farms. The same in case of paddy production was 172.99 and 170.31 mandays respectively. The labour absorption was marginally higher on sustainable farms compared to non-sustainable farms. Out of all the operations, weeding, harvesting, sowing or transplanting, threshing and stripping, irrigation (paddy) turned out to be the major

operations that consumed 85 per cent of the labour. The percentage of hired labour use in both the crops of different size groups on sustainable and non-sustainable farms was more than the proportionate family labour involvement.

The cattle labour use exhibited inverse relationship with the farm size in groundnut and paddy cultivation. On the other hand, machinery use showed direct relationship with the size of the holding reflecting mechanization of farm operations on large farms. Small sustainable and non-sustainable farms used more cattle labour than that of large farms.

On an average the cost of cultivation of groundnut and paddy worked out to Rs.12,735.27 and Rs.21,267.40 per hectare respectively on sustainable farms, whereas the same was Rs.12,228.14 and Rs.21,171.50 per hectare respectively on non-sustainable farms. The cost of cultivation of paddy was higher than that of groundnut. The total costs were higher on sustainable farms compared to non-sustainable farms.

The share of operational and fixed costs were in the ratio of 66:34 in case of groundnut and 60:40 in paddy production. Among the variable costs, seed, manures and fertilizers were the major items of expenditure in groundnut production whereas human labour, fertilizers, bullock labour and plant protection chemicals were the important cost components of paddy cultivation. In both the crops, rental value of owned land turned out to be the major component of fixed cost.

On an average, sustainable farms produced 11.55 quintals of groundnut and 46.48 quintals of paddy as against 10.25 and 45.31 quintals per hectare of groundnut and paddy on non-sustainable farms. The productivity of groundnut and paddy was negatively related

with the farm size on sustainable and non-sustainable farms. The productivity of both the crops was higher on sustainable than that of non-sustainable farms.

The findings of the study indicated that the samples farmers incurred Rs.1,078.15 and Rs.457.56 and Rs.1,161 and Rs.467.24 per quintal of groundnut and paddy on sustainable and non-sustainable farms respectively. The cost of producing a quintal of groundnut and paddy was higher on large farms than on small farms. The cost of production of both the crops was higher on non-sustainable farms compared to sustainable farms.

Cost B and Cost C exhibited inverse relationship with the size of holding in the production of groundnut but in the case of paddy cultivation, cost A₁/A₂, cost B and cost C showed direct relationship with the farm size.

The average gross returns per hectare of groundnut and paddy on sustainable and non-sustainable farms were Rs.15,631.63 and Rs.29,165.50 and Rs.14,218.13 and Rs.28,243 respectively.

Net income from groundnut production declined from 3,394.73 per hectare on small farms to Rs.2,664.88 on large sustainable farms. On non-sustainable farms too, the net income decreased from Rs.1,982.04 on small farms to Rs.1892.93 on large farms.

On an average, small, large and pooled sustainable farms realised a gross income of Rs.29,380.50, Rs.28,904 and Rs.29,165.50 per hectare respectively from paddy production. In case of non-sustainable farms the gross income was Rs.28,367.50 on small farms, Rs.28,039.50 on large farms and Rs.28,243 for the sample as a whole.

The farm business analysis revealed that all income measures viz., gross income, net income, farm business income, family labour income and farm investment income exhibited inverse relationship with the farm size on sustainable and non-sustainable farms in the production of groundnut and paddy.

The benefit cost ratio of groundnut and paddy of sustainable and non-sustainable farms were 0.26 and 0.37 and 0.16 and 0.33 respectively.

The resource productivity in groundnut cultivation on sustainable and non-sustainable farms revealed that seed (X₂), machine labour (X₄) and fertilizers (X₃) were positively significant. The regression coefficients of variables like land (X₁) and manures (X₆) were positively related but found non-significant on sustainable farms.

In case of paddy production, on sustainable and non-sustainable farms, bullock labour (X₄), human labour (X₅) and manures (X₆) were turned out to be negative and significant. The other variables like land (X₁), seeds, (X₂) and fertilizers (X₃) were positive but non-significant.

The Gini concentration ratio estimated was 0.8227 and 0.7507 for small and large farmers of sustainable farms and 0.7881, 0.7603 for the same categories of farmers in respect of non-sustainable farms. The inequality in income distribution was greater for small farmers of sustainable farms over small farmers of non-sustainable farms. In respect of large category, the income inequalities were slightly higher on non-sustainable farms over sustainable farms.

About 83 per cent of farmer opined that increased income was the main reason for adopting intercropping. Shortage of labour was an important problem in adopting intercropping as reported by fifty per cent of the respondents. Majority of the respondents stated that growing of trees on farms provide raw materials for implements, fodder for livestock and green manuring. Availability, easy handling and quick response were the main reasons for increased use of pesticides. Decline in cattle population and availability of chemical fertilizers were the two important reasons for decline in the use of organic manures. Non-availability of productive inputs, awareness of modern practices and improved technology were the reasons for non-adoption of methods of sustainable agriculture.

5.2 CONCLUSIONS

1. The average size of land holding was more on sustainable farms than on non-sustainable farms.
2. The family size was positively related with the size of holding on sustainable and non-sustainable farms. However, the participation of family members on the farm showed inverse relationship with the size of the farm. The average size of the family was more on non-sustainable farms.
3. Sample farms exhibited indirect relationship between the value of assets and farm size. The value of assets was marginally higher on both the size groups of non-sustainable than that of sustainable farms.
4. Intercropping, crop rotation, agro-forestry, integrated pest management and integrated nutrient management were the indicators of sustainability.

5. The labour utilisation was marginally higher on sustainable farms compared to non-sustainable farms. Family labour use exhibited inverse relationship with the farm size. The percentage of hired labour employment in groundnut and paddy cultivation on different size groups of sustainable and non-sustainable farms was more than the proportionate family labour use.
6. Cattle labour use is negatively related with the farm size while the opposite was true in case of machinery use. Small sustainable and non-sustainable farms used more cattle labour than large sustainable and non-sustainable farms. Machinery use was positively related with the farm size.
7. Total costs in the production of groundnut and paddy were higher on sustainable farms compared to non-sustainable farms. Cost of cultivation of groundnut was negatively related whereas paddy production was directly related with the size of the holding.
8. Productivity of groundnut and paddy was higher on sustainable over non-sustainable farms. Productivity was inversely related with the farm size.
9. Unit cost of production was directly related with the size of holding on sustainable and non-sustainable farms. The unit cost of production of both the crops was more on non-sustainable farms compared to sustainable farms.
10. All the income measures viz., gross income, net income, farm business income, family labour income and net income were higher on sustainable farms compared to non-sustainable farms.
11. The net returns per rupee of investment was inversely related with the farm size. The benefit-cost ratio in the cultivation of groundnut and paddy was higher on sustainable farms than on non-sustainable farms. Paddy producers of sustainable and non-sustainable farms earned more net returns per rupee of investment compared to the producers of groundnut crop.

- 12. The functional analysis indicated positive impact of **seeds, machine labour and fertilizer** on groundnut yields. On the other head, **bullock labour, human labour and manures** had negative impact on paddy production.
- 13. The inequality in income distribution was greater for small farmers of **sustainable farms** over small farmers of **non-sustainable farms**. In respect of large category, the income inequalities were slightly higher on **non-sustainable farms over sustainable farms**.
- 14. **Non-availability of productive resources, awareness of modern practices and improved technology** were the important reasons for non-adoption of methods of **sustainable agriculture**.

The main factors that are instrumental in achieving the objectives of **sustainable agricultural development** are (a) literacy (b) market forces (c) technologies (d) institutional changes in terms of agrarian reforms. Achieving full literacy would go a long way in bringing awareness with regard to **environment and other aspects which are linked with sustainable agriculture**. Another potential area that needs much concentration is the development of **environment friendly and economically viable technologies**.

LITERATURE CITED

- Ahmed S and Prasad N K 1996 Sustainable intercrop association of little millet with groundnut and pigeonpea. *Indian Journal of Agronomy* 41(3): 354-358.
- Alshi M R and Joshi C K 1993 A study on profitability and causes of low yield of summer groundnut in Akola district, Maharashtra. *Indian Journal of Agricultural Economics* 48(3): 447.
- Bali S V, Badhoria B S and Singh H 1998 Integrated nutrient management for crop production in dry land areas of Jammu and Kashmir. National symposium on recent advances in dry land agriculture, Hyderabad Abstracts; 28.
- Beltagy A, Handi Y and Hussein A 1997 Dryland farming research in Egypt. Strategies for developing a more sustainable agriculture. *American Journal of Alternative Agriculture* 12(3): 124-129.
- Chandrakar M R and Koshtar A K 1998 A comparative economics of energy utilization in rice cultivation under irrigated and rainfed farming. *Indian Journal of Agricultural Economics* 53(3): 294.
- Chowdary K R, Krishna Rao G V and Vasudev N 1993 Yield gaps in groundnut crop A case study of Anantapur district in Andhra Pradesh. *Indian Journal of Agricultural Economics* 48(3): 381.
- Conway Gordon R, Jennifer A, Mc Cracken and Jules N Pretty 1987 Training notes for agrosystem analysis and rapid rural appraisal. International Institute of Environment and Development, London.
- Devidayal and Reddy P S 1991 Intercropping of rainfed groundnut with annual oil seed crops under different planting patterns. *Indian Journal of Agricultural Sciences* 61(2): 299-302.

Dhoble M V, Bhosle B R and Khating E A 1990 Studies on comparative performance of different intercropping systems under dryland conditions. Indian Journal of Agronomy 35(4): 346-352.

Dilipkumar majumdar 1994 Nutrients and water management for sustainable agriculture and environment. Agricultural Situation in India : 242.

Dubey P P and Sene 1994 An alternative system for sustainability of Indian agriculture, a case study of eastern Uttar Pradesh. Economic Affairs 39(3): 185-192.

Dubey S K, Sharma R S and Vishwakarma S K 1997 Integrated nutrient management for sustainable productivity of important cropping systems in Madhya Pradesh. Indian Journal of Agronomy 42(1): 13-17.

Elswaify S A, Walker T S and Virmani S M 1983 Dryland management alternatives and research needs for alfisols in the semi-arid tropics. International Crop Research Institute for the Semi-arid Tropics 349.

Fenster G R 1989 Fifty years of tillage practices for winter wheat Proceedings of the International Conference on Dryland Farming. Texas A & M University Press College Station, Texas.

Fussell L K and Seratini P G 1985 Crop associations in semi arid tropics of West Africa. Research strategies present and future; 218-235.

George P S 1994 Management of renewable natural resources-sustainability of agriculture. Indian Journal of Agricultural Economics 49(1): 42.

Goldstein W A and Young D L 1987 An agronomic and economic comparison of a conventional and a low input cropping system in the palouse. American Journal of Alternative Agriculture 2(2): 51-56.

- Hesterman O B and Thorburn T L 1994 A comprehensive approach to sustainable agriculture. W.K. Kellogg's Integrated Farming Systems. Initiative Journal of Production Agriculture 7: 132.
- Jadhav K L, Thakane G G and Wadkar S S 1993 Resource productivity in summer groundnut production in Sindhudurg district of Maharashtra. Indian Journal of Agricultural Economics 48 (3): 401.
- Jain S K and Idnani N L 1996 Resource productivity and sustainability of rainfed paddy in Madhya Pradesh. Agricultural Situation in India 15(8): 571.
- Jodha NS 1991 Sustainable agriculture in fragile resource zones: Technological Imperatives. Economic and Political Weekly. 26(13): 15-26
- Karam Singh, Balkarsingh Dhillon and Nirmal Singh 1996 Improving productivity and sustainability of natural resources in an under developed region. Agricultural Situation In India. 24-25.
- Katar Singh 1999 Sustainable development, Some reflections. Indian Journal of Agricultural Economics 54 (1): 12-13.
- Kathmale D K, Patil R C and Mulik B B 1995 Effect of intercropping of various oil seeds and pulses in groundnut on yield and economics in western plain zone of Maharashtra. Journal of Oil Seeds Research 12(2): 232-234.
- Lerohl M L 1991 The sustainability of selected prairie crop rotations. Canadian Journal of Agricultural Economics 39(4): 667.
- Mc Dicken K G 1981 Leucaena as a fallow improvement crop A first approximation paper presented at EWC workshop on environmentally sustainable agro-forestry and fuel wood production with fast growing, nitrogen fixing, multipurpose legumes. East West Centre, Honolulu, November.

Madden P 1987 Can sustainable agriculture be profitable? Environment 29(4): 18-20.

Malik R P S 1994 Public policy and sustainable agricultural development - A natural resource accounting approach Indian Journal of Agricultural Economics 49(4): 570-572.

Mei F Q 1992 Sustainable agriculture and Chinese agricultural development with sustainability. Chinese Rural Economy 5: 7-20.

Mishra S K 1994 Economics of fertilizer. Sustainable growth of Agriculture in India. 31-47.

Mulik S P, Ghadge H C, Jadhav A S and Patil S K 1996 Sustainability of rainy season cropping systems under dry land conditions of vertisols. Indian Journal of Agronomy 41(3): 359-363.

Mulik S P, More S M, Deshpande S S and Patil J D 1993 Intercropping for better stability in crop production in dryland watersheds. Indian Journal of Agronomy 38(4): 527-530.

Nadagouda V B, Desai B K, Manjappa K and Palled Y B 1993 Performance of rabi/summer groundnut in an agro-forestry system as influenced by management of eucalyptus tree rows. Journal of Oil Seed Research 10(2); 261-263.

Nadkarni M V 1993 Sustainable development concept and issues with reference to agriculture. Indian Journal of Agricultural Economics 48(3): 516.

Napier T L, Krecek J, Rajwar G S and Haigh M J 1996. Socio economic and institutional constraints on the adoption of soil conservation practices in USA, Implications for sustainable agriculture hydrological problems and environmental management in high lands and head waters; 185-196.

Okigbo R N, Edwards O A, Lal R and Madden P 1990 Sustainable agricultural systems in tropical Africa. *Sustainable Agricultural Systems*. 323-352.

Patil A J and Kulkarni S D 1988 Effect of organic recycling of subabul on yield, nutrient uptake and moisture utilisation by rabi sorghum. *National symposium on recent advances in dryland agriculture, Hyderabad Abstracts* 30-31.

Parikh K, and Ghosh U 1991 Natural resources accounting for soils towards an empirical estimate of costs of soil degradation for India. *Indira Gandhi Institute of Development Research Bombay*. 40-48.

Pichot J, Sedogo M P, Poulain J F and Arrivets J 1981 Evolution de la fertilité d un sol ferrugineux tropical sous influence des fumures minérales et organiques. *Agronomy of Tropics* 36: 122-133.

Pradhan B K and Mandal S S 1997 Integrated nutrient management for sustaining productivity and fertility building of soil under rice based cropping system. *Indian Journal of Agricultural Sciences* 67(7): 307-310.

Rafey A and Prasad N K 1996 Competition functions and economic viability of intercropping of sorghum and blackgram in drylands. *Indian Journal of Agronomy* 41(4); 523.

Rajput A M, Verma A R and Kailash Magar 1998 Economics of energy use of groundnut production in Khargone district of Madhya Pradesh. *Indian Journal of Agricultural Economics* 53(3): 280.

Rangaswamy A, Venkataswamy R, Premsekhar M and Palaniappan S P 1992 Sustainable agriculture for rice based ecosystem. *Indian Journal of Agronomy* 37(2): 215-219.

Rao M R and Willey R W 1980 Preliminary studies on intercropping combinations based on pigeonpea or sorghum. *Experimental Agriculture* 16(3): 29-39

- Ratna Reddy V 1995 Environment and sustainable agricultural development conflicts and contradictions. *Economic and Political Weekly* 30(12): 23.
- Reganold J P, Papendick R T and Parr J F 1990 Sustainable agriculture. *Scientific American* In Press : 20
- Samui R C and Roy A 1990 Possibilities of increasing production of oil seeds through intercropping system. *Journal of Oil Seed Research* 7: 14-21.
- Selvam V S and Soundararajan M S 1991 Intercropping groundnut with short and long duration red gram in drylands. *Indian Journal of Agronomy*. 36(4): 541-544.
- Singh Y, Choudhary P C, Singh S P, Bhardwaj A K and Dheer singh 1996 Sustainability of rice-wheat sequential cropping through introduction of legume crops and green manure crop in the system. *Indian Journal of Agronomy* 41(4): 510-514
- Singh R P and Jha D 1984 Stability of sorghum based intercropping systems under rainfed conditions. *Indian Journal of Agronomy* 29(4): 101-106.
- Stockle D, Papendick R T, Saxton K F and Campbell G S 1994 A frame work for evaluating the sustainability of agricultural production systems. *American Journal of Alternative Agriculture* 9(1-2): 45-51.
- Subbarama Raju K, Veera Reddy N and Damoder Reddy D 1987 Resource use efficiency in groundnut production. A case study in Mahaboobnagar district of Andhra Pradesh. *The Andhra Agricultural Journal* 34(3): 252-255.
- Swaminathan M S 1988 Sustainable food and nutrition security for the 1990's. *Agricultural Situation in India* 23(5): 363-367.
- Swindae L D 1990 Research on sustainability in the International Agricultural Research Centres. *Sustainable Agriculture* 1(3): 11.

Thirupathaiah G and Naidu M R 1993 Costs and returns of kharif groundnut in Vizayanagaram district of Andhra Pradesh. Indian Journal of Agricultural Economics 30(3): 376.

Trolldalen Jon Martin 1990 Sustainability and dryland management; Constraints and Challenges. Sustainable Agriculture 1: 21

Umrani N K, Gaikwad C B and Gare B N 1992 Sustainability of cropping systems under dry land conditions of vertisol. Indian Journal of Agronomy 37(4): 645-649.