THE CAUSES AND EFFECTS OF AGRICULTURAL MECHANIZATION AND LABOUR DISPLACEMENT IN NWFP

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DEPARTMENT OF ECONOMICS
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ABSTRACT

The present study is based on cross sectional data of 200 randomly selected respondents (130 mechanized and 70 traditional farms) in Peshawar District. The study shows that land owners have brought over 20 % of waste land under cultivation by utilizing farm machinery. The farm mechanization displaced over 35 % tenants who adopted other professions resulting in significant increase in their income.

The study exhibits that wheat and maize are the major crops in the research area. The manual labour requirements of the mechanized farms are nearly 23 % (in case of the wheat crop) and 50 % (in case of the maize crop) of that used on the traditional farms. The mechanization has, therefore, substantially reduced the manual labour input. Moreover, the rate of change of the mechanized farms is higher by 2.49 units for wheat and 2.33 units for maize than the traditional farms. The Marginal Physical Product (MPP) of machinery is higher than that of the manual labour and animal labour. The MPP of machinery is significantly higher on the owner cultivator farms as well as large farms.

The analyses show that the yields per unit land of the major crops and milch animal population of the mechanized farms are significantly higher than that of the traditional farms. The summation of income elasticity of inputs is less than one for each of the farming systems (mechanized/ traditional). As such it is operating at the stage of decreasing returns to scale. However, in this respect the traditional farms are worse than the mechanized farms. Both the cropping intensity and land use intensity of the mechanized farms are higher than that of the traditional farms. The mechanized farms have higher off-farm earnings due to their higher educational level as compared with traditional farms.

The results depict that mechanization of agriculture of the NWFP is lower as compared to other parts of the country. The availability of credit for different farm operations through a simple lending procedure is essential for the needy farmers. As the average land holding of the Province is much lower than the national average, so small size tractor/ machinery would be more appropriate for cultivation over here. With the adoption of these steps the crop productivity will increase due to which the country's food and raw materials for manufacturing sector requirements will be met adequately. These measures can enhance the employment opportunities both at the agricultural and manufacturing sectors.

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ACRONYMS

ADBP	Agricultural Development Bank of Pakistan
Adj	Adjusted
Ani	Animal Labour
AUP	Agricultural University Peshawar
Av.	Average
CD	Cobb- Douglas
FAO	Food and Agriculture Organization, UNO
FATA	Federally Administered Tribal Areas
FMPM	Farm Mechanization Policy Mission
Frag.	Fragmentation
FYM	Farm Yard Manure
GDP	Gross Domestic Product
Govt.	Government
Ha	Hectare (one hectare =4.94 Jareeb)
HP	Horse Power
HYV	High Yielding Verities of seed
ICP	Intensity of Cropping /Cropping Intensity
IDS	Institute of Development Studies
ILO	International Labour Organization, UNO
ILU	Intensity of Land Use
Kg/Kgs.	Kilo Gram(s)
Kharif Crops	Crops sown in summer and harvested in winter
Km(s)	Kilo Meters
Lab	Manual Labour
Ln.	Logarithm
Log.	Logarithm
MAF	Million acre feet
M/O	Ministry Of
mm	Mille Meter
Mound	40 Kgs = 1 Mound
MPP	Marginal Physical Product
NCA	National Commission for Agriculture

NGO	Non Governmental Organization
NWFP	North West Frontier Province
OC	Owner Cultivators
R^2	Coefficient of Determination
Rabi Crops	Crops sown in winter and harvested in summer
RSS	Residual Sum of Square
Ten.	Tenant cultivators
Tra	Tractor
UC	Union Council- A Cluster of Attached Villages
UNO	United Nation Organization
W.R.T	With respect to

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CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Notwithstanding the structural changes in Pakistan's economy since its Independence in 1947, agriculture is still the single largest economic sector of the country. This sector being the lynchpin of the country's economy continue to be the single largest sector and a dominant driving force for the growth and development of the national economy. It supports about half of the country's population for their livelihood and accounts for one-fourth of the Gross Domestic Products (GDP).

In the country food requirements of the ever growing population are met by the agricultural sector. Also majority of the established manufacturing units in the country are agro-based. The raw material requirements of these units, such as textile, sugar, tobacco, wood, cooking oil and food and fruit processing, are being provided by the agricultural sector. These products have markets both at national and international levels. Therefore, this sector contributes substantially to the Pakistan's exports earning. This very sector provides linkages through which it can stimulate growth in other sectors of the economy.

Although agriculture remained the single larger sector of the economy, however it could not receive proper attention. The agricultural sector was consequently neglected and its ill effects soon began to appear on the surface. The country, which was producing surplus food before and after Independence, had to face recurring food shortages in the 1950's and there after[1]. As mentioned in Agricultural Statistics of Pakistan 1975, it was for the first time in 1952-53 that Pakistan imported over eight thousand tons of wheat

[1] For a very detailed study of this scenario see Hussain S.A. (1960); Falcon and Gotsch C.H. (1968); and Khan M.H. (1984)

and the heavy import bill became a regular drain on the country's economy (Govt. of Pakistan, 1976). Papanek (1967) has also noted that in order to feed the ever growing population, import of food items averaged at one million ton per year. However, in spite of this, the agricultural sector did not receive proper attention from the Government till the end of the fifties. The planners paid attention to the agricultural sector through the various Five Year Plans in early sixties (see Chapter 4). Efforts were made to provide the essential agricultural inputs (i.e. improved seeds, fertilizers and pesticides) to the farmers. The high yielding seed varieties (generally known as Max-Pak) of wheat and rice were introduced and popularized amongst the farming community. The farm inputs such as fertilizers, pesticides, agricultural machinery (i.e. particularly tractor) and plant protection equipments were subsidized. Efforts were made to ensure reasonable prices for agricultural products through minimum support prices under procurement programmes and other related measures (Griffen and Khan, 1972; Khan M.H.,1982).

Nulty (1972); Afzal (1984); and Arbab (1989) have observed that the policies initiated in the beginning of the 1960's, started yielding convincing results in the late 1960's. They have pointed out that the agricultural production per unit of land substantially increased so much so that the phenomenon was rightly referred to as the "Green Revolution" in the literature. The remarkable achievements of the revolution also encouraged the process of mechanization in the country. It was noted that the application of agricultural machinery (especially tractor) could spare the land for other crops, which is used for feeding the cattles. Moreover, as noted by Hamid (1973); Gotsch (1973); Agarwal (1980); Clayton (1983); Khan M.H. (1984); and Rane. et. al. (2000), the high yielding varieties of different crops together with recommended doses of fertilizer required well-prepared seed-beds, which were easily and timely possible through mechanized (i.e. tractor etc.) power. In all these measures of agricultural

development the mechanization has been the most controversial issue[1].

In spite of the substantial progress made in agricultural sector, crop yields per unit of land in Pakistan are still lower than many other developing countries in more or less similar stages of economic development. The fact that , bulk majority of the population of the country engaged in agricultural activities cannot produce adequate supply of food and fiber at reasonable prices for the small segment of people working in other sectors, indicates a low level of productivity in crop and livestock productions.

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[1] For example, the Agricultural Enquiry Committee in its report of 1951 (Govt. of Pakistan, 1952) pointed out that agricultural mechanization has an adverse effect on labour employment. Khan and Karim (1991) have concluded that complete agricultural mechanization in Pakistan would displace two-third of the labour force. Bukhari S. et. al. (1991) have estimated that in Pakistan, labour requirements for machine and manual harvesting of wheat, for example, were 28.5 and 88.6 mound/hectare respectively and the use of machinery will displace labour. Mufti and Khan (1995-A) are of the view that in Pakistan the cost of mechanized farming is 50% higher than that of traditional farming. They have pointed out that the use of machinery in agriculture would be an extra burden on national exchequer and wastage of financial resources. Some of the scholars are of the view that with mechanization the land preparation is a matter of days resulting multiple cropping, which can increase labour requirements. For example, Hamid (1973) has observed that improved seed varieties and intensive cultivation require better seed-bed preparation which can not be properly and timely arranged by manual and bullock power. He pointed out that mechanization would be of great help to get the maximum benefits in terms of higher output and employment. Ahmad, B. (1975) is of the view that mechanization in the Punjab, Pakistan, has increased the labour requirements rather than displacing them. Ahmad (1976) is of the view that the rice yield of the mechanized farms is nearly 40 per cent higher than that of the traditional farms giving an over all increase of 13 per cent in the labour requirements. Garg, Mehal and Sharma (1997) have estimated that, in India, in case of paddy cultivation, the mechanization could give an increase in the output by 250 kg/ha. saving of 45 per cent in cost and 60 per cent in labour compared to traditional methods of cultivation. Also see Bose and Clark (1969); Salam A. et.al. (1981); Khan M.H. (1984) and Gotsch C.H. (1986).

The available data (on land and population) in Pakistan show that on average, presently one hectare of cultivated land supports nearly six persons and with the passage of time, due to population growth, the number of persons per hectare will shoot up. The traditional agricultural practices (i.e. the use of manual and animal labour) will not bring about a visible increase in productivity. As such there is a need to increase per unit land production which can be achieved easily through the application of improved agricultural practices. Also cultivated land, as crystal clear, cannot be expanded except to bring the available waste land under plough and increase land use intensity etc. In 1978-80, for example over 145 thousands hectares of land was developed through agricultural machinery and brought under cultivation. Such measures clearly explain the positive aspect of agricultural machinery (Govt. of Pakistan, 1980).

Similarly, Pakistan is a labour surplus country and nearly 68 per cent of its population lives in rural area and majority of them depend on agriculture. The high growth rate of the population is adding more people to the labour force every year and there is hardly any means where this can be absorbed (Govt. of Pakistan, 1998). The manufacturing sector has absorbed a tiny percentage of the labour force and it is unlikely that this sector (which is the 2nd after agriculture in terms of employment) will provide enough employment opportunities, particularly in rural area, for the country's growing labour force (Ali, 1992).

The unemployment and hence poverty, particularly in the rural area, is a basic economic issue facing the underdeveloped countries of Asia, Africa and Latin America. The importance of agricultural progress in accelerating the pace and process of economic development in the contemporary less developed countries has increasingly

been stressed by a number of economists[1]. However, despite the critical role of agriculture in economic development[2], the bulk of the development literature has been concerned with structural transformation of the developed countries particularly through rapid industrialization, in line with the historical pattern of development of currently economically advanced countries[3]. It has largely been ignored that this structural transformation may itself be dependent on agricultural progress in the sense that low agricultural output may impose an important barrier to industrial development and hence to the overall economic growth. The remedy is not in industrialization so much as in the development of agriculture which will expand the production and employment opportunities in rural area. The development of agriculture and an increase in agricultural productivity in food grains have an added significance for developing countries. The growth of food production is important for economic growth and increased agricultural production is a necessary condition for industrial development (Nichols, 1963; Shah, M.K., 1993).

Agriculture and industry are inter-dependent and should, therefore, be developed simultaneously. Many researchers have repeatedly and consistently pointed out this fact indicating how much the development of one sector depends on the development of the other sector. For example, Ranis et.al. (1961) claimed that unless productivity in agricultural sector is raised, the manufacturing sector cannot continue to expand.

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[1] For example see Witt (1965); Nulty (1972); Buchhoiz (1983); and Colman & Nixon(1986).

[2] For a detailed survey of the literature on the role of agriculture in the process of development see Eicher and Witt (1964); World Development Report (1982)

[3] The detailed can be seen in Lewis (1954); Jorgenson (1961); Nichols (1963); and Shah M.K.(1993)

Similarly Jorgenson (1961) argued that a rapid improvement in agricultural technology, in conjunction with a decline in the population birth rate, would result in economic growth and thus could break the "Vicious Circle of Poverty". Schultz (1964) also stressed that modernizing traditional agriculture is essential for economic growth and this objective can be achieved by making easy availability of inputs to farmers. Another example is that of Kuznets (1976) who suggested that without a marked improvement in agricultural productivity, the economies of Europe and United States could not have attained such high country-wide rate of growth.

A detailed explanation is that of Ruttan (1987) who argues that economic development cannot be attained without a concomitant improvement of productivity in the agricultural sector. Agriculture has a vital role to play in the growth process, and agricultural output is a key determinant of how fast economic development can be processed, especially during the initial stages. He further points out that because of the increase in agricultural output, income will increase and this in turn will expand the home market for industrial products. Moreover, the importance of agricultural progress in accelerating the pace and progress of economic development in less developed countries has increasingly been stressed by a number of other economists; Meier (1984); Colman and Nixon (1986) and Irnon (1987).

Raising farm productivity is an important challenge for Pakistan. The goal of increasing farm productivity has been pursued by the Government. The introduction of improved seed varieties, chemical fertilizers, tube-well irrigation and farm machinery, etc; at subsidized rates are some of the major steps taken by the Government. Mainly because of these measures the productivity increased. The wheat, maize and rice per hectare annual production, for example, increased from 830 kg., 1023.82 kg. and 931.6 kg. in 1960-65 to 2196 kg., 1658 kg. and 4486.7 kg. in 1995-2000 showing increases of

164.6, 61.9 and 381.67 per cent in the respective crops. However, costs of production of various crops in the country are not competitive due to low productivity mainly because of inefficient farming practices (Govt. of Pakistan, 2004 –A).

Despite the efforts that have gone into the improvement of agriculture, the yield per acre of the major crops of Pakistan is very low when compared to the yield per acre of these crops in the main growing countries. The yields for the major crops of Pakistan with the comparison of other growing countries are presented in Table-1.1 below. Pakistan (when compared to even other under developed countries) is producing approximately one third of the wheat yield per unit of land as compared to Egypt and less than two third of China's. Similarly Pakistan's rice yield is one third of Egypt's and nearly half of China. India and Indonesia's maize per hectare yield is much more than that of Pakistan's. Sugar cane yield of Egypt, India and Ecuador is considerably higher than that of Pakistan's.

Table-1.1 Yield per Hectare of Main Crops in Major Growing Countries

Crop	Country	Yield (kgs.)	Pakistan as %
Wheat	China	3907	60.9
	Egypt	6150	38.5
	France	6255	38.1
	Germany	6503	36.6
	India	2773	85.8
	Mexico	4788	49.7
	USA	2974	80.1
	Pakistan	2381	
Rice	China	6118	49.9
	Egypt	9431	32.4
	Japan	5871	52.0
	India	3034	100.6
	Bangladesh	3429	89.0
	USA	7448	41.0
	Vietnam	4649	65.7
	Philippine	3216	95.0
	Pakistan	3055	
Maize	China	4854	30.0
	Canada	7819	18.6
	France	7170	20.3
	India	2130	68.4
	Indonesia	3279	44.4
	Italy	8702	16.7
	Turkey	3826	38.0
	USA	8924	16.3
	Mexico	2526	57.7
	Pakistan	1457	
Sugar cane	China	70708	67.8
	Brazil	72825	65.8
	Egypt	90909	52.7
	India	67442	71.0
	Ecuador	77978	61.5
	Mexico	70614	67.9
	USA	77290	62.0
	Pakistan	47934	

Source: Govt. of Pakistan (2004), *Agricultural Statistics of Pakistan 2002-2003.*

The agricultural productivity of Pakistan is well below the potential level (Muhammad, 1984; Bashir, 1993). As long as the yield per unit of land of crops remain low, the great bulk of land will continue to be devoted to the growing of subsistence cereals for the human population and there will be very little possibility of crop diversification to include more nutritious foods and commercial crops.

The agricultural sector employs about half of the active labour force in Pakistan. In this sector the use of mechanized techniques could create a severe problem of unemployment (Boss & Clark, 1969; Hemmi and Atsumi, 1981; Bukhari, 1991). At the same time, however, it is more likely that the application of these very techniques could lead to an increase in agricultural output which could not easily be brought about by traditional methods of agriculture (Ahmad, 1976). To meet the food requirements of the ever increasing population and raw materials for the agro based manufacturing units, the adoption of mechanization in agriculture will be of great help to achieve the objectives (Suzuki, 1983). However, this application may have an adverse impact on human labour requirements. Thus, any decision on the adoption of such technologies could involve a conflict of choice between higher employment and higher output and the present study is focused on these issues.

1.2 The Causes of Agricultural Mechanization in Pakistan

In Pakistan agricultural mechanization has been defined as the use of tractors and their accompanying equipments. It is also argued that this process is a labour saving technology. One of the bottlenecks in the development of agriculture in Pakistan is the inadequate availability of power. The Farm Mechanization Policy Commission (FMPM), as mentioned in the Fifth Five Year Plan, comprising Pakistani and FAO experts, concluded that selective mechanization was essential for agricultural progress,

and in fact, was unavoidable. The Agricultural Enquiry Committee pointed out that although mechanization is labour saving, the power constraint of the agricultural sector could be overcome with the use of tractor. The committee noted that the availability of power for agricultural purpose is about 0.1 Horse Power (HP) per acre as against a recommended minimum of 0.2 HP per acre (Govt. of Pakistan, 1975). The committee pointed out that tractor population is about 35 thousands. Power is an important input and to reach a target of 0.2 HP per acre the country needs 15 million bullocks (cattle) which will provide a great competition with human being for food and feed. Bose and Clark (1969) have calculated that 2 cropped acre of land is needed to feed a pair of bullock per year. As such, feeding of these 15 million animals would need 15 million cropped acres which is about 26 per cent of the total cropped acreage and nearly equal to the wheat acreage of the country. As such the feeding of these animals by growing fodder would further aggravate the already inadequate supply of food and fiber for the growing population. This also shows that for every bullock that is eliminated by mechanization, one crop acre of land would be released for other crops rather than fodder.

Bose and Clark (1969) are of the view that delay in the planting of Kharif crops in Pakistan mainly occurs because both animal and manual powers are busy in wheat harvesting etc. Bashir (1993) has estimated that a delay of one day in sowing of wheat could reduce production as high as 30-40 kg. per hectare. On the other hand Din (1963); Shaw A. (1967); Salam (1977) and Bukhari (1991) have argued that the use of tractor reduces human labour requirements.

The literature published during the last few decades or so on the impact of mechanization has produced conflicting evidences. In view of the lumpy nature of investment required for tractor, access to them by operators of various farm sizes may

not be necessarily uniform (this is in contrast with chemical fertilizers and improved seeds, which are divisible in nature, and generally all farmers can have access to them). What impact the promotion of mechanization creates on farm output and labour employment is, therefore, not known with a certain degree of accuracy.

Following the Green Revolution, the agricultural sector in Pakistan has accommodated many changes. Agricultural modernization, adoption of high yielding varieties (HYV) of seed, progressive use of chemical fertilizers and improvements in irrigation facilities are clearly the results of Green Revolution which increased the productivity. Various studies in Pakistan and elsewhere have been undertaken to assess the impact of the Green Revolution on the agricultural sector[1]. The views expressed in these studies show that although the overall impact of the Green Revolution is favourable, the exact contribution made by various components is not clear.

From the policy point of view it becomes necessary to have a complete knowledge of the various effects of a certain input. The tractor, for example, may be a labour substitute or complement (net contribution). The use of tractor, therefore, should be appreciated if it increases productivity. At the same time, if its labour displacing effects are known or certain, then they should be neutralized.

1.3 The Substitution/Contribution View of Mechanization

The issue of mechanization of agriculture in the context of less developed countries has been discussed in details[2]. A thorough study of the arguments presented in

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[1] For a comprehensive study of the Green Revolution see Ghulam M. (1965); Papanek (1967); Falcon and Gotsch (1968); Mellor (1975); Wizzarat (1981); Aftab (1985); and Arbab (1989).

[2] See for example, Khan (1964); Sarkar (1966); Barbero (1972); Binswanger (1978); Kadri et. al. (1982); Mufti and Khan (1995); Iqbal. et. al. (1998); Rane et. al. (2000); and Cheng et. al. (2001).

favour of and against the impact of mechanization / tractorization in all such studies shows that basically there are two broad views i.e. the substitution view and the net contribution view. Both of the views are briefly elaborated below.

1.3.1 The Substitution View

According to this view, tractor and draught animals are two different sources of power that technically are perfect substitutes. The switch from the former to the latter is thus primarily guided by factor prices, i.e. tractors can be an important engine of growth provided that they become cheaper relative to animal labour. Thus, the adoption of mechanization has a negative impact on employment[1].

1.3.2. The net Contribution View

According to this view, power is a primary constraint on agricultural production almost regardless of factor prices. It is argued that tractor, through deeper tillage, timely operation and reclamation of land would lead to higher yields, both directly and through more extensive double cropping. This would lead to higher level of outputs which would require more labour in those operations which are not performed by tractor. The tractor could, therefore, contribute to increase productivity without necessarily displacing labour. Thus according to this view mechanization would be consistent with employment objectives[2].

1.4 Statement of the Problem

In Pakistan, the application of agricultural machinery in the North West Frontier Province (NWFP) is lower than the rest of the country, especially the Punjab and Sindh

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[1] For detail see Bose and Clark (1969); Abercrombie (1972); McInerney and Donaldon (1975); and Suzuki, (1983).

[2] See for example Sarkar (1966); Inukai (1970); Rao (1974); Roy and Balse (1978); Ahmad B. (1983); Anwar , et. al. (1995); and Saeed K.A. (2000).

Provinces, where mechanization was introduced in the early stage of its inception. Most of the research work in Pakistan on farm mechanization, and its labour displacement effect, therefore, have been focused on these two provinces (Giles, 1967; Falcon and Papanek, 1971; Salam, et. al., 1981; Khan M.A. et.al., 1986; and Arbab, 1993). The situation in the NWFP is not very much clear, as far as the effect of the adoption of agricultural mechanization on agricultural labour, livestock holdings and cropping intensity, etc., is concerned.

Going through the agricultural policies implemented for the well being of the population one feels that they may not be without ill effects. For example, there is a fear that the introduction of taxes, subsidies and other incentives may distort market prices. If this occurs then the question arises as to what would happen to the regional situation. Thus it becomes desirable to see the effect of such policies at the regional level Rao (1975); Arbab (1989); and Ali (1992) have pointed out that from policy point of view it is imperative to study the regional situation, especially for the large sector of the economy[1].

For devising effective policies at regional level it is necessary to analyze the situation in the NWFP and give feedback to policy makers. The NWFP, therefore, merits serious consideration of the study of the application of agricultural mechanization. It is hoped that the analysis attempted here will be of some help in

[1] Freebairn (1974); Hayami and Ruttan (1984) are also of the view that agricultural technology often tends to be location specific and thus it may not be equally adoptable to all regions of a country at the same time. Griffen & Khan (1972); Chaudhry, G. (1982); Mian, M.N. (1983); Theodre and Mai (1984); Faiz M. (1984); and Arbab (1993) have pointed out that in Pakistan farm mechanization is mainly concentrated in the provinces of the Punjab and Sindh. The figures of the Pakistan Agricultural Census 2000 also support the view as the agricultural machinery owners (in percentage) in the NWFP is even much lower than that at the national level.

providing guidelines for agricultural development in the country and particularly in the NWFP. The study under reference is an attempt to this end with the following objectives.

1.5 Objectives

The main objectives of this study are to:

(a) study agricultural mechanization in general and tractor use in particular and its impact on human labour requirements for the major crops (wheat and maize) in the study area.

(b) assess the impact of agricultural mechanization on land use and cropping intensity in the study area.

(c) study the impact of agricultural mechanization on crop productivity and livestock holdings in the study area.

1.6 Hypotheses

The major hypotheses of the study are that:

(i) agricultural mechanization has not affected the amount of manual labour input by crops.

(ii) the benefits of tractor use are inversely related to the size of landholding.

(iii) the use of agricultural mechanization has not changed: land use intensity, cropping intensity, output per unit of land and livestock holdings.

1.7 Organization of the Study

This study is divided into nine chapters and a brief of each chapter is as follows:

Chapter 1 covers the introduction, causes of mechanization in Pakistan, substitution and net contribution view of the mechanization, rationale, objectives and hypotheses of the study.

Chapter 2 elaborates the research methodology. Accordingly it highlights the selection of the universe and sampling procedure. It also describes the variables and data collection. Analytical techniques (Chow-test and t-test) and the model used in the

study have been explained.

Chapter 3 is devoted to the literature review. The relevant literature on the impact of mechanization on manual labour, livestock holdings, yield and cropping intensity etc; have been discussed at length.

Chapter 4 gives a background of the history of agricultural mechanization. It also throws lights on the emergence of mechanization in Pakistan and the Government policies regarding this issue.

The position of the agricultural economy of the NWFP and a comparison of the Province to that at the national level are accommodated in the Chapter 5.

Chapter 6 is aimed at respondent's profile. Some of the comparisons of the mechanized and traditional farms have also been presented in it. The techniques explained in Chapter 2 have been applied on the input/output data of the crops which provide ground for detailed analyses.

The elasticity of each of the inputs, the output, the use of manual labour and manual labour requirements model for the wheat and maize crops have been captured in Chapter 7 & Chapter 8 respectively.

Chapter 9 presents the summary, conclusions and recommendations.

CHAPTER 2

METHODOLOGY

2.1 Introduction

This chapter explains the various techniques which have been used in the study to meet the objectives and to test the hypotheses as described in the preceding chapter. Accordingly it highlights the selection of the universe, study area, sampling procedure and sample size. It also describes the variables, data collection and its limitation. The statistical tests and the model used in the text have been explained.

2.2 Universe

The universe of the study is the NWFP where the adoption of agricultural mechanization is lower than that at the national level. As can be seen in the Pakistan Agricultural Census 2000, that 54 per cent (the lowest level in the country) of the forming community in the Province is applying mechanization in agricultural practices against 71 per cent at the national level and 81 per cent in the Punjab. Moreover, over 61 per cent (the highest percentage) of the bullock user farmers of the country is from the NWFP (Govt of Pakistan, 2003). Per hectare yields of all major crops of the Province are lower than that of the national average (See Chapter 5).

2.3 Selection of the Study Area

The selection of a proper (representative) area is very important in the research study. The Peshawar District in the NWFP (Pakistan) was selected as the most suitable area from which to select the sample villages after considering the physical and financial resources available for the study. There were, however, several other reasons for focusing the study to this area. Peshawar is the backbone of the provincial's economy. Also it is mainly this area where agriculture has made a visible progress in the last few decades. In terms of agricultural productivity it ranks highest

among the regions of the Province. This derives from its highest yield per unit of land in wheat and maize (the major crops), while at the same time keeping pace in the yield per hectare for other crops like sugar cane, tobacco, vegetables and fruits (Hussain, 1990; Saeed, 1996; Govt. of Pakistan, 2004).

In this District a reasonable number of farmers have been using new inputs of production such as high yield seed varieties, chemical fertilizer, farm yard manure and agricultural machinery for many years. The application of these inputs along with a good irrigation system of surface water has helped a lot in achieving high yield per unit of land. Moreover, relevant information on the change in agrarian structure and agricultural development is not quite as adequate for any other area in the Province as for District Peshawar. Also, there exists a high degree of homogeneity in the soil, climate and crop conditions in the sample area, as a result these factors are least effected in the study area (Govt. of Pakistan, 1975-A; Sareer et. al., 1983; Shah M.K., 1993).

2.4 Sampling Procedure

All the irrigated farm households in District Peshawar constitute the population. For this study the mechanized farms are those where the farmers generally use agricultural machinery and do not use the traditional methods of cultivation or use it but very rarely. Traditional farms in the present case are those where the growers oftenly do not use agricultural machinery or use it but very sparsely.

A list of all those Union Councils in the District was obtained from the Agricultural Department, Peshawar, where both traditional and mechanized methods of cultivation were practiced. In the District agricultural land and hence agricultural activities are mainly carried out towards the East-South and East-North (where as the West-South and West-North are mostly mountain areas). The list was divided in to two

parts: one for the East-South areas and the second for East-North area. This division was made so as to take account of regional differences and ensure complete representation of farms, in terms of climate, soil type, irrigation and cropping pattern.

In the 1st stage Union Council Lala and Gul Bela were randomly selected from the South-East and North-East lists respectively. In the second stage village Tarnab from Lala Union Council and Kochian from Gul Bela Union Council were randomly selected[1].

After the selection of villages, a complete census of each village was made. Total number of households in these two villages was over one thousands which matches the 1998 Population Census figures. The number of households in each village was nearly equal (over 500 in each). Of the total population in these villages, 70 per cent was engaged in farming. Assuming a difference of 0.4 between population and sample means, the sample size $\{n= [(K^2S^2N)/ (Ne^2+K^2S^2)]\}$ stood at nearly 200 households[2]. Of the total population engaged in agriculture, 70 per cent used mechanized farming and the rest used traditional methods of farming. The sample size was, therefore, proportionately distributed in the mechanized and traditional farms.

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[1] The detail of Union Council and villages is given in Govt. of NWFP, District *Census Settlement of Peshawar*, 1988.

[2] For detail of the sample size Ser Parel et al. (1973), p. 13. It is assumed that S = 3 and k = 2. Jehanzeb (1999) has also taken a sample size of 200 for his study McInerrey and Donaldson (1975)have also taken a sample of 202 for their study in Punjab-Pakistan. This means that our sample size is fairly good for the present study.

In each category (i.e. mechanized/traditional) the respective sample size was proportionally divided in small [under 5 hectares (bellow 24.7 Jareebs)] and large [5 and above hectares (24.7 Jareebs and above)] farm sizes. Each size was proportionally divided in owner and tenants cultivators[1]. The detail is given in Table 2.1 below.

Table 2.1. Sampling Distribution of the Respondents

Village/	Small Size			Large Size			All Sizes		
Farming System	OC	Tenant	All	OC	Tenant	All	OC	Tenant	All
Kochian All	48	23	71	17	12	29	65	35	100
Traditional	16	8	24	7	4	11	23	12	35
Mechanized	32	15	47	10	8	18	42	23	65
Tarnab All	48	23	71	17	12	29	65	35	100
Traditional	16	8	24	7	4	11	23	12	35
Mechanized	32	15	47	10	8	18	42	23	65
All Area	96	46	142	34	24	58	130	70	200
Traditional	32	16	48	14	8	22	46	24	70
Mechanized	64	30	94	20	16	36	84	46	130

Note: OC = owner cultivators

In each group (i.e. tenancy and farm size-as mentioned in the above table), the major crops (wheat and maize) growers were randomly selected. The data were collected from both mechanized and traditional farms from each village at a uniform time so as to neutralize the climate and crop conditions etc.

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[1] The owner-cum-tenant was not considered because their number was very small (less than 5 per cent). Even at the country and provincial levels the number of owner-cum-tenant has declined. For example, the number of owner-cum-tenant decreased from 14 per cent in 1980 to 8 per cent in 1990 and to 6 per cent in 2000 (for details see the respective Agricultural Census reports). Saeed (1996) and Naved (1976) have also ignored this category mainly because of their small number. Salam (1978) has also taken two sizes (small and large) and two tenancies (owner and tenant cultivators). In the study area the measurement unit of land is known as "Jareeb" which is equal to half of an acre (2.4711 acre = 1 hectare) as such all the data on land were collected in Jareeb and have been presented in this Unit accordingly in the report for the study area.

2.5 Data Collection

This study is primarily based on farm level data collected through the sample survey for which a questionnaire was designed. The questionnaire was prepared with consultation of people having good experience in the cultivation of the wheat and maize crops. The same was discussed with the persons experienced in field survey. Moreover, old questionnaires regarding farming activities were also studied. After designing the questionnaire, it was pre-tested in the survey area. On the basis of the feedback, it was redesigned and a series of trial-interviews were conducted so as to finalize it (Annexure 1). For data collection help of lecturers (all master degree holders in Economics) of the Institute of Development Studies (IDS), NWFP Agricultural University, Peshawar, was obtained. Before the field survey training sessions were held at the IDS to explain the objectives of the study to the members of the team. The questionnaire was discussed in detail during the training session to ensure that each team member understood the meaning of each question, how to ask the question properly and how to fill in the questionnaire.

Field work was undertaken, under the supervision of the researcher, at two different times of the agricultural years 2002-03, each at the end of seasons Kharif and Rabi (an explanation of these seasons is given in Chapter 5). Generally the growers forget about the amount of inputs and its prices. As such two visits were made at the end of each season so as to collect more reliable data for each crop. The data were collected from the farmers through face to face interview. Interviews were usually conducted in Hujra[1] or in the farmer's fields, keeping in view the maximum convenience of the farmers. In each village the help of Zakat Committee Chairmen was taken. They were informed about the objectives of the study. Many of the

[1] Hujra is a place which is used for social gathering by male.

respondents also showed their eagerness to know the purpose of the study, because they suspected that their information might put them under some financial burden or official's problems. Therefore, in conducting the interview the main purpose of the study was also briefly explained to such farmers and the need and importance of such information in developing agriculture. The Zakat Committee Chairmen and also the farmers were assured that the provided information would be kept confidential. Such explanation to the farmers was necessary so as to encourage them to give all the information frankly and to the best of their knowledge. The information was collected mostly through interviewing the head of the household, as it is believed that they are the people who have full knowledge of their farming and housing etc.

2.6 Limitation of the Data

Information was obtained from 200 respondents and recorded in the questionnaire. Actual information was reported by the farmers. However, when it was not possible to get actual information (in a very few cases) estimated information was accepted with the condition that these estimates were first suggested by the farmers in the presence of the village elders and when they agreed upon. Editing of each questionnaire was carried out on the same day. In so far as possible, verification of the data was done on the next day data was collected. Some of the farmers did not maintain any record of fixed costs and sale proceeds, but for the broader questions i.e. ownership of land holding, cropping pattern, and output produced and inputs used etc., large majority were highly cooperative in supplying the information. In spite of the bottlenecks we were able to collect reasonably reliable data.

2.7 Description of the Variables

The data regarding family composition, farm production, inputs (quantity and cost) and livestock holdings etc., were carefully collected. In the following paragraphs we briefly describe the variables included in the questionnaire.

Data on family composition included information on the total family size (sex-wise), dependent and working members. Information with respect to time allocation to agricultural and non-agricultural activities of the working members, income from off-farm activities and literacy status was collected from the respondents.

Data on farm production included information on the use of inputs (quantities and prices) and observed outputs (quantities and prices) for both the major crops (wheat and maize) of the respondents. The list of inputs included seed, farm yard manure, chemical fertilizers, irrigation, human labour, animal labour, use of tractor along with accompanied equipments and rent /other[1]. The outputs include main product and by-product.

The data on livestock holdings included number and value of all animals (like bullocks, buffaloes, cows and sheep/goats) kept by the respondents. Information regarding the monthly expenditure and net income of the animals was also collected.

Regarding information on mechanization, the ideal method would be to use data on the input of tractor power (tractor-hours) per farm (Rao, 1974). Thus, information on the use of tractor was gathered in the form of tractor-hours used per farm. Both animal and manual labours were also measured in animal hours and

[1] Other includes rent, expenditure on Pest/Inst. measures and refreshment served to the labour. However, the big portion is rent, therefore, we use either rent/other, rent or other.

manual hours at a farm level. Thus, prediction regarding the employment or displacement of human labour in this case is strictly limited to farm only. It does not capture the indirect employment generated or displaced in the process of manufacturing, distribution and servicing of tractors, fertilizers, other non-agricultural inputs, and marketing and distribution of additional output.

The costs incurred on inputs were measured in terms of the prices paid by respondents for each input. However, for some of the family provided resources like human labour, animal labour and farm yard manure, the local market prices were used to impute a cost to these inputs.

2.8. Basic Tests

As said earlier, we have collected data from mechanized and traditional farms. However, before going to analysis it is necessary to test whether or not there is any difference between these two groups of farmers[1]. Here we investigate whether mechanized and traditional farms can be considered as having been drawn from a normal population with the same mean and variance. We assume the population is normal and base the test on the means and variances of both the samples to see the compatibility of the means of both the groups. For this purpose our hypothesis that there is no difference between the two groups i.e. mechanized and traditional farms, is tested for its validity. The original hypothesis is equivalent to two separate hypothesis:

(a) no differences between the means; and

(b) no differences between the variances.

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[1] If these tests, on the assumption that samples have been drawn from normal population, show that there is difference between the two groups then the analysis would be carried out for each group. However, if the tests do not give difference between the two groups, then the entire data would be pooled. For more detail see shah M. K. (1993).

A t-test is used for (a) and generally Chow test is used for (b) and both the tests are summarized below:

2.8.1 Test for Difference Between the two Means

As the number of observations regarding mechanized farms (n_1) is not equal to that of traditional farms (n_2) we, therefore, are concerned with a test involving two unpaired, independent samples with the following test:

(t-test) : $t = \dfrac{\overline{X}_1 - \overline{X}_2}{\hat{\delta}\sqrt{1/n_1 + 1/n_2}}$ distributed as $t_{(n_1 + n_2 - 2)}$ under H_o where as $\hat{\delta}$ is

unknown and $= \sqrt{\dfrac{n_1 S_1^2 + n_2 S_2^2}{n_1 + n_2 - 2}}$

$\overline{X}_1$, $\overline{X}_2$ are the sample means of mechanized and traditional farm respectively and S_1^2 and S_2^2 are the respective sample variances. The null hypothesis to be tested is that the two population means are identical i.e. H_o: $\mu_1 = \mu_2$.

2.8.2. Test for Differences Between Variances

The hypothesis of "no differences between the two variances" is tested here by using Chow-test[1]. The null hypothesis Ho : $\delta^2_1 = \delta^2_2$ is tested against the alternative hypothesis H_1 : $\delta^2_1 \neq \delta^2_2$. The Chow-test, is used to test the hypothesis of similarity. The Chow - test is as:

$$F = \frac{S_a/k}{S_b/\sqrt{n_1+n_2}-2}$$

Whereas F is (k, n_1+n_2-2) d.f.

d.f. means degree of freedom

S : stands for Residual Sum of Square (RSS)

n_1 = sample size of 1st population.

n_2 = sample size of 2nd population.

k = number of parameters estimated.

$S_b = S_1 + S_2$ [Residual Sum of Square (RSS) of the respective population]

$S_a = S_c - S_b$ [where as Sc is the RSS of the combined Regressors]

These basic tests have been applied on the relevant data in the text.

2.9 Specification of Econometric Model

The main aims of this section are to describe the regressors and dependent variable. The exogenous variables obviously include all factors of production like human labour, animal labour, tractor, seed, fertilizers, FYM, water and rent/others. The dependent variable is obviously output (main output and by-product).

We have applied the most generally applied Cobb-Douglas (CD) production function. A cost function rather than a production function is used (Binswanger, 1974)[2]. The general form of the CD production function is expressed by $\theta = AL^{\alpha} K^{\beta} e^{U}$, where as θ is output, L and K are inputs and e is residual. However, the appropriate form of the function in agricultural related activities is its non-linear form. The corresponding coefficients of the regressor variables are the respective elasticities which give clear picture regarding the return to scale, whether constant, increasing or decreasing. The general form of the function is as[3]:

$$Y = b_o X_1^{b1} X_2^{b2} .... X_n^{bn} e^{\epsilon}$$

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[1] The detail of the Chow-test is given by Gujrati (1987).

[2] A comprehensive list of the advantages associated with the use of cost function rather than a production function is given by Binswanger (1974).

[3] The Cobb Douglas production function has been applied by many people. Majority have adopted this function for agricultural productivity. For example Lau, and Yotopoulos (1978) conducted a study in Taiwan and on the cross-sectional agricultural data used Cobb-Douglas function. Bernum and Squire (1979) have used Cobb-Douglas to their primary cross-sectional agricultural data of 207 respondents in Malaysia. Kuroda and Yotopoulos (1980) conducted a study in Japan, based on 72 respondents grouped by farm size. For the estimation of the parameters they incorporated the Cobb-Douglas function. Adulavidhaya et. al. (1984) used cross-sectional data on the agricultural commodities consumption and the estimations were obtained by using Cobb-Douglas function. Shah, H.N. (1993) has also used the Cobb Douglas function for estimating allocative efficiency in irrigated agriculture and has mentioned the limitations (such as scale and external economies), of the function. He has concluded that despite the limitations the Cobb Douglas gives better results. Jehanzeb (1999) in his study has applied the Cobb Douglas function on 200 respondents.

In logrithimic form it can be written as:

$$\text{Ln } Y = \text{Ln bo} + b_1 \text{LnX}_1 + b_2 \text{LnX}_2 + \ldots\ldots + b_n \text{LnX}_n + \in$$

$$= \text{Lnb}_o + \text{bi} \sum \text{LnX}_i + \in \quad [\, i = 1,2,3,\ldots n]$$

Whereas:

Ln: stands for natural logarithm.

Y = Income (output values)

Xs = Various input variables, and

$\in$ = Error terms

This model has been used for both the major crops in the study area. The computer programs SPSS and Excel have been used for the estimations. Our analyses are based on cross sectional data where the auto-correlation problem is generally not considered. The Durban Watson (d) test, as pointed out by Gujrati (1987), is applied to the time series data for detecting auto-correlation. As explained by Loomis and Walsh (1997) that there is no problem of multi-collinearity if the correlation coefficient $\rho < |0.8|$. We have calculated the correlation coefficients of all the variables used in various models which are in the range of $|0.5|$ (i.e. lower than 0.8) so there is no problem of multi-collinearity. John (1984) has observed that if R^2 is less than 99 per cent then there is no problem of multi-collinearity. Kvalseth (1985) has pointed out that $R^2_{(\text{Adjusted})}$ is to be used instead of R^2.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

Review of relevant literature is one of the basic requirements for conducting research study, as it provides necessary insight and helps in conceptualization of the problem. Accordingly relevant literature on farm mechanization is reviewed.

The literature on agricultural mechanization is quite rich. Various researchers have approached the issue from various angles. The prevalence of differences in climates, culture and socio-economic conditions in each of these countries, (or different regions of the same country) has resulted in infertile impact on farm mechanization.

Various hypotheses have been tested in many different environments. Since our main concern is to study the impact of agricultural mechanization on manual labour requirements, livestock holding, yield per unit of land and cropping intensity etc., we have reviewed literature on the following topics.

i. Tractor and human labour

ii. Tractor and animal labour/livestock holdings

iii. Tractor and yield

iv. Tractor and cropping intensity

In the following paragraphs we briefly present the relevant literature on each of the above topics.

3.2 Tractors and Human Labour

Whether tractors and human labour are substitutes or not is the most controversial issue and there are many different views about it. The empirical findings are grouped here according to similarity in opinions.

One group is of those who found either no relationship or a very weak

relationship between tractors and human labour. For example, Khan A.Z. (1964) is of the opinion that the selective use of tractors in Pakistan (i.e., during harvesting and threshing) will smooth the fluctuation in wages particularly the rising tendency. He further adds that the tractor may be used profitably without creating much unemployment. A study (Sarkar, 1966) undertaken in Dharwar District -India) revealed that no relationship, year by year, existed between the purchase of tractors and the percentage reduction in labour use. These results were supported by quoting the empirical evidence from the historical experience of the western countries where the first phase of farm mechanization reduced the workload on the existing labour rather than to reduce labour requirements. In the case of Italy, Barbero (1972) showed that mechanization was not seriously affecting the demand for labour but it was likely to reduce labour demand in the future. He added that these effects would vary from crop to crop and region to region in Italian agriculture. In the case of the Philippines, Barker et. al. (1972) established that labour on mechanized rice fields was not displaced. They found that the changes in labour requirements per acre were not significant. They added that long run labour displacement was less certain.

Gotsch (1973) has shown that rapid mechanization by large farmers increased inequalities of income because of unequal land tenure arrangements. Employment effects were, however, not so clear cut. Saeed, K. A. (2000) has argued that, in Pakistan, the small land holders still use traditional methods of farming. Therefore, the labour displacement effect of the farm mechanization is of minor significance in their case.

The second group consists of those who say that tractor is just smoothing the demand for human labour. For instance, Billings and Singh (1970) argued that mechanization in their study area (where demand for labour was more than supply) could reduce the future demand to equate it to future supply. A study by Inukai (1970)

of rice farmers in Thailand, where the use of tractors allows transplanting rather than broadcasting of rice, shows an increase in income and employment. This relationship of complementarily between the two was considered true on the assumption that tractor use could enhance the scope for labour absorption through increases in productivity and cropping intensity. Marsden (1973) says that although labour may be in surplus in most periods of the year, there is labour scarcity during peak operations. Mechanization enables the farmers to spread the labour load more effectively.

Aurangzeb and Rahim (1993) are of the view that the adoption of agricultural mechanization in Pakistan has increased manual labour requirements in other related sectors. Anwar et.al. (1995) argued that in Pakistan labour shortages at the time of harvesting have adversely affected the output. They are of the view that mechanization has greatly helped to reduce such losses.

Rockenbach, Sette and Stukor (1997) have conducted a survey of 12 rural family involved in dairy activities and maize and tobacco cultivation in Serra Santacatrina, Brazil, indicated that as the level of mechanization in each activity increased, women participation in the related activity decreased. In general, as mechanization increased women became more involved in other economic activities. Prandhan et. al. (1998) have observed that rice harvesting is labour consumptive and expensive agricultural activities, therefore, steps were taken to evaluate and select an appropriate harvesting methods for rice in Orissa. They have calculated that cost of mechanical harvesting is just half of that of manual harvesting. Balasankari and Salokhe (1999) carried out a survey of 88 farmers using tractor in Coimbetore, India. Of all the respondents, 75 per cent were of the view that inconvenience was involved in maintaining animals for cultivation purpose. Similarly, 67 per cent of the respondents argued that use of tractor helps to overcome the labour shortages at the

peak season. And 64 per cent pointed out that there is saving of time in using tractor instead of manual labour. Difficulty in repaying the loan for such a high investment was expressed by majority of the farmers as the main reason for not being able to buy such a tractor.

Muhammad, Sivaswami, and Jayan (1999) have examined that paddy cultivation in Kerela (India) needs appropriate mechanization to cope with the increased cost of cultivations due to high wages and scarcity of manual labour. Ploughing, transplanting, puddling, spraying, harvesting and threshing are done almost completely by using machines. Cheng et. al. (2001) have argued that agricultural mechanization contributes to agricultural production. They have pointed out that the contribution of farm machinery in raising labour productivity is determined by its contribution to the production increment and its capacity as a substitute for labour force.

Yet another group consists of those who found that although the use of tractors is decreasing the demand for manual labour in certain operations, its overall impact is positive. For example, Ali (1963) has observed that manual labour inputs of tractorized farm are 8 per cent lower than that of bullock farm in the Punjab, Pakistan. Gross net income of the mechanized farm is 30 to 41 per cent higher than that of the bullock farm. Lawrence (1970) reviewed the economic aspects of farm mechanization in the Punjab and Sindh, Pakistan, and observed that in the cotton-wheat belt of the area, per acre demand for manual labour was higher on tractor cum thresher farm (73 man-hour) than on bullock farm (70.5 man-hours). He, therefore, concluded that technology of tractor and thresher would generate large gains both in the form of high yield and more employment.

Hamid (1973) pointed out that further extension of intensive cultivation even

in areas with sufficient irrigation facilities had become limited due to the lack of sufficient manual labour and animal power. In addition, the new seed varieties require better seed-bed preparation. He proposed that in such a situation, the most suitable machine for Pakistan could be a two wheel tractor of 10 H.P. which unlike large tractor would displace animals not people. He further added that such a two-wheel tractor would create employment for 3 to 7 workers per farm, with about 58 per cent in overall manual labour use. Rao (1974) showed that the use of tractors displaces manual labour, particularly the seasonal labour force but the overall impact will be positive as tractorization increases output through increases in cropping intensity and thus creates jobs at harvest time.

Hussian (1980) claimed that the number of tractors and workshops increased almost in harmony with each other in the Punjab, Pakistan. Besides providing valuable services in the field of repairs, the tractor workshops afforded employment to a number of people. The level of employment was about 5 persons per workshop and 2 persons at each spare-part shop. This number will further increase if the employment offered by the manufacturing of spare-parts, and its transportation etc; are considered. Mufti and Khan (1995) have carried out the performance evaluation of Yanmar APR-8 Paddy Transplanter and have estimated that the cost of mechanical transplanting was 50 per cent higher than that of the manual transplanting. The manual labour requirement for mechanical transplanter was observed to be one-third of that of manual transplanting. Also the mechanical transplanter gives 30 per cent increase in the output as compared to the manual transplanting. As mentioned in the study the mechanical transplanting has disadvantage of higher cost and advantage in the cost of manual labour.

Another group comprises of those who found tractors and human labour to be

substitutes. For example , Singh (1968) while comparing six tractor holdings with 22 non-tractor holdings in the Punjab, India, concluded that on the whole, for all agricultural operations taken together, an application of 8.8 tractor hours per acre saved as much as 52 hours per acre of manual labour and 46 hours per acre of animal use. The study of Bose and Clarke (1969) considered to be the Ist study in Pakistan based on farm survey, on the issue under discussion, estimated a net labour force displacement of 50 per cent compared to the pre-tractor period. The study established that while mechanization has the indirect positive effect of diffusing technical competence and craftsmanship, the direct social cost arising from manual labour displacement effects more than offset the social benefits arising from the diffusion of such a skill. The study was not of much help in policy formulation, as pointed by Khan M.A. et. al. (1986), because of the nature of data and assumptions used in the study. Abercrombie (1972) has shown that the introduction of four wheel tractors has created rural unemployment in Latin America. He estimates that each tractor in Chile, and about four workers in Colombia and Guatemala displaced three workers. Overall, he estimates that a total of approximately 2.5 million jobs have been displaced by tractors at present in use in Latin American agriculture. He also shows that labour displacement by mechanization increases with the size of farm and that continued mechanization will have similar effects.

Motilal (1973) conducted a comparative study of 60 tractor holdings and 60 bullock operated holdings in Alipure, Delhi, India. It was found that yields on tractor farms were significantly higher than that on bullock operated farms. There was no significant difference in cropping intensity for all farms together. Labour employment on tractor farms was 32 per cent less than that of the bullock farms. Tractor farms had 58.78 per cent higher net income than that of bullock operated farms. In the case of

Pakistan, McInerney and Donaldson (1975) have shown a 38.9 per cent reduction in manual labour requirement. Salam (1977) explained that the main reason for the tenant displacement by tractor holders in Pakistan was their extension of direct cultivation to the land previously cultivated by tenants.

Lockwood (1981) narrated the results of a study on farm mechanization carried out in the Punjab province of Pakistan. He claimed that in the context of Pakistan, tractorization had led to the expansion of farm area operated by the tractor farmers at the expenses of tenants, and others who previously farmed the area involved. There was little evidence to suggest that tractor farms were more intensively farmed, and it was possible that the areas taken over from tenants might be less intensively cultivated. The argument that tractorization leads to more intensive cropping and, therefore, more on-farm employment did not hold for Pakistan. On the other hand, the expulsion of tenant families directly reduced the amount of manual labour applied to the area previously rented out. The recent spread of tractor-powered-wheat-thresher had reduced directly employments in the important seasonal activity. Adoption of other tractor power equipments such as rice thresher and harvesters would reduce still further the main employment and income earning opportunity for the rural labour community. The rapid spread of hire-services based on tractor and attachments duplicated the labour saving effects on farms which had not invested in tractors. However, the study has not mentioned the amount of displaced labour. Moreover, it has not given any comparison with the traditional farming.

Likewise another study providing irrefutable evidence of the magnitude of the displacement of labour is the one conducted by ILO (Theodore and Mai, 1984) under the Asian Employment Programme in 1982. The study found that in Pakistan larger land owners in the category of 50 acres and above increased their farm sizes by both

resuming own cultivation of previously rented out land and purchasing land from small farmers for self cultivation using tractors. They have pointed out that farm mechanization often induces intensification of cropping and accumulation and concentration of land towards the machinery owners. As a result tenants and share croppers are either ejected or became farm workers. It is also observed that the adoption of mechanization within the country is uneven. In Pakistan, for example, the farm mechanization is mainly concentrated in the Provinces of the Punjab and Sindh.

Bukhari et. al. (1991) estimated that in Sindh, Pakistan, labour requirements for machine and manual harvesting of wheat were 28.5 and 88.6 mound per hectare respectively and the use of machinery will definitely displace manual labour. Khan and Karim (1991) have concluded that in Pakistan complete mechanization would displace two-third of the farm labour force. Mufti and Khan (1995-A) investigated that in the Punjab, Pakistan, the cost of mechanized agriculture is 50 per cent higher than that of manual operations. They have concluded that the use of machinery in agriculture would be an extra burden on national exchequer and wastage of financial resources.

Garg, Mehal and Sharma (1997) have calculated that the use of six row paddy transplanter machine could give an increase of 250 kg./ha. in the yield, saving of 45 per cent in cost and 60 per cent in manual labour as compared to manual transplanting. These figures are based on the assumption of 50 per cent subsidy on the purchase of the machine. The results of Usman, Habito and Duff (1998) revealed that in Pakistan manual labour requirements have been considerably reduced by farm mechanization.

3.3 Tractor and Animal Labour/Live Stock Holdings

The literature shows that there are two main views regarding this hypothesis. One view is about the simultaneous use of bullocks and tractor. This view is justified

on the ground that farmers do keep bullocks either because of tractors breakdown or because tractors cannot do some of the jobs at all or as efficiently as bullocks can do it. For example, Inukai (1970) states that according to the farmers in Thailand, tractors can plough deeply before the pre-monsoon rain starts but cannot be operated effectively in breaking up the soil, particularly in the water logged paddy fields. The best results are, therefore, achieved by a combination of tractor ploughing and buffalo pudding. Marsden (1973) pointed out that tractors are not without technical drawbacks. They do not operate efficiently in deep mud and need to be replaced by water buffaloes for harrowing in Philippine rice cultivation. This view does not indicate that tractor use does not affect the use of animal labour, but what it does show is that a tractor is not a perfect substitute for a bullock.

The other view is that the tractor is a substitute for bullock labour. For example, Azam (1968) has noted that the work animals must be fed whether they are working or not, while the machinery has no such costs. One of the great benefits of the machinery is that it releases land from fodder cultivation required to maintain draught animals. Accurate estimates of the actual areas released in this way are few, but it appears that in the United State and Western Europe, approximately three acres are needed for feeding one horse. He argued that in the Punjab, Pakistan, excluding Concentrates and Hey, about 1.5 to 2 acres of fodder are needed to maintain a pair of bullock, which represents rather a too much pressure on small holdings. Besides, for small farms of 3-5 acres, a yoke is considered as uneconomical. The mechanization of these farms would result in a mass exodus of bullock labour and the released quantities of fodder and husk is likely to become available to facilitate the substitution of increased number of milch animals on farms.

Raj (1973) says that the inadequacy of pasture in the dry zone probably makes

the cost of maintenance of draught animals relatively high for which reason even small holders of land could have enough incentive to hire tractors for tillage purposes instead of keeping animals for this purpose. It is important to note that both views support the relationship of substitution between tractor and animal labour and even a single case cannot be cited where these two are shown as complements.

Binswanger (1978) has noted that farm mechanization has not adversely affected the livestock holding rather it has increased the milch animal population. Lockwood and Munir (1981) conducted a survey of 88 tractor owning farmers in the Punjab, Pakistan, and observed that tractor farms have reduced the draught animal by 52 per cent and increased the milch animals by 4 per cent.

The study of Shrivastava and Shrivastava (1998) is based on a sample of 40 randomly selected respondents owning 20 tractors and a similar number of farms using bullock in Madhya Pradesh. The results of the investigation demonstrated that the average size of operated holding on the tractor operated farms was substantially higher than those of the farms using bullocks. Tractors help in the timely accomplishment of farm operations and realization of higher cropping intensity, giving greater return per unit of area. Wheat, rice and soybean were the important crops grown by the respondents, which represented more than 70 per cent of gross cultivated area of the farm. For bullock, it was more profitable to hire than to own. As tractors are mainly involved in preliminary tillage operations, so there is no reduction of manual labour input on tractor farms. The use of tractor influenced the increased use of inputs, generating more employment opportunity through extensive as well as intensive utilization of land, expanded output and maximized net return. Behera et. al. (1998) have argued that in order to reduce the cost of operation and time requirements, it is advisable to replace bullock by tractor for the operations such as

transplanting, seeding, weeding and harvesting which are both time consuming and labour intensive.

3.4 Tractor and Yield per Unit of Land

The literature available on this relationship can be classified into two groups. According to one group the relationship between mechanization and yield per unit of land is positive. For example, a study conducted by the Indian Council of Applied Economics in Muzafarnagar District of India, in 1973, using a sample of 60 farms for the crops of wheat and sugar cane, showed that there were differences in yields between fully mechanized and non-mechanized farms of 1.7 and 31.2 quintals (one quintal =100 kg.) per acre in the case of wheat and sugar cane respectively (Ali, 1992). In studies of Bangladesh, Ahmed (1977) established that the application of higher fertilizer doses, greater weeding, and intensive irrigation, accompanied by the tractor has led to higher yield on mechanized farms.

Yet some studies have, however, associated the increase in yield to tractors only arguing that tractors with their tremendous power and speed can make timely operation and better seed-bed preparation possible. For example, Jussawala (1949) found that yield per acre in India increased on Government farms by 40 per cent and often more where tractors are used in different farm operations. Gill (1962) reported that in the Punjab, Pakistan, tractor farming gave increased crop yield by 16 to 33 per cent and reduced cost of cultivation by 12 per cent as compared with that of bullock farm.

A well known case has been documented where tractor cultivation induced a dramatic increase in rice yields on the Mwea irrigation scheme in Kenya which is more than justified the tractor costs incurred (Gigioli, 1965). A study by the Punjab Agricultural University in Ferozepure District of India indicated that the yield per acre

of almost all crops was higher on tractor farms both under tube wells and canal irrigation conditions (Punjab Agricultural University, India, 1969). Another study in Haryana, India, revealed that in 1965-67 the yield of wheat, rice, maize and barley increased after the use of tractors while the yield of bajra (millet), mong (pulse), mash(pulse), sugar cane, masoor (lentil) and jawar (sorghum) declined after the use of tractors (Government of Haryana, 1968).

Cline (1970) estimated a regression of yields per hectare against a constant, the number of tractors per hectare, and fertilizer. The results showed a statistically significant positive effect to mechanization on yields. Shaw (1970) concludes that surprisingly, there is very little evidence to show that the introduction of mechanical cultivation has increased crop yields. Abercrombie (1972) states that better soil preparation, including operations such as deep ploughing and sub-soiling, that are only possible with mechanization, increases the yield per hectare. In the case of cotton growing in Uganda, the use of tractors can enable the planting of cotton in early May rather than in early June when manual labour is used. It has been observed that yield increases of about 25 per cent have thereby been achieved which have more than off-set the costs of tractor cultivation (Clayton, 1973). In another study, Marsden (1973) has noted that the yields reported in Japan in 1960 for high mechanized farming were not higher than those reported for land farmed by hoe.

Sharma (1974) in a study of the Karnal District (India) in 1969-70, found a difference in the yields of wheat and rice of 100 kgs. and 156 kgs. respectively per acre in favour of tractor farms over bullock farms. Singh (1974) in his study on the land productivity effects of mechanization showed that yield per acre of wheat was higher on farms using tractors in both Meerut and Janipure, India. Yet in another study in the Punjab (India) Kahlon (1976) showed a significant difference in the yield for

rice, wheat, cotton and sugar cane in favour of tractor farms. In the case of Punjab (India) Roy and Balse (1978) showed that tractor farms had a significantly higher output per acre relative to bullock farms.

Agarwal (1980) found that the use of tractors in India is associated neither with a higher per acre farm output nor with higher per acre employment. These findings were further confirmed by Gill (1983) in his study of Bangladesh. He established that the scope for mechanized cultivation to produce higher yields is limited. Clayton (1983) concluded that increased yield should result from better seed-bed preparation. He added that if used with skill, a tractor will certainly produce a better seed-bed than hand labour, particularly on heavy soils. Increased yields can also come from more timely farm operations, especially planting, which the extra power and speed of the tractor could be expected to facilitate.

Iqbal et. al. (1998) described the present status of mechanization and future strategies for the adoption of mechanized farming in Pakistan. They concluded that mechanization will help to increase productivity. However, small farmers can not afford to have own farm machinery. In order to encourage them to use this technology, contract hiring services may be provided to them. Rane et.al. (2000) are of the view that the use of mechanization in sunflower cultivation is necessary to increase yield. They have quantified that the yield per unit of land increased by 20.45 per cent over the average yield using the conventional methods of sunflower cultivation. However, they have not considered the manual labour requirements of the mechanized and traditional methods of cultivation.

Iqbal et. al. (2002) are of the opinion that tractor ownership plays a positive role in the adoption of recommended seed varieties, which play a significant role in the increase in production. Subhan (2002) is of the opinion that with the adoption of improved agricultural technology in Swat, Pakistan, the productivity of wheat, onion and tomato has been increased by over 50 per cent.

3.5 Tractor and Cropping Intensity

In most of the studies it is shown that tractorization does increase cropping intensity. This was associated with the power and speed of machines involved in performing agricultural operations. For example, Khan (1964) is of the opinion that due to its speed in operations the tractors permit a third crop of rice to be grown in some areas. This is possible because the tractor can prepare the seed-bed ahead of the monsoon rains, and thereby gets the first rice crop in the field much earlier than with the limited power of the bullock and country plough. As such the cropping intensity can be enhanced with the application of tractor.

A study undertaken in Mysore, India, revealed that 61.5 per cent of the farmers gave timeliness of operations as their main motive for buying a tractor (Sarkar and Prahladachar, 1966). In a study conducted in the Ludhiana District of the Punjab (India), it was concluded that cropping intensity could be raised to 191.88 per cent on a 13.4 acre farm by tractorization (Kahlon and Sharma, 1969).

Lawrence (1970) found that both the net private and net social benefits were positive. He attributed increase of 15 to 25 per cent in yield and 200 per cent in cropping intensity to tractor. In the case of India, Chopra (1974) showed that cropping intensity was higher on tractor farms than on bullock farms. McInerney and Donaldson (1975) studied a case of 202 tractor owner formers in the Punjab (Pakistan) and looked in detail into the adverse effects of tractors. They established that tractors did not significantly increase yield per acre and cropping intensity. They found that tractor owners extended their operated holding from 45 to 109 acres after purchasing tractors. This increase in farm size was reported to be from various sources. For example, a 12 per cent contribution came from purchase of land, 42 per cent from land previously rented out, 24 per cent from renting in land from other owners and 22 per cent from land previously

uncultivated. This led to the eviction of tenants at the rate of 4.2 families per tractor farm and a 40 per cent decrease in manual labour use per cultivated acre. They collected data relatively to 1969-70 for after conditions. The data collected were in 1969-70 on recall basis i.e. after 3 years reliability of which is questionable. Binswanger (1978) and Khan M. A. et. al. (1986) is of the opinion that data collected on recall basis are not reliable.

In Tamil Nadu, Umakesan (1971) found a statistically significant increase (i.e. by 20%) in cropping intensity on tractor farms as compared to bullock farms. Another study by Motilal (1973) also established that cropping intensity, though small, was higher on tractor farms. Abercrombie (1973) is of the view that the much greater speediness of mechanization in land preparation is of paramount importance. This is crucial in overcoming the seasonal labour shortages that generally occur even in labour surplus economies. For example, in arid areas where only a limited time is available for land preparation and in tropical areas where multiple cropping is possible, provided the land can be prepared quickly for the next crop. Gotsch (1973) bears out this contention for Pakistan, particularly in the case of vegetables and green fodder. Both these types of crops have short growing seasons and where supplementary water is available several crops can be obtained in a single season provided that old crop residues can be removed, a seed-bed prepared and the new crop planted, all is a matter of days. According to cultivators, themselves this can only be done with the help of mechanical tillage equipments.

Binswanger (1978) after reviewing the relevant studies on the issue concludes that his survey fails to provide evidence that tractors are responsible for substantial increases in cropping intensity, yields, timeliness, and gross returns on farms in India, Pakistan and Nepal. Pudasani (1980) while conducting a survey of traditional and mechanized farms in Bara, Nepal, found that tractor ownership allowed large farms to

achieve higher cropping intensities through speedy and timely operations. In reassessing the Roy and Balse (1978) study in the Punjab (India), Agarwal (1980) concludes that cropping intensity on tractor farms is higher as compared with bullock farms. A study conducted by Ahmad B. (1983) found an increase (11.9%) in cropping intensity on tractor farms in the Punjab, Pakistan. The findings on manual labour displacement were, however, mixed as the use of casual labour was found higher by 84.9 per cent while that of hired labour was found lower by 17.5 per cent on tractorized farms as compared to bullock farms.

3.6 Conclusion

A review of relevant literature suggests that there has been conflicting evidence of the effects of farm machinery (tractorization) in different countries and also with in different regions of the same country. In many cases there has been a tendency to attribute higher yield, cropping intensity and net income on tractor farms. Similarly most of the studies have shown an adverse effect of mechanization on manual and animal labour requirements.

In the contexts of Pakistan, it can be said that the geographical coverage of most of the studies has been rather narrow. Further more, many of the studies have been carried out in the Punjab and Sindh Provinces where the farm mechanization was introduced in the very beginning. From the discussion on the issue in Pakistan, it can be concluded that agricultural mechanization has been thoroughly discussed mainly in the Punjab and Sindh Provinces. However, very little has been said on the issue under reference about the NWFP. Keeping in view the importance of the issue there is a dire need to investigate it in the context of the NWFP. This study will be an attempt to fill in this gap.

CHAPTER 4

AGRICULTURAL MECHANIZATION AND ITS DEVELOPMENT IN PAKISTAN

4.1 Introduction

Agriculture is the oldest profession of man. The word agriculture has been derived from (i) Agri: which means field/soil and (ii) Culture which mans cultivation (Sahibzada, 2000). In the early era the tillage practices were performed by human labour. Subsequently animal labour was used which helped the farming community in the cultivation of land. The introduction of tractor (the main engine of agricultural mechanization) was a great revolution in the development of agriculture. In the following paragraphs we briefly describe the development/use of tractor over the period.

4.2 Agricultural Mechanization: Historical Perspective

Industrial Revolution had revolutionized the methods of production in the industries of Europe by the use of machinery during the 18th and 19th centuries. But due to a number of reasons the mechanization of agriculture did not develop during the same period on parallel line. It was at the end of the 19th century that efforts were made in Europe to harness the power of machines for the development of this sector of the economy. But what was lost on the swings, so to say, was gained on the roundabout. Mechanization of agriculture was late in coming but when it did come it came with a rush. By the beginning of the 20th century it extended to large area of Europe and United States of America[1]

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1. For detailed study of these observations see Bare and Michel (1966); Kaneda (1967) and Franks (1984).

Commenting on the invention of tractor Afzal (1975) elaborated that almost to the end of the Eighteen-century tillage and other agricultural operations all over the world were very different from country to country. Most of the operations were performed by human power. Animal power came to be more widely used towards the end of the Eighteenth-century. In the Nineteen-century, the use of animal power was at its highest. Mechanical power came to be used towards the end of the Nineteenth-century when the first tractor was invented and patented in United States of America (USA) in 1890. This tractor was, however, too cumbersome to work. In 1897 an oil-burning tractor was patented in England (UK) which was comparatively better than that of the USA's. In 1918 USA made a modified tractor which got popularity in the farming community. The use of tractor, however, remained limited till 1935, when hydraulic control equipment was invented and installed on tractors. As a result the number of users in the world enhanced very rapidly.

4.3 Agricultural Mechanization in Asia

In Asia mechanization of agriculture was first of all tried in Japan. As pointed out by Ogure (1963); Johnston (1966) and Franks (1984) that the basic reasons for the experiment in Japan were the same as in other countries in which mechanization was tried i.e. shortage of farm labour and need for increase in per acre production to feed the increasing population. As a result at the end of the Second World War mechanization of agriculture in Japan was taken up in right earnest. It was so successful that on the basis of availability of power per acre productivity Japan led the world in agricultural mechanization. Consequently Japan went ahead of the Industrial Revolution of the UK.

The use of agricultural mechanization in the sub-continent was considered in early 1920's. However, it was not recommended. Sethi (1946) argued that Indian agriculture was largely of subsistence type, operated predominantly on small holdings

and thus opposed mechanization. However, as pointed out by the author, it was recommended that if mechanization was to be introduced, some system like collective, cooperative or joint farming would have to be evolved.

For the application of machinery in agriculture a Royal Commission was appointed in 1928. The Commission in its Report, considered tractorization to be a labour displacing technology and emphasized the need to improve the existing agricultural implements being used by the farmers such that they were well adapted to the capacity of draught animals and locally available repair facilities. Furthermore, the report pointed out the role of mechanization in the development of land heavily infested with deep rooted weeds and grasses. Since then various studies have been undertaken to assess the issue from various angles. The famine Inquiry Commission of 1945, similarly recognized the role of mechanization for the reclamation of waste land. However, it also emphasized the function of mechanization in releasing for food production land that had been previously devoted to fodder production. This report also recognized the labour displacing aspect of agricultural mechanization (Hussain, 1982).

4.4 The Emergence of Agricultural Mechanization in Pakistan: Public Policy and Historical Perspective

The available literature on the issue under discussion in Pakistan reveals that before the 1960's a selective approach - emphasizing both positive as well as negative aspects - to mechanization was advanced. The positive aspects included its role in reclaiming new lands, deeper tillage, and timely operation while the negative aspects, obviously, included its impact on the displacement of human labour[1].

The first major study on agriculture in the post Independence period in Pakistan

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1. For more detail of these and other aspects of agricultural mechanization in Pakistan see Govt of Pakistan (1952); Gill (1967); Azam (1968); Boss and Clark (1969); Ahmad (1975) and Ali, K. (eds) (1986).

was the report of the Agriculture Inquiry Committee of 1951 (Govt. of Pakistan, 1952). The report has also pointed out the mechanization's role in releasing land for food production that had been previously devoted to fodder production for feeding the bullock. The report of Agriculture Inquiry Committee of 1951 though mindful of the labour displacement caused by tractor examined the possibility of the rapid development of barren land and the eradication of weeds in the riveraine areas so as to bring them under cultivation[1]. The committee declared "we depend on imports of most of the fuel oil and lubricants, as also the tractors and implements. These are two serious handicaps. Labour, owing to the high growth rate of population, is abundant. It has got to be provided with employment. For these reasons it would be unwise to follow exactly the same pattern of rapid transaction from animal to tractor power as adopted by other countries like UK, USA and Japan and referred to above. It is estimated that complete farm mechanization in Pakistan would displace at least 2 out of 3 labourers. Such a change in agricultural economy might create a serious problem of unemployment. Caution against too rapid mechanization is, therefore, needed in settled areas as industrial development will take considerable time to absorb the surplus human labour. We must, therefore, develop mechanization to suit our own conditions".

At the time of Independence in 1947 the country had 500 tractors mostly in private sector (Govt. of Pakistan, 1967). In 1953 the Govt. of Pakistan received 110 tractors from Australia as a part of the economic aid of that country to Pakistan. But due to inexperience in the matter and lack of proper organization and co-ordination of

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1. In order to cushion the labour displacement effect of agriculture mechanization, the Committee sought to synchronize agricultural mechanization with the industrial programme.

development effort, much use could not be made of this consignment of tractors received by Pakistan. In 1955, as pointed out by Beg (1971), the government went a step further on the road to mechanization by entering into an agreement with FAO, under which Pakistan promised to take the following measures:

i. To undertake experiments on the introduction of mechanized farming in the country;

ii. Improvement of local implements of agriculture and production of spare parts of the tractor with in the country;

iii. Production of improved implements of agriculture on a large scale and

iv. Arrangement of the training of the tractor drivers and mechanics.

Under this agreement six work shops were established in the country, however, the mechanization process could not get a great breakthrough.

The various studies concerning labour force displacement issues undertaken in Pakistan played an important role in shaping the related policies. In the light of recommendations from various studies the Government of Pakistan implemented appropriate policies from time to time. Reviewing these policy documents one can see how the issue was defined, and coped with over time.

The First Five Year Plan (1955-60) embarked an amount of Rs. 48.7 millions for the development of agricultural mechanization in the country (Govt. of Pakistan, 1955). The term of mechanization was used in its wider sense including any improvement in the traditional implements used for agricultural operations. The plan, however, restricted the use of tractors to the following fields.

i. Reclamation of derelict area and culturable waste land;

ii. Rapid development of land in the new irrigation project area;

iii. Anti-erosion and flood control work;

iv. Dry farming and moisture conservation work; and

v. Any other activity where tractors use is justified for special reasons.

The above observations of the plan give an explanation of the situation that mechanization was not for cultivation purposes like ploughing, planking, seed-beds preparation, harvesting, and threshing.

Also the Food and Agricultural Commission of 1960 (Govt. of Pakistan, 1960), on the one hand pointed out that mechanization may lead to unemployment in Pakistan, while on the other hand it put forward two basic reasons for examining the case of mechanization. These reasons included (a) the assessment whether tractor use may or may not earn/save more foreign exchange than its importation cost and (b) whether by uncapping agricultural production it creates for more jobs in the long run than it displaces.

In the Second Five Year Plan (1960-65) the Govt. of Pakistan earmarked Rs. 63 millions, for the development of agricultural mechanization in the country, but the basic policy regarding tractor cultivation remained the same. This plan also restricted the use of tractor for the rapid development of areas opened up by irrigation projects, for land reclamation and for anti erosion and flood control purposes. However, for the first time it was recommended to explore the possibilities of using small tractor with an aim of saving bullock power (Govt. of Pakistan, 1960-A).

The Third Five Year Plan (1965-70) advocated for the first time a definite shift in the Government policy in favour of agricultural mechanization. It assigned an increasingly important role for farm mechanization for agricultural sector during the plan period. It suggested that the number of tractors in both public and private sectors be augmented and requirements of wheel type tractors by private individuals be met increasingly by both the import and local manufacturing (Govt. of Pakistan, 1965).

The Fourth Five Year Plan (1970-75), pointed out that the surge for mechanization had increased both in public and private sectors. It was recommended to encourage the expansion of farm mechanization in the private sector. The facilities for training of mechanics, drivers and drillers were promised to be extended to the Divisional level (Govt. of Pakistan, 1970-A).

As mentioned in the Fifth Five Year Plan (1978-83) mechanization policy was reviewed in 1975 by the Farm Mechanization Policy Mission (FMPM), comprising Pakistani and FAO experts (Govt. of Pakistan, 1978). The Mission concluded that selective mechanization was essential for agricultural progress and was, in fact, unavoidable. Thus, the Fifth Five Year Plan adopted the same policy of agricultural mechanization as that implemented in the Fourth Five Year Plan period. Recognizing the recommendation made by the FMPM, efforts were made to increase the net population of tractors, excluding replacement, from about 71,000 in 1977-78 to about 111,000 in 1982-83. The Government also decided to undertake assembly and progressive manufacture of tractors and to promote wider use of tractor-drawn implements. As such the local production of tractor manufacturing started in the plan period.

The Sixth Five Year Plan (1983-88) focused on attaining greater self-sufficiency in agriculture and considered modernization of agriculture as one of the main components of this strategy (Govt. of Pakistan 1983). The Plan very clearly stated that "the quantum jump envisaged during the Sixth Plan in the agricultural sector would not be possible without large scale mechanization of the agricultural sector. It is obvious that we have to take measures to shift, as expeditiously as possible, from bullock-based farming to modern tractor-based farming". In April, 1986 the Government set up a National Commission on Agriculture (NCA). The recommendation of the Commission

formed an integral part of the Seventh Five Year Plan (1988-93) strategy.

The Seventh Plan has the objective of accelerating the mechanization of the agricultural sector to achieve a growth rate substantially higher than that of the population growth so that this sector could generate resources for sustained development of the economy with a high degree of self reliance (Govt. of Pakistan, 1988).

The Eighth Five Year Plan (1993-98) mentioned that agricultural mechanization has become necessary for intensifying production (Govt. of Pakistan, 1994). As such the plan envisages a sale of 151, 200 tractors. In the fiscal year (2000-2001), over twenty six thousands tractors were sold so as to increase agricultural productivity (Govt. of Pakistan, 2001).

In the Three Year Perspective Plan (2001-04) it is proposed to add 45 thousands tractors per year to the existing fleet so as to accelerate the mechanization process (Govt. of Pakistan Sept., 2001). The Agricultural Development Bank of Pakistan has stepped up its efforts to give major portion of developmental loan for the purchase of tractor/attachment, etc., (Govt. of Pakistan, 2002).

From the on going discussion it can easily be concluded that virtually there was no agricultural mechanization in Pakistan at the time of its birth. However, despite these difficulties, the process of agricultural mechanization got impetus and as a result the country became a producer of the agricultural machinery. The number of fertilizer producing units increased from 3 in 1962-63 to 15 in 2000. However, Pakistan is still a net importer of fertilizers. Similarly, the manufacturing units of Thresher, Sheller, Reaper Harvester, Drill, Spray Machines and Water Pumps (for tube wells) etc; were increased from 3 to 120 units during the mentioned period[1]. However, in all these

[1] The details of all these developments are given in various issues of *Census of Manufacturing Industry*, Government of Pakistan.

machinery tractor is the most important engine. As most of the above machinery particularly Thresher, Sheller, Reaper Harvester, Drill and Spray Machines are operated through tractor for which the country was entirely dependent on imports. Even today the country is importing tractors, however, they are also domestically produced and the production is given in Table-4.1 below. To meet the ever-increasing requirements of the agricultural sector, the country still needs expansion in the production of agricultural machinery at reasonable prices.

Table-4.1 Production of Tractors in Pakistan (1980-2002)

Sr.No.	Years	Number
1	1981-82	16476
2	1982-83	21089
3	1983-84	31622
4	1984-85	31246
6	1985-86	24815
7	1986-87	22241
8	1987-88	20819
9	1988-89	24639
10	1989-90	19939
11	1990-91	13841
12	1991-92	10077
13	1992-93	16628
14	1993-94	15129
15	1994-95	17063
16	1995-96	16218
17	1996-97	10417
18	1997-98	14144
19	1998-99	26885
20	1999-00	35038
21	2000-01	32413
22	2001-02	35038

Source: Govt. of Pakistan (2003-A) *Agricultural Statistics of Pakistan* 2001-02

CHAPTER 5

THE AGRICULTURAL ECONOMY OF THE NWFP

5.1 Introduction

This chapter has been devoted mainly to elaborate the economic structure of the NWFP and its contribution in Pakistan's agriculture. Most importantly the aim of the chapter is to highlight the farm mechanization and other agricultural related issues of the Province. In this respect a comparison of the performance of agricultural sector in the Province has been made with the national level.

5.2 Geographical Location of Pakistan & the NWFP

Pakistan lies between 24° N and 37° N latitude and between 61° E and 75.5° E longitude. On the North, Pakistan is bounded by the Himalayan Mountains and a small and narrow part of Afghanistan, the Chinese territories of Sinking and Tibat, and Kashmir border on the North and East. Pakistan's border with China is about 599 Kilometers (Kms.). On the west, low dry hills separate Pakistan from Afghanistan. The border of Pakistan with Afghanistan is about 2,253 kms. long. Pakistan has 80 kms. long border with Iran. On the East, it is bounded by the two Indian states of the Punjab and Rajisthan, which covers 1464 kms. The Arabian seas lie to the south of the country.

The North West Frontier Province (NWFP) is one of the four administrative units of Pakistan known as "Provinces". The NWFP, as its name indicates, is situated in the North-west part of the country. Previously the NWFP was a division of the then Punjab province consisting of Peshawar, Hazara and Kohat Districts. In 1901 it was separated from the then Punjab province and was given the status of a Province and it's headquarter (Capital) was established at Peshawar.

The NWFP is bounded on the North and North West by Afghanistan, on the Northeast by the Northern areas, on the east by the Azad State of Jammu and Kashmir and the Punjab province, on the south by D.G.Khan of the Punjab province and in the west by Federally Administered Tribal Areas (FATA) across which lies Afghanistan.

The Province lies between 31.4° and 37.8° North latitudes and 70.1° and 74.7° East longitudes. Its extreme length between those parallels is about 600 kms. and its extreme breadth between these meridians is nearly 400 kms.

The total area of the Province is about 101.74 thousand square Kms. It includes 27.2 thousand square Kms. of tribal belt which has a separate administrative set up controlled by the Federal Government.

The geographical area of the Province is 10.17 million hectares, which is about 13 per cent of the country's geographical area (excluding tribal and northern areas due to unavailability of record). The Province falls into three main geographical groups; i) the rugged mountainous region on the North-West; ii) The comparatively narrow strip of plain and plates between the Indus in the east and the hills in the west, along the boundary with FATA and; iii) the Cis-Indus division of Hazara form a wedge extending north eastward far into the outer Himalayan range.

5.3 Population of Pakistan and the NWFP

According to the 1998 Pakistan Population Census Report (the latest one), total population of Pakistan was 131.5 millions. The rural population of the country was about 88.80 millions which made up about 68 per cent of the total population. The overall growth rate per annum of the population was about 2.45 per cent between the 1981 and 1998 population censuses. The proportion of the rural population declined from nearly 72 per cent in 1981 to nearly 68 per cent in 1998.

The population of the NWFP increased from 11.1 millions in 1981 to 18.0 millions in 1998. However, the population growth rate per annum of the Province declined from 3.3 per cent to 2.8 per cent in the respective censuses. The population growth rate of the Province is higher than that of the national level. The total population of the Province was 13.1 per cent of the country's in 1981, which increased to 13.4 per cent in 1998. As such the Province ranks third in the population of the country.

5.4 The Climate of the NWFP

The climatic conditions of the Province are extremely diversified. In the mountainous regions, in the North, the climate is temperate in summer and intensely cold in winter. On the other hand, the plain regions are the hottest areas in the Province. The air is generally dry, and the daily annual ranges of temperature are frequently very large. The temperature varies from snow fall level in North-East in winter to over 40° centigrade in summer in southern parts. The average rainfall of the Province is about 70 milli meter (mm), which ranges from 36 mm in South to 150 mm in hilly area of North-East.

5.5 Agriculture in the NWFP

Like other parts of the country, the NWFP heavily depends on agriculture. Majority of the active labour force is absorbed by agriculture followed by social and personal services and construction representing 42.1, 21.7 and 14.5 per cent respectively (Govt. of Pakistan, 1998). The major components of agriculture such as farms and farm area, tenurial classification, crops grown, credit facilities, irrigation and mechanization of the Province are presented below.

5.5.1 Farms and Farm Area

Both the number of farms and farm area have been increased at the National and Provincial levels. The number of farms in the country (including the state farms) was

4.07 million having an area of 19.1 million hectares in 1980. The NWFP had 0.5 million farms which had an area of 1.6 million hectares. As such the shares of the NWFP in the total national level are over 23 per cent in farms and 8 per cent in farm area.

According to the Pakistan Census of Agriculture 2000, the total number of agricultural farms in the country increased to 6.6 million with an area of 20.4 million hectares. These farms also include 170 state managed farms comprising an area of 0.03 million hectares. The increase in the agricultural farms over the period is mainly due to the distribution of lands among the family members. The increase in the area may be due to mechanization, which is used to bring the waste land under cultivation. The share of the NWFP in the total farms and farm area was over 20 and 11 per cent respectively.

5.5.2 Cultivated Area

On the average of 2002-03 total cultivated area of the country was 22.11 million hectares of that 15.58 million hectares was net area sown (i.e. 70 per cent of the cultivated area) and the rest was current fallow. Similarly, total reported area of the NWFP was about 8.34 million hectares, which was about 14.3 per cent of the country. The forest area was 1.30 million hectares and this accounted for 37.8 per cent of the forest area of Pakistan. Cultivated area of the Province was 1.9 million hectares which was 8.6 per cent of the country. The net area sown of the Province was 8.9 per cent of the country.

5.5.3 Tenure Classification and Farm Fragmentation

According to the Pakistan Census of Agriculture 2000, out of the total 6.6 million farms in the country, 78 per cent were owner cultivated, 8.4 per cent owner cum tenant and 14 per cent tenanted farms. According to the classification at the provincial level, 83 per cent of the farms were owner, 6 per cent owner-cum-tenant and 11 per cent tenanted farms.

The tenancy classification has been considerably changed over the last few decades. For example, when compared to Agricultural Census 1980 the number of owner cultivated has increased by 42 per cent, the reduction in owner cum tenant is of 57 per cent and that of tenanted farm is 46 per cent.

According to Agricultural Census 2000 report, total number of fragmented farms in the country was nearly 2.6 millions which are over 39 per cent of the total farms. Table 5.1 below gives the overall picture of fragmentation in the country.

Table 5.1 Number of Farm Fragmentation and its Average Area in Pakistan and Provinces

Locality	Total Farms	Fragmented Farms		Area/Fragment (hectares)
		No.	% of Total	
Punjab	3864070	1438018	37.21	2.7
Sindh	1069882	270150	25.25	5.7
NWFP	1356234	723062	53.31	1.3
Baluchistan	329868	170377	51.65	6.3
All	6620054	2601607	39.29	2.8

Source: Govt. of Pakistan (2003), *Pakistan Agriculture Census 2000*, PP.32-39

The above table exhibits that the highest figure of fragmented farms (in terms of percentage) is that of the NWFP. Similarly, per fragment area of the Province is the lowest one in the country. Per fragment area of the Province is 1.3 hectares against 2.8 hectares at the national level. This means that per fragmented area of the Province is just 46.4 percent of that of the national level. This means that in the NWFP the area distribution in the small packet is higher than all other provinces. It is so because in terms of area the NWFP is the smallest Province of the country. The low application of agriculture machinery at the provincial level may be due to the small land holding. McInerney and Donaldson (1975), Theodore and Mai (1984) and Jehanzeb (1999) are also of the view that farm mechanization has been mainly adopted by large farm size. Similarly Gotsch (1973) and Iqbal et. al. (1998) have pointed out that farm mechanization has mainly helped the large farms.

5.5.4 Area and Production of Major Crops Grown in the NWFP

In the NWFP, on the annual average of 1995-2000, the bulk of the area (i.e. 41.2 per cent of the cropped area) was devoted to wheat, followed by maize with 25.6 per cent, fodder with 6.5 per cent, pulses with 5.5 per cent, sugar cane with 5 per cent, rice with 3.1 per cent, fruits 2.2 per cent and the rest 10.9 per cent is accounted for sugar beet, tobacco, oil seed, potato, rice, jowar (sorghum) and other miscellaneous crops[1]. Area and per hectare yield of the major crops of the Province are given in Table-5.2 and Table-5.3 respectively. In the following paragraphs we give a brief of some of the major crops grown in the Province.

5.5.4.1 Food Crops

In terms of area wheat, maize and rice are the major food crops in the Province. We summarize the area and production of these crops below:

i. Wheat

Wheat is the major staple food crop grown everywhere in the Province. On the annual average of 1980-85, area under the crop accounted for 801.5 thousand hectares having a production of 926.7 thousand tonnes. In 1995-2000 the area and production on annual average, stood at 858.2 thousand hectares and 1182.5 thousand tonnes respectively showing an increase of 7.07 per cent in area and 27.60 per cent in production. Of the increase in production, 34 per cent was due to increase in area and 66 per cent was due to increase in per hectare production. The area and production of the Province, on the annual average of 1995-2000, are 10.33 and 6.48 per cent respectively of the country's level. The production share of the Province is lower than that of its area contribution. The main reason is that the per hectare yield of the Province is the lowest one in the country, as it is about 62 per cent of that of the national level and much below than that of the Punjab's and Sindh's.

ii. Maize

In the NWFP maize is the second major food crop after wheat. The area under

[1] For the comparison of area, production and yield of all crops (1990-2000) of the province with the country see appendix Table-1.

maize, on annual average, of 1980-85 was 420.4 thousand hectares, which yielded a production of 534.2 thousand tonnes. The corresponding figures, on the annual average, of 1995-2000 stood as 533.9 thousand hectares and 818.2 thousand tonnes respectively.

Table 5.2: Area Under Major Crops in the NWFP (1980-2000)

(Annual Average)

Crop	Area (000) hectares		Per cent Change
	1980-85	1995-2000	
Wheat	801.5	858.2	7.07
Rice	70.1	66.1	-5.71
Maize	420.4	533.9	27.0
Bajra	15.9	7.5	-52.83
Jawar	22.0	11.2	-49.1
Barley	75.7	53.2	-29.72
Sugarcane	98.5	105.8	7.41
Tobacco	26.0	31.1	19.61
Sugar beet	9.7	5.52	-43.1
Pulses	96.6	115.2	19.25
Potato	9.7	9.4	-3.1
Vegetables	16.0	30.5	90.62
Fruits	21.1	44.9	112.79

Sources: Govt. of Pakistan (2004), *Agricultural Statistics of Pakistan, 2002-03*
Govt. of Pakistan (1995), *Agricultural Statistics of Pakistan, 1993-94*

Table 5.3 Yield of Major Crops in the NWFP (1980-2000)

(Average Annual)

Crop	Yield/hectare in Kg.		Per cent change
	1980-85	1995-2000	
Wheat	1156	1378	19.20
Rice	1597	1920	20.2
Maize	1272	1532	20.44
Bajra	438	533	21.69
Jawar	438	643	46.80
Barley	782	1038	32.74
Sugarcane	39500	45400	14.94
Tobacco	1817	2232	22.84
Sugar beet	26200	27100	3.44
Pulses	409.9	437.5	6.73
Potato	9600	11800	22.92
Vegetables	13700	10911	-20.35
Fruits	10511	11501	9.42

Source: As of Table 5.2 above.

Per hectare yield increased from 1272 kilograms (kgs.) in 1980-85 to 1532 kgs. in 1995-2000 showing an increase of over 20 per cent. Of the increase in total production, 51 per cent was due to increase in area and 49 per cent due to increase in per hectare yield. The maize area of the Province is 56.52 per cent and production is 52.25 per cent respectively of the country. These figures show that production share of the Province is lower than its area contribution. The main reason is the low productivity, which is nearly 64 per cent of that of the national level.

iii. Rice

Production of the rice crop is on increasing trend in the Province. On the annual average of the 1980-85, the area and production accounted for 70.1 thousand hectares and 112 thousand tonnes respectively. The annual figure of area and production changed to 66.1 thousand hectares and 126.9 thousand tonnes respectively in 1995-2000 showing a decrease in area and increase in production. The per hectare yield increased from 1597 kgs. in 1980-85 to 1970 kgs. in 1995-2000 showing an increase of over 20 per cent. The area and production share of the Province at the country level, on the annual average of 1995-2000, are 2.83 and 2.82 respectively. The yield per hectare of the Province is lower than that of the national level.

iv. All Cereals

Area under all cereal crops, on yearly average, during 1980-85 was 1405.6 thousand hectares and the production was 1650 thousand tonnes. In 1995-2000, on the annual average, the area under cereal crops increased to 1530.1 thousand hectares which gave a production of 2194.0 thousand tonnes. The production has shown an increase of 544 thousand tonnes during the period. Of the increase in production, 27.3 per cent was due to the increase in area and 73 per cent was due to the increase in per hectare production. Per hectare output of cereals crops of the Province is lower than that of the national level.

5.5.4.2 Cash Crops

The NWFP has a very important position in some of the cash crops. Most important cash crops of the Province are sugar cane, tobacco and sugar beet. Area,

production and yield of these crops are briefly described below.

i. Sugar cane

On the annual average of 1980-85, the area under the crop stood at 98.5 thousand hectares which provided a production of 3892.1 thousand tonnes as such per hectare yield is 39.5 tonnes. The annual average area and production figures during 1995-2000 increased to 105.8 and 2803.5 thousands respectively and per hectare yield came to the level of 45.4 tonnes (an increase of 15 per cent). The area and production of the Province are 10.27 and 9.93 per cent respectively of that of the country's level. Per hectare yield of the Province is nearly 96 per cent of that of the national level.

ii. Tobacco

The NWFP has a very dominant position in tobacco production. On the annual average of 1980-85 the area under the crop was 26.0 thousand hectares (58.3% of that of the country's) from which 47.2 thousand tonnes production was obtained. During 1995-2000, the annual average area was 31.1 thousand hectares, which gave output of 69.4 thousand tonnes. During these mentioned periods the per hectare yield increased from 1817 kgs. to 2232 kgs. (i.e. an increase of 23 per cent). Of the total increase in the production 41.6 per cent was due to increase in area and 58.4 was due to increase in per hectare yield.

iii. Sugar beet

The NWFP is the only Province of Pakistan where sugar beet is grown and white crystal sugar is produced from it. During 1980-85 the annual average area under the crop was 9.7 thousand hectares and 259.8 thousand tonnes output was received from it (i.e. per acre yield is 26.2 tonnes). During 1995-2000, the annual average area was 5.5 thousand hectares, which gave production of 149.1 thousand tonnes (i.e. per hectare yield is 27.1 tonnes). As such the increase in yield per hectare is 3.4 per cent.

5.5.4.3 Pulses

Area under all pulses increased from the annual average of 96.6 thousand hectares in 1980-85 to 115.2 thousand hectares in 1995-2000. The production figures increased from 39.6 thousand tonnes to 50.4 thousand tonnes respectively showing an

increase of 6.5 per cent in per hectare output. The provincial's share, at the national level, of area and production stood as 7.5 and 5.5 per cent respectively. Per hectare yield of the Province is lower than that of the national's level.

5.5.4.4 Fruits

Area under all fruits in the Province was 21.1 thousand hectares and its production was 291.3 thousand tonnes on the annual average of 1980-85. On the annual average figure of 1995-2000, area increased to 44.9 thousand hectares (increase of nearly 113 per cent), which gave output of 516.4 thousands tones (an increase of 77 %).

5.5.5 Cropping Pattern

In Pakistan (also in the NWFP) there are two crop sessions known as "Kharif" and "Rabi" crops[1]. At the country level, as reported by Pakistan Agriculture Census 2000, area under kharif crops was 44 per cent of the cropped area, Rabi crops area was 54 per cent of the cropped area and 2 per cent was covered by orchards. In the NWFP the kharif and Rabi crops area accounted for 39 and 60 per cent respectively whereas one per cent area was covered by orchards.

5.5.6 Cropping Intensity

The overall cropping intensity[2], as reported by Agriculture Census 2000, both at the national and provincial levels stood at 142 per cent each. Both at the national and provincial levels cropping intensity varied with in the tenurial status and also at farm size. At the national level it was 140, 146 and 147 respectively for owner, owner-cum-

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[1] Kharif Crops are sown in summer and harvested in late summer or early winter. The important kharif crops in Pakistan are cotton, rice, maize, jowar, Bajra, Sugarcane (which is a full year crop but counted as a kharif crop), kharif fodder and vegetables. Rabi crops are sown in winter and harvested in late winter or during early summer. The important Rabi crops are wheat, grain, barely, tobacco, sugar beet and rapeseed and mustered. Also there are rabi fodder and vegetable.

[2] Intensity cropping (ICP) = (Total cropped area/Total cultivated Area) x 100

tenant and tenant cultivators respectively. It was inversely related to the farm size; as for the largest size it was 109 per cent against 168 per cent for the small farm size. At the NWFP level the cropping intensity of the owner, owner-cum-tenant and tenant arrived at 141, 130 and 160 per cent respectively. The farm size, like the country, had inverse relation as the largest had intensity of 110 as against 164 for the smallest size.

5.5.7 Inputs use

i. Fertilizer and Farm Yard Manure

At the national level out of total 6.62 millions farmers, 53 per cent reported the use of chemical fertilizers, while 22 per cent reported the use of both chemical fertilizers and farm yard manure. And 5 per cent reported the use of farm yard manure only (Govt of Pakistan, 2003).

The annual average consumption of fertilizers at the national level was increased from 703 thousand N. tonnes in 1980-85 to 1566.4 thousand N. tonnes in 1995-2000 showing an increase of about 123 per cent. Similarly the local annual production of fertilizers increased from 938.2 thousand N.tonnes to 1996.4 thousand N.tonnes during the mentioned period showing an increase of nearly 113 per cent. However, Pakistan is still a net importer of the chemical fertilizers.

At the provincial level there were 1.356 million farmers, out of which 25 per cent reported the use of chemical fertilizes which is lower than that of the national's level, while 43 per cent reported the use of both chemical fertilizers and farm yard manure which is higher than that of the national's level. Similarly 10 per cent farms reported the use of farm yard manure which is double of that of the national level consumption (Govt. of Pakistan, 2003).

The consumption of fertilizers has been considerably increased over the period at the provincial's level. The annual average consumption of fertilizers which was 97.9

thousand N.tonnes in 1980-85 increased to 149.9 thousand N.tonnes in 1995-2000 showing an increase of about 53 per cent (Govt. of Pakistan, 1995 and 2004). The data show that the increase in the fertilizer consumption of the Province is much lower than that of the national level. The comparatively low increase in the consumption of the Province may be attributed to its more FYM consumption.

ii. Improved Seed

At the national level the annual average distribution of improved seed was increased from about 77 thousand tonnes in 1980-85 to 123 thousand tonnes in 1995-2000. Of the total improved seed distribution, wheat and cotton together accounted for 93 per cent. The rest is covered by rice, maize and oil seed etc. In the NWFP the improved seed distribution was increased from 2.9 thousand tonnes to 6.42 thousand tonnes in the mentioned periods. Of the total distribution of the improved seed in the NWFP in 1995-2000, for example, wheat alone constitutes over 95 per cent followed by maize about 2 per cent. The rest is accounted for cotton, rice and so on.

iii. Plant Protection Measures

The number of farmers reporting the use of plant protection considerably increased from 4 per cent during Agricultural Census 1980 to 27 per cent during Agricultural Census 2000 at the national level. However, at the provincial level it was not considerably increased as the number of farmers reporting use of plant protection measures has increased from 4 per cent to only 5 per cent during the two mentioned Census. In the country, plant protection measures are mainly used by cotton growers (71 per cent). In the NWFP the cotton is grown on a very small area so that could be the reason that the application of these measures is comparatively low in the Province.

iv. Irrigation Water/Land

In Pakistan the major sources of irrigation are surface water followed by underground water or tube wells irrigation. The total water availability was 111.66 million-acre feet in 2002-03. The overall water availability from the canal during this period was 87.04 million-acre feet (MAF). Of that 62.83 MAF was for Kharif and 25.01 MAF was for Rabi season. The share of surface water is 78.6 per cent of the total water use. Total number of tube wells in the country was increased from 257.3 thousands in 1985-86 to 703.1 thousands in 2002-03 showing an increase of 173 per cent or over 26 thousand tube wells per annum (Govt of Pakistan, 2004). Of all the tube wells, about 17 per cent were electric, while 83 per cent diesel. Of the total tube wells about 3 per cent were in the public sector and 97 per cent in the private sector.

The overall water availability of the Province in 2002-03 was 1.37 MAF (1.56 per cent that of the country's). Of the total canal water the Province received 0.88 MAF in Kharif and 0.49 MAF in Rabi.

The number of installed tube wells in the Province was increased from 5.67 thousand in 1985-86 to 12.7 thousand in 2002-03 showing an increase of 124 per cent or over 0.4 thousand tube wells per year (much lower than that of the national level). Of these, 80 per cent were electric while the rest were diesel. Of the total installed tube wells, 11 per cent were in the public sector and 89 per cent in the private sector.

Total irrigated area of the country was increased from 15790 thousand hectares in 1985-86 to 18220 thousand hectares in 2000-03 showing an increase of 15.4 per cent. The irrigated area of the Province was increased from 820 thousand hectares to 960 (5.26 per cent of that of the country) thousand hectares showing an increase of 17 per cent in the said period. The increase in the irrigated land both at national and provincial levels may be attributed mainly to the installation of tube wells. The total cropped area

of the Province was 2040 thousand hectares (12.7 per cent of that of the country) out of which 960 thousand hectares (47 per cent) was irrigated and the rest was unirrigated[1].

v. Livestock Holdings

Livestock holdings occupy an important position in the rural areas of Pakistan. They are also a primary source of income of many families in the mountains area, and in the dry tracts where (agronomic) crops cannot be grown mainly due to inadequate irrigation (water).

The total livestock population of the country stood at 110.25 million heads. In the NWFP the total livestock holding was 15.92 millions. The detail is given in the following table.

Table 5.4 Livestock Population in Pakistan and in the NWFP

Sr.No.	Type	Total population (In thousands)				NWFP as % of Pakistan
		Pakistan		NWFP		
		All	%	All	%	
1	Cattles	20424	18.52	4237	26.61	20.75
2	Buffaloes	20272	18.39	1395	8.76	6.88
3	Sheep	23544	21.35	2821	17.72	11.98
4	Goats	41166	37.34	6764	42.48	16.43
5	Camels	816	0.74	65	0.41	7.96
6	Horses	334	0.31	47	0.29	14.07
7	Asses	3559	3.23	534	3.35	15.00
8	Mules	132	0.12	60	0.38	45.4
9	All	110247	100.00	15923	100.00	14.44

Source: Govt. of Pakistan (2004) *Agricultural Statistics of Pakistan 2002-03*, p.189.

The high percentage share of the Province in cattle population is mainly due to its involvement in farming. The bullock users (in terms of percentage) of the Province is the highest in the country.

[1] The detail of the area irrigated by different sources in Pakistan and the NWFP (1990-2002) can be seen in Appendix Table 25.

vi. Agricultural Credit

Agricultural credit facilities play a considerable role in the development of agriculture. For this purpose Agricultural Development Bank (ADBP) was established in the public sector in 1964. The Bank provides loan to the farming communities at a nominal markup rate as compared to other lending institutions. In addition to this majority of the commercial banks and other institutions provide credit facilities to the farmers.

Distribution of agricultural credit was increased from Rs. 12.5 billions in 1985-86 to Rs. 57.3 billion in 2002-03 showing an increase of over 358 per cent, which means annual growth rate of over 9 per cent. The share of the ADBP was nearly 51 per cent, Cooperative Banks 10 per cent and so on. The share of the NWFP in the ADBP's loan was only about 5 per cent on the annual average of 2000-03. The low disbursement of the loan at the provincial level may be one of the reasons for the thin agricultural machinery based. Of the total ADBP's loans 86 per cent was utilized by small farms (upto 5 hectare holding) and the rest was utilized by large farms. Of the total loan of the ADBP in the NWFP, 30 per cent was spent on fertilizers followed by seed and dairy farming each 19 per cent, tractor and tube wells each 3 per cent and the rest was utilized by fisheries, poultry farming and others (Govt. of Pakistan, 2004).

5.5.8 Agricultural Machinery

From the data taken from the Pakistan Agricultural Census of 2000, it seems that a significant number of farmers (70 per cent) are using tractor and the rest are still using bullock etc.

In the NWFP the tractor provided the motive power on 54 per cent of the farms cultivating 57 per cent of the area. On 17 per cent of the farms, cultivating 20 per cent of the area used both tractor and draught animals, and on 29 per cent of the farms

cultivating 22 per cent of the area draught animals alone were used for motive power.

Almost one decade has passed after the census 1990 was compiled and a lot of changes have occurred in the agricultural sector of the Province. Comparing the Census Reports of 1980 and 1990, we find that during the 10 years period between the two Censuses, the number of tractor using farms in the Province increased from 18 per cent in 1980 to 42 per cent in 1990. During this period 40 per cent of the farmers were using draught animal power and the rest were using combination of tractor and draught animal power for the cultivation purpose. The figures taken from Agricultural Census 2000 show that the number of tractor users in the Province was increased from 42 per cent in 1990 to 54 per cent in 2000. The tractor users' number has been increased but it is still lower than that of the national average. In the study area the overall number of tractor users was 70 per cent, which is nearly similar to the country level. Table-5.5 below provides information about the agricultural machinery owners by farm in the Province and Pakistan.

Table 5.5 Farmers Reporting use of Owned Agricultural Farm Machinery in Pakistan and the NWFP

Sr.No.	Agricultural Machinery	Pakistan		NWFP		NWFP as % of Pakistan
		No.	% of all*	No.	% of all*	
1	Tractor	408881	6	17649	1.3	4.32
2	Tube well	811962	12	12685	0.9	1.56
3	Thresher	213139	3	10512	0.7	4.93
4	Sheller	18007	0.3	3215	0.2	17.85
5	Reaper harvester	23751	0.4	598	0.04	2.52
6	Drill	150949	2	2307	0.2	1.53
7	Spray machine	640037	10	13017	0.96	2.03

* % of all farmers.

Source: Govt. of Pakistan (2003) *Agricultural Census, 2000*, p.271

In the ownership of agricultural machinery the NWFP is lagged behind the national level. The tractor, the most popular agricultural machinery, for example, owners

are 6 per cent of the total farms at the country's level and the corresponding figures for the Province is only 1.3 per cent. At the same time total tractor owners in the Province are 4.3 per cent of the total tractor owners' population in Pakistan.

The bullock users for the tillage practices in the country, as reported in Pakistan Agricultural Census 2000, are 610910. Of the total bullock users in the country, the NWFP's share is as high as nearly 62 per cent. Similarly, the bullock cum tractor users in the Province is 18.45 per cent of the country's total users. Similarly the tube wells availability of the Province is only 1.56 per cent of that of the country. These figures indicate the lowest use of agricultural machinery in the Province. The high percentage share of the Sheller's owner may be due to the fact that over 52 per cent of the maize production of the country is contributed by the NWFP.

CHAPTER 6

GENERAL DESCRIPTION OF THE SAMPLE RESPONDENTS

6.1 Introduction

This chapter describes the salient features of the respondents with special reference to some of their demographic characteristics, such as family size, sex and dependency ratios. The chapter also throws light on economic activities of the household members. The agricultural related issues such as land utilization, cropping pattern, investment and net income from livestock holding of the respondents have been discussed. Comparisons of these issues between mechanized and traditional farms are also given. More importantly the tests (mean and variance-explained in Chapter 2) have been applied on the input and output data of the mechanized and traditional farms and also on their respective sizes and tenancies.

6.2 Family Size

Numbers of household members may have an important influence on the economic activities of the sample respondents. Keeping this in view, we briefly explain the overall family size of the sample respondents.

The average family size of the household stood at 8.1 which is at par with Pakistan Agricultural Census 2000 average of the Province. Family size per house hold of the mechanized and traditional farms was 7.4 and 9.7 respectively. This means that the family size of the mechanized farms is nearly 76 per cent of that of the traditional farms. The average family size of the mechanized farms was 6.9 for owner cultivators and 8.2 for tenant cultivators. The average family size of the traditional farms was 9.3 for owner cultivators and 10.4 for tenant cultivators. The detail is given in Table 6.1 below.

Table 6.1 Family Size of the Sample Respondents by Tenurial Status & Farm Size

Farming System/ Tenancy	Farm Size					
	Small		Large		All	
	Total H.H*	Family Size	Total H.H*	Family Size	Total H.H*	Family Size
Mechanized	94	6.6	36	9.3	130	7.4
OC*	64	6.4	20	8.3	84	6.9
Tenant	30	6.8	16	10.8	46	8.1
Traditional	48	8.5	22	12.3	70	9.6
OC*	32	8.0	14	12.4	46	9.3
Tenant	16	9.4	8	12.2	24	10.4
All	142	7.2	58	12.3	200	8.1

Source: Based on Appendix Table-2

* H.H. Stands for Household; OC: means owner cultivators

The data in the table show that family size of the traditional farms, for both owner and tenant cultivators, is higher than that of the mechanized farms. It may be due to the fact that the traditional farms prefer large family to manage the farming activities easily.

6.3 Gender and Dependency Ratios

Of the total population, 56 per cent were male and 44 per cent female as such the sex ratio stood at about 1.2, which is nearly the same as of the Provincial Population Census (1998) reported ratio. Of the total population 45 per cent were below 15 years and they have been defined as dependents[1]. The dependency ratio of the sample population is nearly the same as of the country and Province. For detail of the gender and dependency see Table 6.2 below.

[1] Economically active persons are those people of either sex of 15 years or above in age who can participate in the production of economic goods and services. Below 15 years of age of either sex can be considered as dependent. For details please see Government of Pakistan (2003) *Economic Survey 2002-03*

Table 6.2 Sex and Dependency Wises Distribution of the Sample Households

Farming System/ Tenancy & Farm Size	Below 15 Years			15 Years & Above			All		
	Sex			Sex			Sex		
	M	F	All	M	F	All	M	F	All
Mechanized	228	200	428	319	211	530	547	411	958
OC small	93	74	167	148	99	247	241	173	414
OC Large	42	42	84	50	32	82	92	74	166
Ten. Small	50	45	95	68	42	110	118	87	205
Ten. Large	43	39	82	53	38	91	96	77	173
Traditional	164	150	314	208	158	366	372	308	680
OC Small	61	59	120	74	62	136	135	121	256
OC Large	42	36	78	53	42	95	95	78	173
Ten. Small	36	33	69	50	34	84	86	67	153
Ten. Large	25	22	47	31	20	51	56	42	98
All	392	350	742	527	369	896	919	719	1638

Source: Based on Appendix Table-2

Note: M: Stands for Male, & F: stands for Female; Ten: Stands for Tenant cultivators; OC: means owner cultivators

The table reveals that of the total population 58.49 per cent belongs to mechanized farms and the rest to traditional farms. The population of 15 years and above of the mechanized farms is 59.2 % as against 40.8 % of the traditional farms Below 15 years (dependent population) family members of the mechanized and traditional farms are 428 and 314 respectively. The dependent population of the mechanized and traditional farms is 57.7 % and 42.3 % respectively of the total. The dependency ratio for the mechanized farms comes to 44.6 per cent as against 46.17 per cent for the traditional farms.

6.4 Literacy Status of the Respondents

Out of the total 200 respondents 102 were literate. The literacy ratio of the respondents, therefore, stood at 51 per cent, which is nearly the same as of the national level. The ratio was 55 per cent for mechanized farms and 43 per cent for the traditional farms (Appendix Table 2). The respondents' maximum level of education

was graduation and the lowest was primary. However, in the case of traditional farms, the highest educational level was metric. The education level of above metric level was in the mechanized farms. However, there is no significant difference in the literacy ratio between mechanized and traditional farms (Table 6.6). This may be due to the fact that both the communities belong to the same area where metric level educational facilities are available to every willing individual.

6.5 Economic Activities of the Household Members

Of the total working population, 41 per cent were female. A very few (about 6 per cent) female were in jobs in the provincial Education Department (such as school teachers and peons), Health Departments and NGOs, whereas the big majority were housewives.

Of the total labour force (male), about 46 per cent were in agriculture, which is nearly the same as of the national level labour force involvement in agriculture. The number of family members, per household, involved in agriculture of the mechanized farms was 1.52 as against 2.9 for traditional farms (Table 6.3 below). There is a significant difference in the family members' involvement in agriculture between mechanized and traditional farms (Table 6.6). Of the total economically active male population 74.8 per cent were working and the rest were not working which mostly includes the students and a minor number of old age elders.

Table 6.3 **Economic Activities of 15 Years and Above Male Population of the Sample Households.**

Farming Sy./* Tenancy & Farm Size	All	Not Working		Working in Agriculture		Off Farm Working & Income (Rs)		
		No.	%	No.	%	No.	%	Income (000)
Mechanized	319	104	32.6	120	37.6	95	29.8	687.0
OC* small	148	64	43.2	53	35.1	32	21.7	135
OC* Large	50	7	14.0	23	46	20	40.0	293
Ten.* Small	68	19	28	27	39.7	22	32.3	19.5
Ten.* Large	53	14	26.4	18	34.0	21	39.6	168.3
Traditional	208	29	14	121	58.1	58	27.9	268.7
OC* Small	74	10	13.5	44	59.5	20	27.0	63
OC* Large	53	7	13.2	29	54.7	17	32.1	137.4
Ten* Small	50	7	14	31	62	12	24	34.3
Ten* Large	31	5	16.1	17	54.9	9	29	34.0
All	527	133	25.2	241	45.7	153	29.1	956.3

Source: Based on Appendix Table-3,

* Sy.: means System; Ten: stands for tenant cultivators; OC: stands for owner cultivators.

The mechanized farms family labour in agriculture was 37.6 per cent as against 58.1 per cent in the traditional farms. Nearly 29 per cent of the labour force of the sample population was involved in off farm activities (Table 6.3 above). The overall monthly income from these activities was Rs. 956.3 thousands. The number of male population involved in agricultural activities of the mechanized farms was much lower than that of the traditional farms. On the other hand, the off farm employment population of the mechanized farms was more than that in the traditional farms. Moreover, the off farm employments income per month of the mechanized farms was Rs. 7240 per person as against Rs.4632 per person at the traditional farms (i.e. the mechanized farms off farm income was 56.3 per cent higher than that of the traditional farms). The higher off farm income of the mechanized farms was mainly due to their higher educational level.

The table indicates that "not working" male population of the mechanized farms (in percentage terms) is more than double of the traditional farms. It is mainly because the number of male attending educational institutes of the former is more than the latter's.

6.6 No. of Hired Labour Used by Sample Respondents

The sample respondents had two types of labour (i) permanent and (ii) casual (in this report both permanent and casual labours have been placed together & are called "hired labour").

The number of permanent labour (in percentage terms) is higher on mechanized farms as compared to the traditional farms. It is mainly because of the fact that the family members' involvement of the mechanized farms in agriculture is lower than that in the traditional farms. The mechanized farms fill in the gap of manual labour requirements by hiring permanent labour. Also the labour cost of a permanent labour is nearly half of the off farm earning's of an individual of the mechanized farms. If the cost of permanent labour is considered as the opportunity cost of the individual in mechanized farms then his off farm income is much higher than the cost of hired labour.

Table 6.4 No. and Cost of Permanent Labour Engaged by Sample Respondents

Farming System / Tenurial Status	Permanent Labour		Cost of Permanent Labour(Rs)	
	No.	Per cent	Total (000)	Per Person/ Month
Mechanized	75	60	171.3	2284
OC	69	55	158.6	2298
Tenant	6	5	12.70	2116
Traditional	50	40	134.6	2692
OC	50	40	134.6	2692
Tenant	-	-	-	-
All	125	100	305.9	2447

Source: Survey

As can be seen in the table that of the total permanent labour, 60 per cent were hired by the mechanized farms and the rest by traditional farms (owners only). It is mainly because of the involvement of the family labour of the traditional farms in farming is higher due to which their permanent labour requirement is comparatively lower.

6.7 Farm Area of the Respondents

Total farm area of the respondents amounted to 4459.8 Jareeb. Of the total area, 117.7 Jareeb (2.64 per cent) was used for path, building etc; which is considered as waste land. Of the total cultivated area 2920 Jareeb (67.2 per cent) was cultivated by mechanized farms and the remaining 32.8 per cent was operated by traditional farms. The detail is given in Table 6.5 below:

Table 6.5 Farm Area and its Fragmentation of the Sample Respondents

Farming Sy./* Tenancy/size	Land Holding (area in Jareeb)			No. of Fragmentation	Area Per Fragmentation
	Farm area	Wasted	Net area		
Mechanized					
All	2987.1	67.1	2920.0	206	14.2
OC* Small	1162.2	22.7	1139.5	100	11.4
OC Large	755.9	22.2	733.7	41	17.9
All OC	1918.1	44.9	1873.2	141	13.3
Ten*. Small	524	12.2	511.8	39	13.1
Ten. Large	545	10.0	535.0	26	20.5
All Ten.	1069	22.2	1046.8	65	16.1
Traditional					
All	1472.7	50.6	1422.1	228	6.2
OC Small	618.0	13.0	605	98	6.2
OC Large	402.7	18.8	383.9	48	8.0
All OC	1020.7	31.8	988.9	146	6.8
Ten. small	224.2	7.4	216.8	52	4.2
Ten. Large	227.8	11.4	216.4	30	7.2
All Ten.	452.0	18.8	433.2	82	5.3
All Area	4459.8	117.7	4342.1	434	10.0

Source: Based on Appendix Table-4

* Sy. Means system; Ten. meansTenant cultivators; OC: stands for owner cultivators

The overall waste area is about 2.6 per cent of the farm area. The waste area for the mechanized farms is 2.24 per cent as against 3.44 for the traditional farms. The high percentage of the waste land in the traditional farms is due to the large house for their large family. Also this group needs space to keep the traditional farming equipments.

6.8 Land Fragmentation

The over all area per fragmentation was 10 Jareeb where as in the case of mechanized farms it was 14.2 as against 6.2 Jareeb for traditional farms. This indicates that area per fragmentation of the traditional farms is less than half of that of the mechanized farms. This means that mechanization has been generally applied on large piece of land. Such views have also been given by many others like Griffen (1972); Khan (1981); and Shrivastava and Shrivastava (1998). There is a significant difference in the fragmentation between mechanized and traditional farms (Table 6.6). The number of fragmentation per farm averaged at 1.62 for mechanized farms as against 3.36 for traditional farms. This shows that per farm fragmentation of the traditional farms is considerably (more than double) higher than that of the mechanized farms.

6.9 Intensity of Land use (ILU)

ILU represents the cultural area measure in terms of total cultivated area. The ILU for mechanized farms is 97.75 as against 96.56 for traditional farms. This shows that intensity of land use of mechanized farms is higher than that of the traditional farms. However, the difference is insignificant (Table 6.6).

Table 6.6 Mean Differences between Mechanized and Traditional Farms Regarding Family Labour, Literacy, Land Fragmentation, Cropping Intensity, Land use Intensity and Livestock Holdings

Items	Mean of		t-value
	Mechanized Farms	Traditional Farms	
Family labour in Agriculture	1.52	2.9	-11.856*
Literacy (%)	55	43	1.286
Fragmentation (No.)	1.62	3.36	-4.381*
Cropping Intensity (%)	197.8	183.8	1.982**
Land use Intensity (%)	97.75	96.56	1.59
Milch animal (No.)	4.86	3.057	3.140*
Total livestock (N0.)	4.86	4.76	1.89

Source: Based on Appendix Tables 2, 3, 4, 5, 6, 7, 8, 9, 11 and 12
* Significant at 5 %.
** Significant at 10 %

6.10 Cropping Intensity

The overall cropping intensity (ICP) in the sample area is 193.2 per cent, where as it is 197.8 per cent for the mechanized farms, and 183.8 for the traditional farms. As such the mechanized farms have greater ICP. The difference in ICP between mechanized and traditional farms is significant (Table 6.6). This may be attributed to the fact that mechanized farms don't have power shortage and by spending little time, as compared to the traditional farms, can prepare land for the cultivation of next crop. A similar view has also been given by Bose & Clark (1969); Chaudry (1982); Ahmad (1983) and Ali (1992). In the mechanized farms the cropping intensity of small farm tenants is higher (followed by small farm owner cultivators) than large farms. This may be due to the fact that small growers give more appropriate attention to their farms as compared to large farms where diseconomy occurs due to the large-scale management. Such observations have also been reported in Pakistan Agriculture

Census 2000 (Govt of Pakistan, 2003).

6.11 Cropping Pattern of the Sample Area

Generally the respondents grow wheat, maize, sugar cane, tobacco and fodder etc. Wheat is accounted for 20.2 per cent of the cropped area followed by maize 19.4 per cent, Kharif vegetables for 12.5 per cent and so on. The detail is given in Table 6.7 below. The table indicates that both mechanized and traditional farms have devoted major portion of their land to the wheat crop followed by the maize crop. These two crops jointly covered nearly 40 per cent of the cropped areas. Both the categories have devoted land to fodder because it is needed to feed the livestock.

Table 6.7 Cropping Pattern in the Project Area (in Jareeb)

Farming System/ Tenancy & Size	Area Under Rabi Crops						Area Under Kharif Crops					
	Wheat	S.Beet	Tobacco	Vege	Fodder	All	Maize	S. cane	Vege	Fodder	Nursery	All
Mechanized	1224.4	208.3	103.0	361.8	246.4	2143.9	1150.4	504.3	762.3	950.1	265.5	3632.6
OC Small	501.6	80.9	21.3	137.4	76.7	817.9	510.1	200.2	244.9	365.3	115	1435.5
OC Large	280.0	71.2	36.2	77.5	78.8	543.7	263.1	140.6	215.0	228.7	49.4	896.8
All OC	781.6	152.1	57.5	214.9	155.5	1361.6	773.2	340.8	459.9	594.0	164.4	2332.3
Ten Small	197.8	27.2	22.5	76.9	46.9	371.3	192.2	82.5	143.4	178.1	58.1	654.3
Ten Large	245.0	29.0	23.0	70.0	44.0	411.0	185.0	81.0	159.0	178.0	43.0	646
All Tenant	442.8	56.2	45.5	146.9	90.9	782.3	377.2	163.5	302.4	356.1	101.1	1300.3
Traditional	467.3	88.0	60.2	193.2	177.7	986.4	478.9	266.4	284.1	430.0	169.3	1628.7
OC Small	191.0	34.0	36	80	66	407.0	205	112.0	120.0	190.0	86.0	713.0
OC Large	120.6	25.5	11.6	47.6	47.5	252.8	119.5	83.5	71.9	110.2	47.5	432.6
All OC	311.6	59.5	47.6	127.6	113.5	659.8	324.5	195.5	191.9	300.2	133.5	1145.6
Ten Small	87.8	16.0	5.3	31.9	26.6	167.6	86.4	33.3	51.9	55.2	16.0	242.8
Ten Large	67.9	12.5	7.3	33.7	37.6	159.	68.0	37.6	40.3	74.6	19.8	240.3
All Tenant	155.7	28.5	12.6	65.6	64.2	326.6	154.4	70.9	92.2	129.8	35.8	481.3
G.Total	1691.7	296.3	163.2	555.0	424.1	3130.3	1629.3	770.7	1046.4	1380.1	434.8	5261.3

Source: Based on Appendix Tables 6, 7, 8 and 9.

Note: Vege: Means Vegetables; OC: Means Owner cultivators; Ten: Means Tenant cultivators; S.Beet: Means Sugar Beet; S.Cane: Means Sugar Cane.

6.12 Development of Waste Land

Most of the owner cultivators have reclaimed the uncultivated waste areas. The total reclaimed area is over 618 Jareeb (about 22 per cent of the owner cultivators' area) for which agricultural machinery was used for over 2235 hours, that costed the users over Rs. 301 thousands (about Rs 487/Jareeb)[1]. Of the total area of 445.2 Jareeb (about 74%) was reclaimed by mechanized farms and the rest by traditional farms. The respondents were not sure about the period in which they reclaimed the area, so the amount could not be depleted to find out the present cost. However, per Jareeb cost for reclamation of the traditional owner farms is about 22 per cent higher than that of the mechanized farms. This may be due to the more time spent in the traditional farms. The traditional farmers brought small pieces of scattered land under plough which took more time as compared to the mechanized farmers who had large piece of uncultivated land and was concentrated in one or two places, thereby reducing the machinery movement time and hence cost.

6.13 Contact of the Respondents With the Agricultural Department and Fellow Farmers

Of all the 200 respondents, 144 maintained contact with Agricultural Extension Department and fellow farmers for advice. Of all these respondents, 125 maintained contact with both Agricultural Extension Department and fellow farmers. However, 19 respondents (all mechanized) kept contact with only the Agricultural Extension Department. Of all the owner cultivators who contacted the Agricultural Extension Department, 60 per cent were mechanized and the rest were traditional farmers. Similar was the case of the tenant category. The number of mechanized

[1] The detail is given in Appendix Table 10.

tenants having contact with the Agriculture Extension Department was 65 per cent against 35 per cent of the traditional farms. Majority (75 per cent) of the traditional farmers got suggestions from the fellow farmers. The financial position of the mechanized farmers is comparatively better and they can manage to adopt the recommendations of the Extension Department. The traditional farmers are generally poor due to which they can not afford the expenditure involved in the adoptation of the said recommendations of the Department.

6.14 Livestock Holdings

Livestock keeping is one of the major activities of farming community. All the respondents kept 959 (4.80 per farm) animals of various types such as bullock (12.0%) buffalo (40.7%), cow (28.4%), Goat & sheep (18.8%). A brief of the averages holding is given in the Table 6.8 below.

Table 6.8 Per Farm Livestock Holding of the Mechanized and Traditional Farms

Types of animal	Mechanized Farms			Traditional Farms		
	No.(Average)	Price/Animal	Income*	No.(Average)	Price/Animal	Income*
Bullock	-	-	-	1.66	23528.4	-
Buffalos	2.31	29947.7	2266.7	1.28	29588.9	2225.6
Cow	1.61	16102.4	927.5	0.88	14453.2	790.3
Goat/Sheep	0.94	2577.8	187.7	0.84	2253.4	146.5
All Milch animal	4.86	20028.9	1419.4	3.0	17570.5	1227.6
All animal	4.86	20028.9		4.7	19690.0	

Source: Based on Appendix Tables11and 12
*Net Income per month from sale of milk

As can be seen from the above table that mechanized farms kept only milch animals whereas traditional farms kept both milch animals and bullock. The mechanized farms animal population (all milch animals) stood at 4.86 and the overall per head investment cost arrived at over Rs. 20 thousands. The traditional farms kept 4.7 animals (milch animals and bullock) per household with an investment of about Rs. 20 thousands per animal.

As can be seen in Table 6.8 above, the average milch animal population of mechanized farms is 4.86 as against 3.0 in the case of traditional farms. As such the mechanized farms milch livestock holding is significantly higher than that of the traditional farms (Table 6.6). The same view has been incorporated by Binswanger (1978) and Lockwood and Munir (1981) and they have concluded that the mechanized farms have increased the milch animal population.

The net income from the sale of milk of the mechanized farms is slightly higher than that of the traditional farms. The milk can be soled both in urban and rural areas. The milk price in urban area is higher than that in the rural area. The mechanized farms generally sell out the milk in the urban area where they, despite the transportation cost, get comparatively higher return. The traditional farms have comparatively less milch animals (so less milk output) and large family size which increases the amount of self consumption. Mainly because of low output and more self consumption of milk the traditional farms have little surplus for selling. It is, therefore, uneconomical for them to sell the small quantity of milk in the urban area due to high transportation cost. The overall livestock holding (milch animal plus bullock) of the mechanized and traditional farm is nearly equal.

6.15 Credit Facilities

Out of the total 200 respondents, 190 (95%) obtained credit from various sources. Of all the debtors, 40 per cent got formal (from Banks etc.) loan and the rest obtained informal (from relatives and friends etc;) loan. Most of the loans were for fertilizers (42 per cent) followed by livestock (25 per cent), seed (21 per cent) and other (12 per cent) which is the same as of the provincial and country trend (Govt of Pakistan, 2004). The majority of the respondents obtained loan from informal sources where there is no need of documentation etc. The Institutional loan needs a lot of

documentation and involved a lengthy procedure (Suhail, 2003).

6.16 Tenant Evacuation

Of all the 84 owner cultivators of the mechanized category majority (i.e. 64.28 per cent) were associated with farming since long. In other words this majority has inherited the profession of farming. The remaining 30 owners (35.72 per cent) have started farming recently. These respondents were generally idle and were mainly dependent on the share/rent they received from the tenants. Of all the newly inducted owner cultivators, four have bought tractors and evacuated the tenants[1]. The remaining 26 owners (dependent on hired machinery) have initiated farming mainly due to the mechanization. According to all the newly inducted owners the mechanization has made farming easier and less time consumable. As such these owners, who were previously mainly idle, became active labour force and earning hands. Their income from the rent /share was Rs. 1395 per Jareeb where as self cultivation increased their income to Rs.3060 per Jareeb showing highly significant differences of 119 per cent. The evicted tenants (or their friends/relatives etc.) also gave the same reasons for their evacuation. These evacuated tenants have also adjusted them selves in other various occupations as shown in Table 6.9 below.

Table 6.9 Types of Adjustments and Occupations Adopted by the Displaced Tenants.

Adjustment/Occupation	No	Per cent
1. Business (Shop, milk selling, animal Trading)	12	40
2. Construction Work	6	20
3. Transport (Conductor & Helper etc.)	5	17
4. Farm Labour	5	17
5. Other	2	06
6. All	30	100

Source: Survey

[1]Binswanger(1978)has estimated that 1 tractor ,on average, displaced 4.5 tenants.

It appears that a good majority of the displaced tenants were absorbed by small business followed by construction work. Also their income has significantly increased by 26 per cent by adopting new occupations as shown in Table 6.10 below

Table 6.10 The Earning Differences of Evacuated Tenants

Mean of Income/Season from Farming	Mean of Income from new occupations	t-value
12700	15950	2.039*

Source: Survey
* Significant at 5 per cent

Salam (1977); Naseem (1981); & Khan M.A. (1984) have also observed a similar trend of occupations and adjustment of the displaced tenants. It can be concluded that the displaced tenants have improved their income by adopting new professions. During the survey it was also observed that nearly 35 per cent of the evacuated tenants shifted to other parts of the Province particularly to urban areas where the job opportunities are comparatively higher than that in the rural areas.

6.17 Manure Application

The farm yard manure and chemical fertilizers have been used by both mechanized and traditional farms. In the following paragraphs we briefly discuss the use of these inputs.

6.17.1 Chemical Fertilizers

Both mechanized and traditional farms used fertilizers as can be seen in the following table

Table 6.11 Per Jareeb Use of Fertilizer by Types and Nutrient for Wheat and Maize in the Sample Area

Crop/ Category	Types of Fertilizer (Kg.)				Nutrient (Kg.)	
	Urea	DAP	A.Sulphate	All	N	P
Wheat						
Mechanized	47.22	14.32	0.62	62.16	24.43	6.59
Traditional	48.03	3.52	3.12	54.67	23.39	1.62
Maize						
Mechanized	51.93	1.49	3.73	57.15	24.94	0.69
Traditional	50.20	-	0.68	50.88	23.23	-

Source: Based on Appendix Tables 13, 14, 15 and 16

The data in the above table reveal that the consumption of fertilizers of the mechanized farms is higher for both the crops. This may be due to the comparatively good financial position of mechanized farmers who can make arrangement for the purchase of fertilizers.

6.17.2 Farm Yard Manure (FYM)

The use of FYM is a common practice in the sample area. The consumption of FYM is shown in Table 6.12 below:

Table 6.12 Per Jareeb use of FYM for Wheat and Maize by the Sample Respondents

Crop/Category	FYM used (in mounds)
Wheat	
Mechanized	25.98
Traditional	36.63
Maize	
Mechanized	15.80
Traditional	7.89
All	
Mechanized	41.78
Traditional	44.52

Source: Based on Appendix Tables 17 and 18

As can be seen in the table above that the overall FYM consumption (for Wheat and Maize together) of the mechanized farms is lower than that of the traditional farms. The traditional farmers applied 44.52 mounds of FYM as against 41.78 mounds by mechanized farmers and as such the consumption of the former is nearly 7 per cent

higher than that of the latter. This may be due to low consumption of chemical fertilizers by the traditional farms who meet this deficiency by applying more FYM.

6.18 Application of the Tests on input/output data

The tests explained in Chapter 2 have also been applied on the field data (i.e. inputs and output). These tests are applied to see whether there are differences between mechanized and traditional farms in terms of inputs use and output.

In the following paragraphs we first apply the tests on the field data for both the mechanized and traditional farms. After this discussion these stated tests are also applied on the field data by farm sizes and tenancies at the mechanized and traditional farms separately for each crop (wheat/maize).

The tests (means and variance) mentioned above are conducted on the aggregate data (both mechanized and traditional farmers) for inputs and output of each crop separately. The results in Table 6.13 and Table 6.14 are for differences in means and in Table 6.15 are for the difference in variances respectively and have been subsequently elaborated.

Table 6.13. Test of Equality of Means – Wheat Crop

Variables	Mean values of		t-Ratio
	Mechanized Farms	Traditional Farms	
Wheat Area (Jareeb)	10.38	7.08	3.48*
Seed (Kg.)	21.20	21.6	-3.03*
Farm Yard Manure (trolley)	0.52	0.73	-1.88**
Fertilizer (bag)	1.24	1.06	2.05*
Water (Rs.)	45.02	90.09	-30.3*
Rent/other (Rs.)	2134.9	2026.4	6.88*
Human Labour (Hrs)	15.13	71.48	-34.78*
Animal Labour (Hrs)	0.0	3.75	-613.0*
Tractor use (Hrs)	2.01	0.89	3.28*
Output (Rs.)	9956.6	8928.6	8.018*
No. of observation	130	70	-

Source: Based on Appendix Tables 6,7, 19 and 20.

* Significant at 5 per cent.
** Significant at 10 per cent.

Table 6.14. Test of Equality of Mean – Maize Crop

Variables	Mean values of		t-Ratio
	Mechanized Farms	Traditional Farms	
Maize Area (Jareeb)	9.45	7.18	2.99*
Seed (Kg.)	5.47	5.6	-2.51*
Farm Yard Manure (trolley)	0.31	0.2	1.76**
Fertilizer (bag)	1.14	0.99	3.76*
Water (Rs.)	39.98	85.7	-5.53*
Rent/other (Rs.)	1381.1	1428.3	-6.45*
Human Labour (Hrs)	46.3	94.6	-62.6*
Animal Labour (Hrs)	0.0	3.12	-684.8*
Tractor use (Hrs)	1.94	0	856.0*
Output (Rs.)	6204.6	4910.9	28.8*
No. of observation	130	70	-

Source: Based on Appendix Tables 8, 9, 21, and 22

* Significant at 5 per cent.
** Significant at 10 per cent.

Table 6.15: Test of Equality Between Variances of Mechanized and Traditional Forms-Wheat and Maize Crops

Crop/Farming System	RSS	DF	Chow value (Calculated)
Wheat			
Mechanized	0.106	123	
Traditional	0.020	63	31.11*
Combined	0.285	193	
Maize			
Mechanized	0.057	123	
Traditional	0.019	63	5.72*
Combined	0.095	193	

Source: Based on Appendix Tables 19, 20, 21, and 22
* Significant at 5 per cent.

The general impression of the results supports the differences between mechanized and traditional farms. However, they are interpreted in detail below by Ist taking the mean tests to be followed by variance tests.

6.18.1 Tests of Mean

The results of the mean test show the differences in inputs used/output by the two groups. In the following paragraphs the result of each of the input is described.

6.18.1.1 Seed

Tables 6.13 and 6.14 reveal that the difference in the mean use of seed per unit of land of both wheat and maize between mechanized and traditional farms (two groups) is significant. The use of seed is less on mechanized farms as compared to the traditional farms. The reason is that tractor use through deeper tillage, timely operation and better moisture conservation increases the probability of seed germination.

6.18.1.2 Chemical Fertilizers

The difference in chemical fertilizers use is significant between the two groups. The chemical fertilizer use on the mechanized farms is higher than that on the traditional farms. The reason is that the latter's financial position is not as good as that of the former's, the fertilizer application on their farms is comparatively higher.

6.18.1.3 Farm Yard Manure (FYM)

The differences in FYM use on the two groups are significant. The over all (taking both the crops simultaneously) farm yard manure consumption of the traditional farms is higher than that on the mechanized farms. The reason is that the traditional farms chemical fertilizers consumption is comparatively lower and they cover this deficiency by applying more quantity of FYM.

6.18.1.4 Human Labour

According to the mean values, in Tables 6.13 & 6.14, the over all labour use declines with an increase in the use of tractor. The reason is that tractor is a substitute for human labour. The operation performed through manual labour and bullock power can be carried out through tractor use in a shorter time and with comparatively less labour involvement.

6.18.1.5 Irrigation

The irrigation cost of both the crops for the mechanized and traditional farms is significantly different. The cost of irrigation of the mechanized farms is lower than that of the traditional farms. This is mainly due to the more fragmentation of land of the latter. As a result it takes more time and manual labour to arrange the flow of water to different pieces of scattered land.

6.18.1.6 Tractor and Animal Power

The use of both tractor and animal power is significantly different for mechanized and traditional farms (Tables 6.13 and 6.14). This is so because in the case of maize the traditional farms entirely depend on animal power and manual labour whereas the mechanized farms use machinery and manual labour. In the case of wheat the situation is similar with a slight change that both the categories use thresher. As such there are significant differences in the use of tractor and animal power in the mechanized and traditional farms.

6.18.1.7 Output

Tables 6.13 and 6.14 show that the difference between output on mechanized and traditional farms is significant. The reason is that the mechanized farms performed all the tillage practices well in time without any delay giving them higher yield.

6.18.2 Test of Variances

The results of test of equality of variances between mechanized and traditional farms for both the crops are provided in Table 6.15 above. The test shows significant difference in variances in mechanized and traditional farms for both the crops.

The calculated value of Chow-F-ratio for the wheat crop is 31.11 as against the

tabulated value of 1.98, thus the hypothesis of equality between the variances is rejected.

The calculated value of Chow-F-ratio for the maize crop is 5.72 which falls in the rejection region. The Chow-test thus suggests rejecting the hypothesis of equality between variances for the maize crop.

6.18.3 Variances and Means Tests: Comparison Between Farm Sizes and Tenancies in Each Farming System

We have data for two sizes (i.e. small and large) with respect to two tenancies (i.e. owner and tenant) for both mechanized and traditional farms. We, therefore, apply the said tests for making comparison between (i) small and large sizes and (ii) owner and tenant cultivators. In other words we have used Chow and t-tests for observing differences between variances and means in mechanized and traditional farms for wheat and maize as:

i) Making a comparison between small and large farm sizes by ignoring the tenancy (i.e. irrespective of owner or tenant cultivators)

ii) Making a comparison between owner and tenant cultivators and ignoring the farm sizes (i.e. irrespective of sizes).

The results of the test of equality of variances between sizes and tenancies for the mechanized and traditional farms for the wheat and maize crops are presented in Table 6.16 and Table 6.17 below respectively.

Table 6.16: Test of Equality of Variances Between Sizes and Tenancies of the Mechanized and Traditional Farms: Wheat Crop

Farming system/grouping	R.S.S.	D.F.	Chow-Calculated
Mechanized farms			
Size wise			
Small Farms	0.034	87	16.5*
Large Farms	0.006	29	
Combine	0.106	116	
Tenancy wise			
Owner cultivators	0.143	77	
Tenant cultivators	0.020	39	2.37 *
Combine	0.190	116	
Traditional farms			
Size wise			
Small Farms	0.009	40	4.5 *
Large Farms	0.001	14	
Combine	0.020	54	
Tenancy wise			
Owner cultivators	0.003	38	
Tenant cultivators	0.003	16	12.00*
Combine	0.022	54	

Source: Based on Appendix Tables-23 and 24.

Table 6.17: Test of Equality of Variances Between Sizes and Tenancies of the Mechanized and Traditional Farms: Maize Crop

Farming system/grouping	R.S.S.	D.F	Chow-values
Mechanized farm			
Size wise			
Small Farms	0.037	87	
Large Farms	0.013	29	2.01*
Combine	0.057	123	
Tenancy wise			
Owner cultivators	0.038	77	
Tenant cultivators	0.002	39	5.7 *
Combine	0.056	123	
Traditional farms			
Size wise			
Small Farms	0.008	41	
Large Farms	0.005	15	2.94 *
Combine	0.019	63	
Tenancy wise			
Owner cultivators	0.003	39	
Tenant cultivators	0.014	17	2.35*
Combine	0.024	63	

Source: Based on Appendix Tables-23 & 24.

Note: D.F. stands for degree of freedom; R.S.S. Means Residual Sum of Square

* Significant at 5 percent

The test of equality between variances (Tables 6.16 & 6.17) shows the over all significant differences between farms sizes and tenancies in the mechanized and traditional farms for each crop.

The test of equality between means of inputs used and output (Table 6.18 through Table 6.25 below) shows the over all significant differences between farm sizes and tenancies within the mechanized and traditional farms for both the crops. In the light of the results of these tests we have presented these categories (i.e. farm sizes and tenancy wises) separately in the analysis. The detail is given in Chapter 7 (for wheat) and Chapter 8 (for maize) respectively.

Table 6.18 Farm Size-Wise Test of Equality Between Means of Inputs Used for the Production of Wheat in Mechanized Farms.

Variables	Small Farms	Large Farms	t-test
Area (Jareeb)	7.4	14.6	-5.86*
Labour (Hr)			
Own	6.3	7.62	-0.57
Hired	10.98	5.95	3.67*
All	17.28	13.57	3.44*
Tractor (Hr)	2.27	1.83	5.14*
Seed (Kg)	21.04	21.33	-1.72**
FYM (Trolley)	0.49	0.53	-1.81**
Fertilizer (Bag)	1.26	1.23	0.32
Water (Rs)	47.6	43.2	4.88*
Rent/other (Rs)	2145.6	2127.2	0.78
Output			
Main (Munds)	18.58	19.03	-1.69**
By (Bosara)	1.11	1.02	1.01

Source: Based on appendix Tables-6 & 23

* Significant at 5%.

** Significant at 10%.

Table 6.19 Test of Equality Between Means of Inputs Used for the Production of Wheat in Mechanized Farms by Tenurial Status.

Variables	Owner	Tenants	t-test
Area (Jareeb)	10	10.95	-0.65
Labour (Hr)			
Own	3.14	12.21	-12.8*
Hired	11.75	3.25	9.57*
All	14.89	15.46	-1.24
Tractor (Hr)	2.02	2.01	-1.82**
Seed (Kg)	21.46	20.87	2.37*
FYM (Trolley)	0.53	0.50	-1.78**
Fertilizer (Bag)	1.41	1.01	2.15*
Water (Rs)	45.99	43.75	3.04*
Rent/other (Rs)	2159.5	2102.7	3.9*
Output			
Main (Munds)	19.3	18.3	2.02*
By (Bosara)	1.1	0.96	2.501*

Source: Based on appendix Tables-6 & 19.

* Significant at 5%.

** Significant at 10%.

Table 6.20 Farm Size-Wise Test of Equality Between Means of Inputs Used for the Production of Wheat in Traditional Farms.

Variables	Small Farms	Large Farms	t-test
Area (Jareeb)	5.76	8.62	-4.19*
Labour (Hr)			
Own	42.38	43.98	-0.23
Hired	28.59	27.91	-0.038
All	70.97	71.89	-0.58
Animal (Hr)	3.81	3.70	2.108*
Tractor (Hr)	0.89	0.87	1.944**
Seed (Kg)	21.58	21.55	-0.02
FYM (Trolley)	0.70	0.75	-2.209*
Fertilizer (Bag)	1.07	1.06	1.903**
Water (Rs)	89.60	90.90	1.42
Rent/other (Rs)	2048.76	2009.03	1.44
Output			
Main (Munds)	16.59	16.55	1.86**
By (Bosara)	0.94	0.93	1.76**

Source: Based on Appendix Tables-7 & 24.

* Significant at 5%.

** Significant at 10%.

Table 6.21 Test of Equality Between Means of Inputs Used for the Production of Wheat in Traditional Farms by Tenurial Status.

Variables	Owner	Tenant	t-test
Area (Jareeb)	7.12	7.0	0.105
Labour (Hr)			
Own	29.56	59.46	-19.4*
Hired	42.81	10.92	25.7*
All	72.37	70.38	0.49
Animal (Hr)	3.65	3.87	-1.67**
Tractor (Hr)	0.88	0.89	-0.78
Seed (Kg)	21.67	21.42	0.75
FYM (Trolley)	0.87	0.59	1.86**
Fertilizer (Bag)	1.13	0.99	2.92*
Water (Rs)	69.22	114.73	-2.35*
Rent/other (Rs)	2005.4	2051.3	-2.19*
Output			
Main (Munds)	16.51	16.65	-1.808**
By (Bosara)	0.9	1.0	-1.82**

Source: Based on Appendix Tables-7 & 20.

* Significant at 5%.

** Significant at 10%.

Table 6.22 Farm Size-Wise Test of Equality Between Means of Inputs Used for the Production of Maize in Mechanized Farms.

Variables	Small Farms	Large Farms	t-test
Area (Jareeb)	7.4	12.3	-4.92*
Labour (Hr)			
Own	17.34	19.11	-0.313
Hired	28.91	27.64	0.834
All	46.25	46.75	1.099
Tractor (Hr)	2.01	1.83	2.233*
Seed (Kg)	5.53	5.43	1.854**
FYM (Trolley)	0.33	0.35	1.805**
Fertilizer (Bag)	1.16	1.12	2.018*
Water (Rs)	90.87	62.76	-2.082*
Rent/others (Rs)	1383.68	1379.0	1.635
Output			
Main (Munds)	13.78	13.55	1.841**
By (Bundle)	4.95	4.75	2.126*

Source: Based on Appendix Tables-8 & 23.

* Significant at 5%.

** Significant at 10%.

Table 6.23. Test of Equality Between Means of Inputs Used for the Production of Maize in Mechanized Farms by Tenurial Status

Variables	Owner	Tenant	t-test
Area (Jareeb)	9.78	8.48	0.697
Labour (Hr)			
Own	9.38	32.13	-27.919*
Hired	36.02	15.70	24.526*
All	45.40	47.83	-1.87**
Tractor (Hr)	2.00	1.84	2.123*
Seed (Kg)	5.45	5.52	-0.507
FYM (Trolley)	0.30	0.34	2.207*
Fertilizer (Bag)	1.24	1.0	2.268*
Water (Rs)	46.82	29.28	-30.405*
Rent/others (Rs)	1379.17	1384.14	-0.054
Output			
Main (Munds)	13.57	13.81	-1.848**
By (Bundle)	4.67	5.10	-2.097

Source: Based on Appendix Tables-8 & 21.

* Significant at 5%.

** Significant at 10%.

Table 6.24 Farm Size-Wise Test of Equality Between Means of Inputs Used for the Production of Maize in Traditional Farms.

Variables	Small Farms	Large Farms	t-test
Area (Jareeb)	5.98	8.58	-3.701*
Labour (Hr)			
Own	45.35	42.90	0.79
Hired	49.50	51.48	-0.70
All	94.85	94.38	0.72
Animal (Hr)	3.04	3.18	-1.725**
Seed (Kg)	5.67	5.66	0.094
FYM (Trolley)	0.19	0.18	0.656
Fertilizer (Bag)	0.96	1. 02	1.722**
Water (Rs)	92.2	84.4	1.78**
Rent/others (Rs)	1421.46	1433.3	1.03
Output			
Main (Munds)	10.77	10.78	1.732**
By (Bundle)	6.57	5.68	1.238

Source: Based on Appendix Tables-9 & 24.

* Significant at 5%.

** Significant at 10%.

Table 6.25. Test of Equality Between Means of Inputs Used for the Production of Maize in Traditional Farms by Tenurial Status.

Variables	Owner	Tenant	t-test
Area (Jareeb)	7.67	7.0	0.43
Labour (Hr)			
Own	23.55	69.01	-23.5*
Hired	65.77	32.03	25.7*
All	89.32	101.04	-5.9*
Animal (Hr)	2.78	3.54	-2.77*
Seed (Kg)	5.78	5.52	1.09
FYM (Trolley)	0.07	0.33	2.931*
Fertilizer (Bag)	1.09	0.88	1.76**
Water (Rs)	67.89	110.80	4.402*
Rent/others (Rs)	1428.15	1428.57	0.205
Output			
Main (Munds)	10.5	11.11	-2.109*
By (Bundle)	6.6	5.53	1.80**

Source: Based on Appendix Tables-9 & 22

* Significant at 5%.

** Significant at 10%.

CHAPTER 7

RESULT AND DISCUSSION: WHEAT CROP

7.1 Introduction

This chapter describes the importance of the wheat crop in the NWFP. It provides information about the production cost of the crop in the sample area. The price elasticities of the inputs have been calculated. The Marginal Physical Product (MPP) of manual labour, animal labour and tractor is also presented. Manual labour requirements of both mechanized and traditional farms are provided which is followed by a manual labour requirements model.

Wheat is a major staple food item in Pakistan. Every effort is being made to meet the wheat requirements of the country at a reasonable price (Khan and Iqbal , 1981). In terms of area allocated to different crops, wheat is the major crop of Pakistan as well as of the NWFP. On the annual average of 1995-2000, for example, the crop was sown on an area of 8058.5 thousand hectares (over 35 per cent of the country's cropped area) at the national level and 845.1 thousand hectares (nearly 40 per cent of the NWFP cropped area) at the provincial level. In terms of per hectare output the country is much behind many wheat growing countries having more or less similar climate and socio economic characteristics. For example, on the annual average of 2001-2003, Pakistan's per hectare yield was nearly 38 per cent of that of Egypt and 84 per cent of that of India. With in the country, the NWFP per hectare yield, taking the average of 1995-2000, was about 60 per cent and 59 per cent of that of the provinces of the Punjab and Sindh respectively (Govt. of Pakistan, 2004). There is considerable scope for increase in the per hectare yield of the Province (Khan and Iqbal, 1981; Bashir, 1993).

7.2 Inputs Used for Wheat Production in the Project Area

The total area devoted to the wheat crop in the sample area accounted for 1691.7 Jareebs (342.30 hectares). Of the total area, 72.38 per cent was covered by mechanized farms and the remaining by traditional farms.

In the sample area the mechanized farms generally use tractor along with related equipments and manual labour for seed-beds, sowing, harvesting and thresher for getting the wheat output (in the area the agricultural machinery is generally used for the cultivation of the wheat and maize crops). The traditional farms generally carry out the stated operations by applying animal labour, manual labour and thresher. The traditional farms use tractor only for thresher purposes. The thresher is being used by both mechanized and traditional farms[1].

It is worth mentioning to say at the outset that we have estimated elasticities of all inputs and MPP for manual labour, animal labour and tractor as we are interested in finding the effect of these inputs on the production of the crop. To get these

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[1] Generally, there are two different methods of threshing known as "conventional" threshing and "mechanical" threshing. In conventional threshing the harvested wheat is placed on the threshing floor and treated by animal under long twinges of thorny trees intervown with wheat straw. The threshed material is manually winnowed through natural wind currents. Cleaning is done manually by using the broom which separates the piece of straw and unthreshed earpiece from the grain. This process generally takes days per Jareeb. None of the respondent uses the conventional method of threshing. The traditional method of threshing is no more in use in the Province (Shah M.K., 1993).

In mechanical threshing a tractor along with a thresher is used. The tractor and thresher machine are placed near each other such that the thresher machine is revolved with the help of tractor power. The harvested wheat is manually shifted to the thresher which separate grain and straw from each other and the whole process is completed in less than an hour/Jareeb. A combined harvester is another sophisticated type of machine which carries out harvesting and threshing simultaneously. However, this is not used in the sample area because of unavailability.

estimates the Cobb-Douglas function, as described in Chapter 2, has been applied with other mathematical techniques. The model is as:

$$\text{Ln } Y = \text{Ln } (A\, L^{\alpha}\, K^{\beta}\, e^{U}) = \text{Ln } A + \alpha \text{ Ln } L + \beta \text{ Ln } K + U$$

The powers / coefficients (α and β etc.) are the elasticities of the concerned variables. In the entire text the Cobb-Douglas (CD) function has been used in the above manner for various categories, and the concerned variables have been explained with the applied function.

In the following paragraphs we briefly give the overall account of the wheat crop for both mechanized and traditional farms. As mentioned in Chapter 6, there are significant differences between mechanized and traditional farms in terms of inputs use and output, so they have been treated separately. Within mechanized/traditional farms there are significant differences between sizes (small and large) and tenancies (owner and tenant cultivators). As such we present CD production function for each category. First we take mechanized farms and present the models (by sizes and tenancies) which are followed by a combination of all sizes and tenancies simultaneously. The same procedures have also been applied to traditional farms. In a later stage both mechanized and traditional farms have been jointly treated by introducing a dummy variable for mechanization in the model. At the end manual labour requirements of mechanized and traditional farms have been presented which is followed by a manual labour requirements model.

7.3 Mechanized Farms

The total area under the wheat crop of the mechanized farms is 1224.4 Jareebs, which is 57.1 per cent of Rabi season area and 21.20 per cent of the cropped area of the mechanized farms. Total production cost of the mechanized farms stood at Rs. 4365.47 per Jareeb whereas the gross income came out Rs. 9956.60 per Jareeb giving a net profit

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$$\text{Ln } Y = \text{Ln } (A\, L^{\alpha}\, K^{\beta}\, e^{U}) = \text{Ln } A + \alpha \text{ Ln } L + \beta \text{ Ln } K + U$$

The powers / coefficients (α and β etc.) are the elasticities of the concerned variables. In the entire text the Cobb-Douglas (CD) function has been used in the above manner for various categories, and the concerned variables have been explained with the applied function.

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of Rs. 5591.13 per Jareeb. The detail is given in Table-7.1 below.

The table exhibits that the labour input and farm size have negative relation, such that as the farm size increases the amount of labour input decreases. The consumption of fertilizers of the owner cultivators is higher than that of the tenant cultivators. The output quantity of the main output and by-product of the owner cultivators (OC) is higher than that of the outputs of tenants cultivators. This may be due to comparatively higher doses of inputs (seed, FYM and fertilizers etc.) used at the OC level.

Table 7.1 **Per Jareeb Inputs its Cost and Output of the Wheat Crop (Mechanized Farms)**

Categories	Manual Labour		Tractor		Seed		FYM		Fertilizers		Rent/ other minor costs	Water cost	Total costs	Output					Net Income
														Main		By		All values	
	Time (hr)	Cost	Time (hr)	Cost	Qty Kg	Cost	Qty. trolley	Cost	Bag	Cost				Qty	Value	Qty	Value		
OC small	16.9	148.52	2.11	856.80	21.03	252.40	0.51	212.06	1.37	808.80	2173.70	48.44	4500.72	18.73	8430.6	1.13	1410.6	9841.2	5340.48
OC large	12.8	108.13	1.92	820.69	21.91	263.03	0.56	204.05	1.47	938.90	2144.48	43.20	4522.48	19.86	8937.0	1.12	1520.9	10457.9	5936.42
Tenant small	18.2	204.86	2.64	947.90	21.04	273.50	0.48	204.17	1.0	578.40	2082.66	45.07	4335.56	18.27	8219.6	1.06	1499.0	9718.6	5382.04
Tenant large	14.3	185.52	1.74	757.15	20.79	270.34	0.51	191.50	1.02	545.60	2111.40	43.18	4104.69	18.27	8221.0	0.92	1489.7	9710.7	5606.01
All	15.1	155.80	2.01	828.50	21.20	263.50	0.52	202.60	1.24	735.15	2134.90	45.02	4365.47	18.84	8480.0	1.05	1476.6	9956.6	5591.13

Source: Based on Appendix Table-19

Note: OC: stands for owner cultivators; Qty: stands for quantity; 1 bag = 50 kg; 1 trolley = 50 mounds; Cost, Value and Income are in rupees.

The table also indicates the differences in the use of inputs and outputs at the farm size and also at the tenancy levels. For each of these categories we use the production function as discussed earlier. The detail of the function and the co-efficient of variables along with the test values of these categories (sizes & tenancies) for mechanized farms are given at the end of the chapter in Table-7.2 to Table 7.5. However, they have been briefly described below.

7.3.1 Small Farms

The production function (Table 7.2) in log linear form for small farms is as:

$$\underset{}{\text{LnY}} = \underset{(4.727)^*}{7.15} + \underset{(0.724)}{0.04\ \text{LnX}_1} + \underset{(2.686)^*}{0.23\ \text{LnX}_2} + \underset{(0.823)}{0.17\ \text{LnX}_3} + \underset{(1.161)}{0.09\ \text{LnX}_4} + \underset{(2.829)^*}{0.16\ \text{LnX}_5} + \underset{(0.449)}{0.02\ \text{LnX}_6} - \underset{(-0.890)}{0.15\ \text{LnX}_7}$$

In the Cobb Douglas form the above function can be written as:

$$Y = 1277.934\ X_1^{0.04}\ X_2^{0.23}\ X_3^{0.17}\ X_4^{0.09}\ X_5^{0.16}\ X_6^{0.02}\ X_7^{-0.15}$$

$R^2_{(Adj)} = 0.544, \quad F^* = 13.73$

* Significant at 5 per cent

(Figures in parentheses are t-values)

Whereas:

$Y =$	Income (value of the produces)
$X_1 =$	Manual labour cost
$X_2 =$	Tractor cost
$X_3 =$	Seed cost
$X_4 =$	Farm yard manure cost
$X_5 =$	Fertilizer cost
$X_6 =$	Water cost
$X_7 =$	Rent and other minor cost

(The variables defined above have been used in all the categories of mechanized farms.)

The R^2 value shows that over 54 per cent of the variations have been captured by exogenous variables. The F-value gives significant result of the model. The value of R^2 is low. However, it is very common in cross sectional data. Salam (1981) is also of the view that low value of R^2 is not uncommon in cross sectional data.

The powers (coefficients) of the regressors are the income elasticities of the respective variables. Each variable contributes positively to income except X_7 which is mainly rent of the land and other minor costs. As such all our variables have acted as we expected (Sahibzada, 2000). The rent has an insignificant inverse effect on the income which is generally believed to be like that (Subhan, 2002).

For finding the Marginal Physical Product (MPP) of manual labour and tractor the above estimated function has been differentiated with respect to (w.r.t.) X_1 and X_2 and the average value of each variable (from X_1 to X_7) has been substituted. As such the MPP of manual labour and tractor are as:

$MPP_{(labour)}$ = 6.629

$MPP_{(tractor)}$ = 8.057

The MPP values suggest that there is a higher return to scale by manual labour and tractor. Moreover, the return to scale of tractor is higher than that of manual labour return.

7.3.2 Large Farms

The production function (Table 7.3) in log linear form for large farms is as:

$$\underset{\substack{(6.27)^* \\ (1.288)}}{LnY = 6.11} + \underset{\substack{(6.638)^* \\ (0.123)}}{0.04\ LnX_1 + 0.84 LnX_2} + \underset{\substack{(1.95)^{**} \\ (0.202)}}{0.001 LnX_3 + 0.003 LnX_4} + \underset{\substack{(1.756)^{**} \\ (-1.39)}}{0.004 LnX_5 + 0.17 LnX_6 - 0.19\ LnX_7}$$

In the CD form we can present the above function as:

$$Y = 452.14\ X_1^{0.04}\ X_2^{0.84}\ X_3^{0.001}\ X_4^{0.003} X_5^{0.004}\ X_6^{0.17}\ X_7^{-0.19}$$

$R^2_{(Adj)} = 0.57$, $F^* = 26.6$

* Significant at 5 per cent

** Significant at 10 per cent

(Figures in parentheses are t-values)

The value of R^2 shows that 57 per cent of the variations in the dependent variable have been covered by the inclusion of independent variables. F-value also shows significance of the model. All the co-efficients of the independent variables are

positive (except rent). The rent has an adverse but insignificant effect on income.

The powers (coefficients) of the variables are the respective income elasticity of each variable and the highest is that of tractor which shows that large farms, as compared to small farms, have got more benefits from this inputs. Differentiating the above equation with respect to X_1 and X_2 and substituting the average value of all the variables (from X_1 to X_7) we get the MPP of manual labour and tractor as:

$MPP_{(Labour)} = 21.00$

$MP_{(Tractor)} = 81.20.$

This means that the large farms are getting high return to scale from these inputs. As far as the MPP of both the key inputs by farm sizes (small and large) are concerned it is observed that the MPP of each of the variable is significantly higher in the case of large farms as compared to the small farms. The corresponding figures are 21.0 and 6.6 respectively for large and small farms in case of manual labour. Similarly, the MPP of tractor on the large farms is about 10 times that of the small farms. This implies that the marginal efficiency of both the main inputs (manual labour and machinery) is considerably higher on large farms.

7.3.3 Owner Cultivators

The production function (Table 7.4) in log linear form for owner cultivators is as:

$$\underset{\quad (2.031)^*}{\text{Ln } Y=5.49+}\underset{(0.63)}{0.05\text{Ln}X_1}+\underset{(1.51)}{0.37\text{Ln}X_2}+\underset{(1.45)}{0.33\text{Ln}X_3}+\underset{(1.53)}{0.05\text{Ln}X_4}+\underset{(3.57)^*}{0.13\text{Ln}X_5}+\underset{(0.08)}{0.015\text{Ln}X_6}+\underset{(0.52)}{0.04\text{Ln}X_7}$$

In CD form the above function can be expressed as:

$$Y = 242.25\ X_1^{0.05}\ X_2^{0.37}\ X_3^{0.33}\ X_4^{0.05}\ X_5^{0.13}\ X_6^{0.015}\ X_7^{0.04}$$

$R^2_{(Adj)} = 0.38, \qquad F^* = 10.09$

* Significant at 5 per cent
** Significant at 10 per cent
(Figures in parentheses are t-values)

All the coefficients are positive and R^2 value suggests that 38 per cent of the variations have been captured by exogenous variables. F-value also supports the significance of the model.

All the powers (coefficients) are the income elasticities of the respective variables. All the inputs are favorably contributing to the income. Differentiating the above function w.r.t X_1 and X_2 and putting average value of all the variables (from X_1 to X_7) we get MPP of manual labour and tractor as:

$MPP_{(Labour)} = 1.82$

$MPP_{(Ttractor)} = 1.948.$

The MPP values indicate that these two inputs have an increasing trend effect on income. Also the MPP of tractor is higher than that of manual labour.

7.3.4 Tenant Cultivators

The production function (Table 7.5) in log linear form for the tenant cultivators is as:

$$LnY = 7.83 + 0.06LnX_1 + 0.21LnX_2 + 0.21LnX_3 + 0.01LnX_4 + 0.14LnX_5 + 0.05LnX_6 - 0.19LnX_7$$
$$(5.891)^* \quad (2.032)^* \quad (4.354)^* \quad (1.398) \quad (0.903) \quad (0.534) \quad (0.926) \quad (-1.553)$$

The above function can be written in its original CD form as:

$$Y = 2509.9X_1^{0.06} X_2^{0.21} X_3^{0.21} X_4^{0.01} X_5^{0.14} X_6^{0.05} X_7^{-0.19}$$

$R^2_{(Adj)} = 0.49, \quad F^* = 2.77$

* Significant at 5 per cent
(Figures in parentheses are t-values)

All the coefficients (except rent) are positive and 49 per cent of the variations have been explained by the inclusion of the independent variables. The F-value shows significance of the model. In the case of this category the rent is negative and insignificant.

All the powers (coefficients) are income elasticities of the respective variables. Differentiating the above function w.r.t X_1 and X_2 and substituting the average value of

all the variables (from X_1 to X_7) we get MPP of manual labour and tractor as:

$MPP_{(Labour)}$ = 1.493

$MPP_{(tractor)}$ = 8.669

The MPP results show that both manual labour and tractor have an increasing return to scale. As far as the MPP by tenurial status is concerned no significant difference is observed within the category of owner farms for these key inputs. However, between the two categories of owner farms and tenant farms, the MPP of tractor is remarkably higher on the farms operated by tenants. The respective figure for the tenant category is more than four times of the owner farms. This shows that the machinery plays a very vital role in the category of tenant farms. However, tenurial status does not have meaningful influence on the efficiency in the case of manual labour.

7.3.5 All Sizes and Tenancies

The production function for wheat in log linear form estimated for the entire mechanized farms is given in Table 7.6. However, a brief of the same is as:

$$LnY = 7.2+0.03LnX_1+0.23LnX_2+0.15LnX_3+0.009LnX_4+0.05LnX_5+0.03LnX_6 -0.13LnX_7$$
$$(10.03)^* \ (0.78) \ (4.154)^* \ (2.863)^* \ (1.271) \ (3.904)^* \ (0.855) \ (-0.264)$$

The above equation in CD form can be produced as:

$$Y = 1339.43 \ X_1^{0.03} \ X_2^{0.23} \ X_3^{0.15} \ X_4^{0.009} \ X_5^{0.05} \ X_6^{0.03} \ X_7^{-0.13}$$

$R^2_{(Adj)} = 0.475, \quad F^* = 10.65$

* Significant at 5 per cent

(Figures in parentheses are t-value)

The F-value shows significance of the model. The R^2 value shows that over 47 per cent of the variations have been captured by the exogenous variables.

Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average values of all the variables from X_1 to X_7 we get

$MPP_{(labour)}$ = 4.62,

$MPP_{(tractor)}$ = 6.49

Both the values suggest that there is high return to scale in case of the mechanized farms. Moreover, the tractor return is higher than that of the manual labour. This means that any additional investment in mechanization will comparatively yield better results than that in the manual labour.

7.3.6 Conclusion

The production functions by size (i.e. small and large farms) and by tenancy (owner and tenant cultivators) of the mechanized farms show that in all the cases the rent input has an adverse effect on the income level. However, in the case of owner cultivators this input contributes positively to the income, which shows that they can increase their income by adopting self cultivation. The sum of the coefficients of the variables for various models (as shown in detail in Table 7.2 to Table 7.5) gives 0.56, 0.88, 0.87 and 0.49 value for small, large, owner and tenant cultivators respectively. As each of the summation is less than one, so every category is producing in decreasing return to scale. However, the large farms are comparatively better than all others followed by owner cultivators. The lowest value, in the case of tenant, is mainly due to the highly negative effect of rent on their income. It is important to note that all the categories, described above, are producing at the stage of decreasing returns to scale which explains that there is a sufficient room for the improvement in their performance by re-allocating all the inputs optimally[1].

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[1] As sum of the elasticities is less than one which means that the percentage change in output is less than the percentage change in inputs (Gravelle, H. and Ress R. (1981)and Seo, K.K. (1984). Jehanzeb (1999) is of the view that in the case of production function if the elasticity is less than one (less elastic) then there is considerable scope for improvement.

The MPP values of all the groups for manual labour and tractor give high return to scale. Moreover, the MPP of tractor is greater than that of MPP of manual labour which means that mechanized farms can improve their performance if mechanization is properly adjusted.

7.4 Traditional Farms

The traditional farms devoted 467.3 Jareeb of land to the wheat crop which is 47.3 per cent of the Rabi season area and 17.86 per cent of the cropped area of the traditional farms of the project area. The overall total production cost of the traditional farms arrived at Rs. 5271.49 per Jareeb and the gross income stood at Rs. 8928.6 per Jareeb giving a net income of Rs. 3657.11 per Jareeb. Both by size and tenancy wises cost accounts/Jareeb of the sample respondents are given in Table-7.7 below.

Table 7.7 Per Jareeb Inputs, its Costs and Output of the Wheat Crop (Traditional Farms)

Categories	Manual Labour		Animal labour		Tractor		Seed		FYM		Fertilizer		Rent/ other minor costs	Water cost	Total costs	Output					Net Income
																Main		By		All values	
	Time (hr)	Cost	Time (hr)	Cost	Time (hr)	Cost	Qty (kg)	Cost	Qty Trolley	Cost	Bag	Cost				Qty	Value	Qty	Value		
OC small	70.14	747.04	3.63	127.17	0.88	1082.80	21.73	315.05	0.74	339.02	1.13	539.80	2005.08	71.44	5227.10	16.36	7364.4	0.93	1502.6	8867.0	3639.6
OC large	74.53	702.16	3.67	128.56	0.88	1116.50	21.63	313.70	0.94	445.40	1.13	641.75	2005.70	67.20	5420.97	16.65	7491.4	0.86	1432.4	8923.7	3502.83
Tenant small	72.18	781.17	4.08	142.65	0.92	942.80	21.36	427.20	0.64	310.52	0.98	440.30	2111.97	114.50	5271.11	16.94	7621.7	0.95	1456.0	9077.7	3806.59
Tenant large	69.24	755.90	3.74	130.80	0.87	1003.60	21.46	429.13	0.57	269.70	0.99	431.40	2012.44	114.80	5147.77	16.47	7410.0	1.02	1484.4	8894.4	3746.63
All	71.48	753.30	3.75	131.35	0.89	1045.11	21.56	366.65	0.73	344.56	1.06	513.98	2026.45	90.09	5271.49	16.58	7459.3	0.94	1469.3	8928.6	3657.11

Source: Based on Appendix Table-20

Note: OC: stands for owner cultivators; Qty. stands for quantity; 1 bag =50 kg; 1 trolley = 50 mounds; Cost, Value and Income are in rupees.

As said earlier (Chapter 6) there exists significant differences in terms of inputs and output between sizes and tenancies, so we give production function for (i) small and large farm sizes (by ignoring the tenancy) and (ii) owner and tenant cultivators (by ignoring the farm sizes) for the traditional farms.

The results of the CD production function by both size and tenancy wises of the traditional farms are given at the end of the chapter in Table 7.8 to Table 7.11 and a brief summary for each category is given below:

7.4.1 Small Farms

The model of the small farm size for the traditional growers (Table 7.8) in log linear form is as:

$$\underset{(2.518)\ *}{LnY=3.72}+\underset{(0.634)}{0.09LnX_1}+\underset{(1.570)}{0.06LnX_2}+\underset{(2.571)*}{0.37LnX_3}+\underset{(1.562)}{0.18LnX_4}+\underset{(1.70)**}{0.002LnX_5}+\underset{(0.264)}{0.006LnX_6}+\underset{(0.463)}{0.03LnX_7}\underset{(-0.670)}{-0.18X_8}$$

In CD form the above function can be written as:

$$Y= 41.388\ X_1^{0.09}\ X_2^{0.06}\ X_3^{0.37}\ X_4^{0.18}\ X_5^{0.002}\ X_6^{0.006} X_7^{0.03} X_8^{-0.18}$$

$R^2_{(Adj)} = 0.51, \qquad F^* = 11.76$

* Significant at 5 per cent
** Significant at 10 per cent
(Figures in parentheses are t-values)

Whereas:

Y	= Income (Production value)
X_1	= Manual labour (Rs)
X_2	= Animal labour (Rs)
X_3	= Tractor (Rs)
X_4	= Seed cost
X_5	= Farm yard manure cost
X_6	= Fertilizer cost
X_7	= Water cost
X_8	= Rent and other minor Costs

(The variables defined above have been used in all the categories of traditional farms)

All the coefficients of the variables (except rent/other) are contributing positively to the income. The rent has an adverse insignificant effect on income. The fit is 51 per cent good and the F-value shows significance of the model.

Differentiating the above function w.r.t X_1, X_2 and X_3 and substituting the average values of the variables from X_1 to X_8 we get the MPP of manual labour, animal labour and tractor as:

$MPP_{(labour)} = 0.370$

$MPP_{(Animal)} = 1.280$

$MPP_{(tractor)} = 1.111$

The small value of $MPP_{(labour)}$ shows a decreasing return to scale where as the $MPP_{(animal)}$ and $MPP_{(tractor)}$ give high return to scale. The MPP of animal is greater than that of tractor because of the minor application (only for thresher) of tractor.

7.4.2 Large Farms

The model for the traditional large farms (Table 7.9) in log linear form is as:

$$\underset{}{LnY} = \underset{(4.12)^*}{3.2} + \underset{(1.442)}{0.06LnX_1} + \underset{(1.592)}{0.04LnX_2} + \underset{(5.643)^*}{0.45LnX_3} + \underset{(0.014)}{0.007LnX_4} + \underset{(0.311)}{0.0003LnX_5} + \underset{(1.333)}{0.01LnX_6} + \underset{(2.367)^*}{0.07LnX_7} - \underset{(-0.245)}{0.01LnX_8}$$

The above model can be written in CD form as follow:

$$Y = 25.33X_1^{0.06}X_2^{0.04}X_3^{0.45}X_4^{0.007}X_5^{0.0003}X_6^{0.01}X_7^{0.07}X_8^{-0.01}$$

$R^2_{(Adj)} = 0.49, \quad F^* = 22.26$

* Significant at 5 per cent
(t-values are given in the parentheses)

The estimates show significance of the model and 49 per cent of the variations have been captured by exogenous variables.

The powers (coefficients) are the income elasticities of the respective variables. The rent has a negative insignificant effect on the income; however, it is comparatively smaller than that of the small farm size. This may be due to the large sizes farms that can avail the economies of scale. Taking derivative of the above equation w.r.t X_1, X_2, and X_3 and substituting the average values of all the variables from X_1 to X_8 we get MPP of manual labour, animal labour and tractors as:

$MPP_{(labour)}$ = 0.118,

$MPP_{(Animal)}$ = 0.598,

$MPP_{(Tractor)}$ = 0.471.

These values suggest a decreasing return to scale which means that the large farms due to its size have some mismanagement. The MPP values of small and large farms show that the value of the latter category is lower than that of the former one. This means that traditional large farms are comparatively worse than the small farms. It is so because large farms due to its size cannot be operated optimally with the traditional methods of cultivation.

7.4.3 Owner Cultivators

The production model for owner cultivators (Table 7.10) in log linear form is as:

$$\underset{\substack{(5.908)^* \\ (1.134)}}{LnY=5.95} + \underset{(2.719)^*}{0.089LnX_1} + \underset{(3.208)^*}{0.09LnX_2} + \underset{(0.747)}{0.3LnX_3} + \underset{(1.485)}{0.04LnX_4} + \underset{(3.222)^*}{0.02LnX_5} + \underset{(1.311)}{0.06LnX_6} + \underset{(2.11)^*}{0.06LnX_7} + 0.1LnX_8$$

The above model in CD form can be written as:

$$Y = 381.07\ X_1^{0.089}\ X_2^{0.09} X_3^{0.3} X_4^{0.04} X_5^{0.02} X_6^{0.06} X_7^{0.06} X_8^{0.1}$$

$R^2_{(Adj)}$ = 0.43, F*= 16.97

* Significant at 5 per cent

(t-values are given in the parentheses)

The results of the model reveal that 43 per cent of the variations has been explained by the exogenous variables. The value of F also gives significant of the model.

All the power (coefficient) values are the respective income elasticities of the mentioned variables and contribute positively to income. Differentiating the above function w.r.t X_1, X_2 and X_3 and substituting the average value of the variables from X_1 to X_8 we get MPP of manual labour, animal labour and tractor as:

$MPP_{(Labour)}$ = 0.618

$MPP_{(Animal)}$ = 3.488

$MPP_{(Tractor)}$ = 1.489.

The $MPP_{(labour)}$ is increasing with a decreasing return to scale where as the other are increasing with increasing trend. The MPP of tractor is lower than that of animal simply because the former is used only for thresher purposes.

7.4.4 Tenant Cultivators

The production function of this category (Table 7.11) in log linear form is as:

$$LnY=7.53+0.14LnX_1-0.07LnX_2+0.27LnX_3+0.1LnX_4+0.005LnX_5+0.03LnX_6+0.08LnX_7-0.24LnX_8$$
(6.215)* (1.212) (-2.061)* (4.752)* (1.401) (5.305)* (1.093) (1.625) (-0.205)

The model can be written in CD form as:

$$Y=1868.70X_1^{0.14}X_2^{-0.07}X_3^{0.27}X_4^{0.1}X_5^{0.005}X_6^{0.03}X_7^{0.08}X_8^{-0.24}$$

$R^2_{(Adj)}$ = 0.469, F* = 20.12

* Significant at 5 per cent
(t-values are given in the parentheses)

The results show that nearly 47 per cent of the variations have been covered by independents variables and the model is significant. The coefficients are positive except animal and rent. The unnecessary use of animal labour on the tenant farms may be the reason of negative effect of the input. The rent contribution is insignificantly negative.

All the powers (coefficients) are the income elasticities of the respective variables. Differentiating the above equation w.r.t X_1, X_2 and X_3 and substituting the average value of all the variables (from X_1 to X_8) we get MPP of manual labour, animal labour and tractor as:

$MPP_{(Labour)}$ = 2.208

$MPP_{(Animal)}$ = -5.937

$MPP_{(Tractor)}$ = 3.210

An explanation of the negative effect in the case of animal labour has already been given. The other variables have been improving the overall production. The results show that the MPP value of manual labour and tractor of the tenant farms are higher than that of the owners. It is so because the tenant cultivators take great care of these inputs.

7.4.5 All Sizes and Tenancies

In the previous few paragraphs we gave detail about the production function by taking sizes and tenancies of the sample respondents. Here we take the entire traditional farms of the wheat crop. The detail of the production function is given in Table-7.12. However, a brief summary in log linear form is presented below:

$$\underset{\substack{(5.53)^* \\ (2.11)^* \\ (0.518) \\ (3.321)^* \\ (1.125) \\ (3.511)^* \\ (1.348) \\ (0.694) \\ (-1.767)}}{\begin{aligned} LnY = 5.8 &+ 0.09LnX_1 + 0.04LnX_2 + 0.3LnX_3 + 0.09LnX_4 \\ &+ 0.003LnX_5 + 0.03LnX_6 + 0.03LnX_7 - 0.15LnX_8 \end{aligned}}$$

The above equation in CD form can be written as:

$$Y = 333.62\ X_1^{0.09}\ X_2^{0.04}\ X_3^{0.3}\ X_4^{0.09}\ X_5^{0.003}\ X_6^{0.03}\ X_7^{0.03} X_8^{-0.15}$$

$R^2_{(Adj)} = 0.482, \qquad F^* = 22.79$

* Significant at 5 per cent
(t-values are given in the parentheses)

The results of the production function show that over 48 per cent of the variations have been explained by the exogenous variables. The F-value gives significant result of the model.

Differentiating the above equation w.r.t X_1, X_2 and X_3 and substituting the average value of all the variables (from X_1 to X_8) we get the MPP of manual labour, animal labour and tractor as:

$MPP_{(Labour)} = 0.602$

$MPP_{(Animal)} = 1.521$

$MPP_{(Tractor)} = 1.426$

The results of the MPPs show that labour is increasing with a decreasing return to scale. This may be due to unnecessary use of manual labour by traditional farms. As can be seen that in the case of mechanized farms the manual labour is giving increasing return to scale, which means that machinery is complimenting the manual labour. The MPP of tractor is giving increasing return to scale but it is much lower than that of the mechanized farms. The reason is that the traditional farms apply machinery only for threshing purposes.

7.4.6 Conclusion

In the case of traditional farms the summation of the coefficients (as taken from Table 7.8 to Table 7.11) of the variables are 0.55, 0.62, 0.77 and 0.32 for small and large farms size; and owner and tenant cultivators respectively. Each of the summations is less than one which means that every category is performing in decreasing return to scale. Similarly, the sum of the coefficients in each category (i.e. size wise/tenancy wise) is lower than the respectively category of the mechanized farms. This shows that the return of the traditional farms is lower than that of the mechanized farms. Moreover, all the categories are producing with decreasing returns to scale which means that there is a considerable scope for improvement in production by re-adjusting the inputs.

As far as comparison of mechanized and traditional farms is concerned it is to be noted that the situation in the case of latter is relatively worse as compared to the former one.

7.5 Pooled Production Function for Mechanized and Traditional Farms

As we have discussed in Chapter 6 that mechanized and traditional farms differ in the overall input requirements and as a result their productivity and hence income are different. We now estimate a combined model for mechanized and traditional farms by

introducing a dummy variable [= 1 for mechanized and zero other wise (animal users etc.)]. First, we give the model in the log linear form and then in the CD form. The detail of the log linear model is given at the end of the chapter in Table-7.13 and a brief description is presented below:

$$\underset{\substack{(3.56)^* \\ (5.90)^* \\ (0.13) \\ (2.69)^* \\ (1.101) \\ (3.03)^* \\ (6.22)^* \\ (1.11) \\ (-1.58) \\ (3.72)^*}}{\begin{array}{l} LnY = 4.2 + 0.36LnX_1 + 0.006LnX_2 + 0.08LnX_3 + 0.1LnX_4 + 0.003LnX_5 + 0.1LnX_6 + 0.07LnX_7 - 0.13LnX_8 + 2.49LnX_9 \end{array}}$$

The above model can be written in its original form as:

$$Y = 68.37\, X_1^{0.36}\, X_2^{0.006}\, X_3^{0.08}\, X_4^{0.1}\, X_5^{0.003}\, X_6^{0.1}\, X_7^{0.07}\, X_8^{-0.13}\, X_9^{2.49}$$

$R^2_{(Adj)} = 0.501,$ $F^* = 19.66,$

* Significant at 5 per cent.

(Figures in parenthesis are t-values)

Whereas:

Y	=	Income (Values of the produces)
X_1	=	Manual labour cost
X_2	=	Animal labour cost
X_3	=	Tractor cost
X_4	=	Farm yard manure cost
X_5	=	Fertilizer cost
X_6	=	Seed cost
X_7	=	Water cost
X_8	=	Rent of land and other costs
X_9	=	Dummy variable

The co-efficient of determination, R^2, indicates that over 50 per cent of the variations in the model have been explained by the explanatory variables and the estimated model has given a good fit to the data. The calculated value of F falls in the critical region, which shows the significant difference of the regression model.

The model is specially designed to capture the effect of mechanization through the dummy variable. This variable is significant showing the income differences between the mechanized and traditional farms.

The model for the mechanized and traditional farms in the log linear form is given

below.

Model for mechanized farms:

$$LnY=6.716+0.36LnX_1+0.08LnX_3+0.1LnX_4+0.003LnX_5+0.1LnX_6+0.07LnX_7-0.13LnX_8$$

Model for traditional farms:

$$LnY=4.22+0.36LnX_1+0.006LnX_2+0.08LnX_3+0.1LnX_4+0.003LnX_5+0.1LnX_6+0.07LnX_7-0.13LnX_8$$

This means that the rate of change of the mechanized farms is two and a half units higher than the traditional farms.

7.6 The Augmented Linear Production Function for Wheat in the Case of Mechanized and Traditional Farms

The parameter estimates and other results of the combined linear model for both mechanized and traditional farms are given at the end of the chapter in Table-7.14 and a brief description is as follow.

$$Y=5953.45+2.48X_1-1.46X_2+0.203X_3+0.847X_4+1.49X_5+0.49X6+1.009\ X_7-0.592\ X_8+1562.16X_9$$
(2.969)* (3.737)* (-0.391) (0.574) (0.229) (5.977)* (1.658)** (1.814)* (-1.283) (2.083)*

All the explanatory variables have been already defined in the preceding section.

$R^2_{(Adj)} = 0.503$, $F = 17.88$*
* Significant at 5 per cent
** Significant at 10 per cent

(Values in parentheses are t-values)

The value of R^2 suggests that over 50 per cent of the variations have been captured by the exogenous variables. The F-value shows the significance of the model. As our dummy (X_9) is significant, therefore, we can write the above model for mechanized and traditional farms as:

Mechanized farms:

$$Y = 7515.169 + 2.48\ X_1 + 0.203\ X_3 + 0.847\ X_4 + 1.499\ X_5 + 0.49\ X_6 + 1.009\ X_7 - 0.592\ X_8$$

Traditional farms:

$$Y = 953.453 + 2.48\ X_1 - 1.46\ X_2 + 0.203\ X_3 + 0.847\ X_4 + 1.499\ X_5 + 0.49\ X_6 + 1.009\ X_7 - 0.592\ X_8$$

In the above model (for traditional) both animal and rent give negative

coefficient and thus have adverse effects on income. However, both the variables are insignificant. The negative effect of animal may be due to un-necessary application of the input by its users. All the other variables have positive co-efficient giving an increase in the income. Moreover, the models show that income of the mechanized farms is greater than that of the traditional farms. A similar view has also been given by Cline (1970); Singh (1974); Salam et.al. (1981) and Jehanzeb (1999) and they have shown that per acre income of the mechanized farms is higher than that of the traditional farms. Our field data results also support the model.

7.7 Manual Labour Requirements of the Wheat Crop by Mechanized and Traditional Farms

One of the basic inputs of production is manual labour. The amount of this input varies with a change in production process. As regards wheat production, for example in our case, generally there are two production methods, namely, mechanized and traditional. Both the farming communities use manual labour. However, as discussed in Chapter 6, the amount of labour requirements of mechanized and traditional farms are significantly different. Table 7.15 below gives detail of the labour requirements of both the categories.

Table 7.15 Per Jareeb Family and Hired Labour Used by Mechanized and Traditional Farms for the Production of Wheat.

Farming/ Tenancy & Farm Size	Family Labour				Hired Labour				All	
	Quantity		Cost (Rs.)		Quantity		Cost (Rs.)		No.	Cost (Rs.)
	No.	%	Amount	%	No.	%	Amount	%		
Mechanized	7.05	46.3	88.5	56.8	8.05	53.3	67.3	43.2	15.1	155.8
OC Small	3.6	21.3	40.9	27.5	13.3	78.7	107.6	72.2	16.9	148.5
OC Large	2.7	21.0	27.2	25.2	10.1	79	80.9	74.8	12.8	108.1
Ten Small	12.4	68.1	164.0	80.4	5.8	31.9	40.0	19.6	18.2	204.0
Ten Large	12.1	84.6	157.6	84.95	2.2	15.4	27.9	15.05	14.3	185.5
Traditional	43.3	60.6	370.1	49.1	28.2	39.4	383.2	50.9	71.5	753.3
OC Small	29.7	42.4	163.0	21.8	40.4	57.6	584.0	78.2	70.1	747.0
OC Large	29.4	39.5	104.8	14.9	45.1	60.5	597.3	85.1	74.5	702.1
Ten Small	60.7	84.1	636.5	18.5	11.5	15.9	144.7	18.5	72.2	781.2
Ten Large	58.7	84.8	622.1	82.3	10.5	15.2	133.8	17.7	69.2	755.9

Source: Based on Appendix Tables 19 and 20
Note: Ten. Stands for tenant; OC: stands for owner cultivators

As can be seen from the above table that per Jareeb manual labour requirements of the wheat crop of the mechanized farms are about 15 as against 71 for the traditional farms. Within the mechanized farms the manual labour input of small farms is higher than that of the large farms. Similarly, the manual labour cost of the small farms is higher than that of the large farms. The family labour contribution of the tenant farms is higher than that of the owner cultivators in each farm size. The family labour contribution of the mechanized small owner cultivators is nearly 29 per cent of the small tenant cultivators. Similarly, in the case of mechanized farms, the family labour contribution of the large owner farms is about 22 per cent of that of the large tenant. In the case of traditional farms the overall family labour input of the tenant farms is higher than that of the owner cultivators. It is worth mentioning that the overall labour cost of the mechanized farms is about 20 per cent of that of the traditional farms and this is mainly due to higher amount of labour input used by the latter.

In the case of the wheat crop it is to be noted that the mechanized farms manual labour requirement is nearly 21 per cent of that of the traditional farms which means that

these many labour times has been saved by mechanized farms. Similarly the animal labour input has been limited to traditional farms. These observations show that tractor has been substituted for manual labour and animal labour. McInerney and Donaldson (1975) have observed that mechanization has reduced the manual labour requirements by nearly 40 per cent. Lawrence (1970) has also observed that the overall use of labour/acre of wheat was higher on bullock farm than that on tractor farm. A similar view has been given by Singh (1968); Beg (1971) and Harry (1972).

7.8 Manual Labour Requirements Model for Wheat

The manual labour requirements are related to the tractor and animal time, use of inputs and output. As the inputs like seed, fertilizers, FYM, water and rent/other and also the outputs (i.e main & by products) can not be taken quantitatively because they are measured in different units, so we have taken these in money terms. A dummy variable [1 for mechanized, 0 other-wise (i.e. for animal etc.)] has been introduced in the model. The detail of the model is given at the end of the chapter in Table-7.16 and a brief description is presented below[1]:

$$\text{Manual labour (time)} = \underset{(1.201)}{60.464} \underset{(-0.956)}{- 3.064 X_1} \underset{(2.02)^*}{+ 0.002 X_2} \underset{(-2.503)^*}{- 0.005 X_3} \underset{(2.046)^*}{+ 0.839 X_4} \underset{(-9.546)^*}{- 44.909 X_5}$$

$R^2_{(Adj)} = 0.493, \quad F^* = 18.01$

* Significant at 5 per cent

(Figures in parentheses are t-value)

Whereas:

Y	=	Manual labour time
X_1	=	Tractor time
X_2	=	Output (Rs)
X_3	=	Input (Rs)
X_4	=	Animal time
X_5	=	Dummy variable

[1] Salam, A.(1981) has also used more or less a similar model for the fertilizer requirements for wheat. Ali (1992) has argued that labour own wage/reward has an inverse relation with the labour requirements.

The results show that over 49 per cent of the variations have been covered by the induction of the exogenous variables. The value of F confirms the significant of the model.

The results are consistent because all the signs of the estimated coefficients are in conformity with the expected ones. As the dummy variable is significant so the mechanized and traditional farms labour model will be as:

Mechanized Farms:

$Y = 15.555 - 3.064\ X_1 + 0.002\ X_2 - 0.005\ X_3.$

Traditional Farms:

$Y = \quad 60.464 - 3.064\ X_1 + 0.002\ X_2 - 0.005\ X_3. + 0.83X_4$

There is a great similarity in the estimates and the field data.

The results reveal that, holding all other factors as constant, the animal labour and output encourage the human labour requirements. It is also observed that input costs and tractor have adverse effects on the manual labour requirements. It is understood that with the increase in the cost of inputs their consumption quantity is generally reduced resulting a decrease in labour requirements. Increase in the output will need more labour to manage it. The application of animal labour also needs manual labour [but much more than the tractor –Ali (1992)]. So the use of animal labour increases manual labour requirements. The tractor has negative but insignificant effect on manual labour. This shows that tractor is a substitute for manual labour. All factors remaining the same (ceteris paribus), the labour requirements of the traditional farms are nearly four times of that of the mechanized farms. This means that in the case of the wheat crop the labour requirements of the mechanized farms are nearly one quarter of that of the traditional farms.

Table 7.2 Mechanized Farms - Wheat Crop Parameter Estimates of Small Farms

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	7.153	1.513	4.727*
2	Manual Labour	0.0355	0.049	0.724
3	Tractor	0.231	0.086	2.686*
4	Seed	0.172	0.209	0.823
5	FYM	0.094	0.081	1.161
6	Fertilizer	0.163	0.0576	2.829*
7	Water	0.022	0.049	0.449
8	Rent/other	-0.154	0.173	-0.890

Source: Based on Appendix Table 23

$R^2_{(Adj)} = 0.544$, $F^* = 13.73$

* Significant at 5 per cent ($t_{(0.025,86)}$, $F_{(7.86)}$)

Table 7.3 Mechanized Farms - Wheat Crop Parameter Estimates of Large Farms

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	6.114	0.975	6.270*
2	Manual Labour	0.0413	0.032	1.288
3	Tractor	0.846	0.127	6.661*
4	Seed	0.001	0.009	0.111
5	FYM	0.0026	0.001	2.610*
6	Fertilizer	0.0038	0.019	0.202
7	Water	0.173	0.099	1.747**
8	Rent/other	-0.186	0.133	-1.398

Source: Based on Appendix Table 23

$R^2_{(Adj)} = 0.573$, $F^* = 26.68$

* Significant at 5 per cent ($t_{(0.025,28)}$, $F_{(7.28)}$)

** Significant at 10 per cent ($t_{(0.025,28)}$, $F_{(7.28)}$)

Table 7.4 Mechanized Farms - Wheat Crop Parameter Estimates of Owner Cultivators

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	5.49	2.075	2.031*
2	Manual Labour	0.053	0.084	0.631
3	Tractor	0.369	0.244	1.512
4	Seed	0.332	0.290	1.145
5	FYM	0.052	0.034	1.529
6	Fertilizer	0.125	0.035	3.571*
7	Water	0.015	0.174	0.086
8	Rent/other	0.04	0.076	0.523

Source: Based on Appendix Table 19

$R^2_{(Adj)} = 0.381$, $F^* = 10.09$

* Significant at 5 per cent ($t_{(0.025,76)}$, $F_{(7,76)}$)

** Significant at 10 per cent ($t_{(0.025,76)}$, $F_{(7,76)}$)

Table 7.5 Mechanized Farms - Wheat Crop Parameter Estimates of Tenant Cultivators

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	7.828	1.329	5.89*
2	Manual Labour	0.063	0.031	2.032*
3	Tractor	0.209	0.048	4.354*
4	Seed	0.211	0.150	1.407
5	FYM	0.013	0.014	0.929
6	Fertilizer	0.142	0.261	0.544
7	Water	0.052	0.057	0.912
8	Rent/other	-0.193	0.154	-1.253

Source: Based on Appendix Table 19

$R^2_{(Adj)} = 0.49$, $F^* = 2.77$

* Significant at 5 per cent ($t_{(0.025,38)}$, $F_{(7,38)}$)

Table 7.6 Mechanized Farms Wheat Crop: All Sizes and Tenancies

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	7.20	0.718	10.029*
2	Manual Labour	0.032	0.041	0.780
3	Tractor	0.239	0.057	4.154*
4	Seed	0.149	0.052	2.863*
5	FYM	0.0089	0.007	1.271
6	Fertilizer	0.053	0.014	3.904*
7	Water	0.028	0.033	0.855
8	Rent/other	-0.126	0.026	-0.264

Source: Based on Appendix Table 23
$R^2_{(Adj)} = 0.45$, $F^* = 10.65$
* Significant at 5 per cent ($t_{(0.025,122)}$, $F_{(7,122)}$)

Table 7.8 Traditional Farms - Wheat Crop Parameter Estimates of Small Farms

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	3.723	1.433	2.548*
2	Manual Labour	0.0958	0.151	0.634
3	Animal labour	0.0581	0.037	1.570
4	Tractor	0.366	0.142	2.571*
5	Seed	0.175	0.112	1.562
6	FYM	0.0017	0.001	1.70**
7	Chemical fertilizer	0.0064	0.024	0.264
8	Water	0.0329	0.071	0.463
9	Rent/other	-0.182	0.271	-0.670

Source: Based on Appendix Table 24
$R^2_{(Adj)} = 0.51$, $F^* = 11.76$
* Significant at 5 per cent ($t_{(0.025,39)}$, $F_{(8,39)}$)
** Significant at 10 per cent ($t_{(0.025,39)}$, $F_{(8,39)}$)

Table 7.9 Traditional Farms - Wheat Crop Parameter Estimates of Large Farms

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	3.232	0.784	4.12*
2	Manual Labour	0.062	0.043	1.442
3	Animal labour	0.043	0.027	1.592
4	Tractor	0.446	0.079	5.643*
5	Seed	0.007	0.050	0.014
6	FYM	0.0003	0.001	0.311
7	Chemical fertilizer	0.012	0.009	1.333
8	Water	0.071	0.030	2.367*
9	Rent/other	-0.013	0.053	-0.245

Source: Based on Appendix Table 24
$R^2_{(Adj)} = 0.49$, $F^* = 22.26$
* Significant at 5 per cent ($t_{(0.025,13)}$, $F_{(8,13)}$)

Table 7.10 Traditional Farms - Wheat Crop Parameter Estimates of Owner Cultivators

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	5.953	1.006	5.908*
2	Manual Labour	0.0896	0.079	1.134
3	Animal labour	0.087	0.032	2.719*
4	Tractor	0.308	0.096	3.208*
5	Seed	0.0448	0.060	0.747
6	FYM	0.0193	0.013	1.485
7	Chemical fertilizer	0.058	0.018	3.222*
8	Water	0.0603	0.046	1.311
9	Rent/other	0.105	0.049	2.11*

Source: Based on Appendix Table 20
$R^2_{(Adj)} = 0.43$, $F^* = 16.97$
* Significant at 5 per cent ($t_{(0.025,37)}$, $F_{(8,37)}$)

Table 7.11 Traditional Farms - Wheat Crop Parameter Estimates of Tenant Cultivators

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	7.533	1.212	6.215*
2	Manual Labour	0.143	0.118	1.212
3	Animal labour	-0.068	0.033	-2.061*
4	Tractor	0.266	0.056	4.752*
5	Seed	0.105	0.075	1.401
6	FYM	0.0053	0.001	5.305*
7	Chemical fertilizer	0.0328	0.030	1.093
8	Water	0.078	0.048	1.625
9	Rent/other	-0.241	1.178	-0.205

Source: Based on Appendix Table 20
$R^2_{(Adj)} = 0.469$, $F^* = 20.12$
* Significant at 5 per cent ($t_{(0.025,15)}$, $F_{(8,15)}$)

Table 7.12 Traditional Farms - Wheat Crop: All Sizes and Tenancies

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	5.81	1.051	5.530*
2	Manual Labour	0.093	0.044	2.110*
3	Animal labour	0.041	0.027	0.518
4	Tractor	0.306	0.092	3.321*
5	Seed	0.090	0.080	1.125
6	FYM	0.003	0.001	3.511*
7	Chemical fertilizer	0.031	0.023	1.348
8	Water	0.034	0.049	0.694
9	Rent/other	-0.152	0.086	-1.767**

Source: Based on Appendix Tables 20 and 24
$R^2_{(Adj)} = 0.48$, $F^* = 22.79$
* Significant at 5 per cent ($t_{(0.025,61)}$, $F_{(8,61)}$)
** Significant at 10 per cent ($t_{(0.025,61)}$, $F_{(8,61)}$)

Table 7.13 Mechanized and Traditional Farms - Wheat Crop Parameter Estimates (In Log Linear Form)

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	4.225	1.18	3.56*
2	Manual Labour	0.36	0.062	5.90*
3	Animal labour	0.006	0.049	0.13
4	Tractor	0.078	0.029	2.692*
5	Seed	0.102	0.092	1.101
6	FYM	0.003	0.001	3.03*
7	Fertilizer	0.093	0.015	6.22*
8	Water	0.068	0.062	1.11
9	Rent/other	-0.138	0.087	-1.58
10	Dummy	2.491	0.669	3.72*

Source: Based on Appendix Tables 19,20,23 and 24

$R^2_{(Adj)} = 0.501$, $F^* = 19.66$

* Significant at 5 per cent ($t_{(0.025,190)}$ $F_{(9,190)}$)

Table 7.14 Mechanized and Traditional Farms-Wheat Crop Parameter Estimates (Linear Form)

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	5953.454	2004.89	2.969*
2	Manual Labour	2.481	0.664	3.737*
3	Dani	-1.460	3.739	-0.391
4	Tractor	0.203	0.354	0.574
5	Seed	0.847	3.695	0.229
6	FYM	0.491	0.296	1.658**
7	Fertilizer	1.499	0.251	5.977*
8	Water	1.009	0.556	1.814**
9	Other	-0.592	0.461	-1.283
10	Dummy	1562.169	749.843	2.083*

Source: Based on Appendix Tables 19,20, 23 and 24

$R^2_{(Adj)} = 0.503$, $F^* = 17.08$

* Significant at 5 per cent ($t_{(0.025,190)}$ $F_{(9,190)}$)

** Significant at 10 per cent ($t_{(0.025,190)}$ $F_{(9,190)}$)

Table 7.16 Manual Labour Requirements of the Wheat Crop: Regression Estimates

Sr.No.	Variable	Co-efficient	Standard Error	t-value
1	Constant	60.464	49.958	1.201
2	Tractor time	3.064	3.20	-0.956
3	Output (Rs)	0.002	0.001	2.023*
4	Input (Rs)	-0.005	0.002	-2.503*
5	Animal time	0.839	0.410	2.046*
6	Dummy	-44.909	4.704	-9.546*

Source: Based on Appendix Tables 19 and 20

$R^2_{(Adj)} = 0.493$, $F^* = 18.01$

* Significant at 5 percent, ($t_{(0.025,194)}$, $F_{(5,194)}$)

CHAPTER 8

RESULT AND DISCUSSION: MAIZE CROP

8.1 Introduction

This chapter gives the importance of the maize crop in the Province. A detailed information of the cost accounts of the maize crop of the sample respondents is given. The price elasticities of the inputs have been worked out. The Marginal Physical Product (MPP) of manual labour, animal labour and tractor has been calculated. Manual labour requirements of both mechanized and traditional farms are given which is followed by a manual labour requirements model. The procedure used in the case of the wheat crop has been applied for the maize crop as well. The wheat crop results have been discussed in detail and to avoid the repetition of the same the discussion on the maize crop has been curtailed.

Maize is one of the essential food stuffs for both human beings and animals and is known to the world from ancient times. On his first voyage to the Americas Columbus detected corn in Cuba in 1492. The 16th and 17th century explorations reveal that corn growing belt extended from Chile to the Great lakes in Americas. However, its most probable centre of origin seems to be Mexico in Central America[1].

Maize is a staple food in Pakistan and particularly in the NWFP. Fresh ears of maize are also consumed after boiling it in water or roasting it in fire. Maize grains are also used after being popped by parching in Kettle with hot dry sand, salt or edible oil. Maize is employed as a food for livestock. Green ears are also fed to animals but mostly its stalks and leaves (green or dry) are employed for this purpose. Maize, thus, also serves as an important source of fodder supply.

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[1] For this detail see Fazli W. and M.Iqbal (1980).

In terms of area allocated to various crops, maize is the second largest crop in the Province. At the national level, the NWFP has a very important position in the production of maize. On the annual average of 1995-2000, for example, a total of 944.6 thousand hectares of land was devoted to maize at the country level. Of the total area the provincial share was as high as 56.5 per cent. However, per hectare yield of the country (also of the province) is much lower than that of the maize producing countries having nearly similar climatic and socio economic characteristics. For examples, per hectare yield of Pakistan is about 44 per cent of that of Indonesia and 68 per cent of that of India and only 32 per cent of that of the world's average. The yield/hectare can considerably be increased if proper arrangements are made (Govt. of Pakistan, 2004).

8.2 Inputs Used for Maize Production in the Project Area

In the sample area a total of 1629.3 Jareebs (329.67 hectares) area was devoted to maize. Of the total area 70.6 per cent was covered by mechanized farms and the rest was accounted for traditional farms. The maize area is 19.42 per cent of the cropped area and about 31 per cent of kharif area of the sample respondents. In the following paragraphs the results of the production function (the one applied in the case of the wheat crop in Chapter 7) are briefly described by taking first the mechanized category followed by traditional farms. At the end a combined production function of mechanized and traditional farms has been given.

8.3 Mechanized Farms

The mechanized farms devoted 115.03 Jareebs of land to the maize crop. Total production cost per Jareeb of the crop stood at Rs. 3360.46 which gave a gross income of Rs. 6204.60 and yielded a net profit of Rs. 2844.14 per Jareeb. The overall accounts of expenditure and quantity of various inputs and output value per Jareeb are given in Table-8.1 (below).

Table 8.1 Per Jareeb Inputs and its Cost and Output Qty of the Maize Crop: Mechanized Farms

Category	Manual Labour		Tractor		Seed		Fertilizer		FYM		Water cost	Rent/ other costs	All costs	Output					Net income
	Time (Hrs.)	Cost	Time (Hrs.)	Cost	Qty Kg.	Cost	Qty Bag	Cost	Qty (Tr.)	Cost				Main		By		All values	
														Qty	Val.	Qty	Val.		
OC small	45.34	376.30	2.05	859.10	5.50	137.30	1.23	537.80	0.33	80.38	48.11	1377.10	3416.09	13.71	6170.30	4.81	55.39	6225.69	2809.6
OC large	45.5	380.80	1.94	822.80	5.40	135.0	1.24	568.64	0.27	68.88	45.35	1381.5	3402.97	13.41	6035.30	4.51	56.41	6091.71	2688.74
Tenant small	48.4	497.30	1.91	829.30	5.64	67.60	1.0	422.0	0.31	78.0	35.68	1399.30	3329.18	13.95	6276.10	5.26	55.60	6331.70	3002.52
Tenant large	47.4	476.20	1.81	807.80	5.46	65.58	1.0	420.0	0.36	89.20	25.73	1375.70	3260.21	13.73	6178.20	5.03	57.20	6235.40	2975.19
All	46.3	419.50	1.94	831.77	5.47	108.97	1.14	500.96	0.31	78.18	39.98	1381.10	3360.46	13.66	6148.50	4.84	56.10	6204.60	2844.14

Source: Based on Appendix Table 21

Note: OC: stands for owner cultivator; Qty stands for quantity; seed qty is in kg; fertilizer qty in bags (1 bag = 50 kg); FYM qty in trolley

(1 trolley = 50 mounds); output main qty in mounds and by product qty in bundle; val = values in Rs; cost in Rs.

The table provides information about inputs and its costs by farm sizes and tenancies. The over all labour requirements of the owner cultivators are lower than that of the tenants. However, the tractor input of the latter is lower than that of the former. This means that manual labour and tractor are substituting each other. The fertilizer input of the owner cultivators is higher than that of the tenant cultivators. However, the farm yard manure input of the former is lower than that of the latter.

The production cost of the small owner cultivators is higher than that of the large owner cultivators. Similarly the production cost of the small tenant cultivators is higher than that of the large tenant cultivators. The same trend also exists in the net income in these groups. The net income per Jareeb of the small owner and tenant cultivators is higher than that of the income of large owner and tenant cultivators respectively.

The highest output per Jareeb has been achieved by the small tenant cultivators which may be attributed to their higher care and seed quantity. The lowest yield per Jareeb is that of the owner cultivators of large farm size which may be due to comparatively small quantity use of FYM and other inputs.

As discussed in Chapter 6, there are significant differences between small and large farm sizes and also in owner and tenant cultivators. In the light of these results we have estimated the production function of the mechanized farms for (i) small and large farms and (ii) owner and tenant cultivators. The detail is given at the end of the chapter in Table 8.2 to Table 8.5. However, a brief description of each category is presented below:

8.3.1 Small Farms

In the case of small farms the log linear production (Table 8.2) function is as:

$$\underset{\quad}{LnY} = \underset{(3.911)^{*}}{5.82} + \underset{(2.50)^{*}}{0.13 LnX_1} + \underset{(2.47)^{*}}{0.23 LnX_2} + \underset{(1.104)}{0.08 LnX_3} + \underset{(0.976)}{0.03 LnX_4} + \underset{(4.345)^{*}}{0.05 LnX_5} + \underset{(0.598)}{0.07 LnX_6} - \underset{(-1.196)}{0.256 LnX_7}$$

In Cobb Douglas (CD) form we can have the above function as:

$$Y=336.97\ X_1^{0.13}\ X_2^{0.23}\ X_3^{0.08}\ X_4^{0.03}\ X_5^{0.05}\ X_6^{0.07}\ X_7^{-0.256}$$

$R^2_{(Adj)}$ = 0.47, F* =14.92,
* Significant at 5 per cent.
(Figures in parentheses are t-values)

Whereas:

Y	=	Income (value of the produces)
X_1	=	Manual labour cost
X_2	=	Tractor cost
X_3	=	Seed cost
X_4	=	Fertilizer cost
X_5	=	Farm yard manure cost
X_6	=	Water cost
X_7	=	Rent and other minor costs

(The variables defined above have been used in all the categories of the mechanized farms)

The powers (coefficients) are the elasticities of the respective variables. Taking derivative of the above equation with respect to (w.r.t) X_1 and X_2 and substituting the average values of all variables (from X_1 to X_7) we get MPP for manual labour and tractor as:

$MPP_{(Labour)}$ = 0.426

$MPP_{(Tractor)}$ = 0.416

The MPP of manual labour and tractor both are contributing but with a decreasing return. All the coefficients are positive except rent/other which has an insignificant adverse effect on income. The exogenous variables have explained 47 per cent of the variations in the dependant variable. The F-value also gives significance of the models.

8.3.2 Large Farms

Our estimates in the log linear forms (Table 8.3) are as:

$$\underset{}{LnY=4.26}+\underset{(2.44)^*}{0.1\ LnX_1}+\underset{(0.954)^*}{0.25LnX_2}+\underset{(2.464)^*}{0.03LnX_3}+\underset{(0.647)}{0.07LnX_4}+\underset{(2.396)^*}{0.04LnX_5}+\underset{(3.083)^*}{0.064LnX_6}-\underset{(0.671)}{0.146\ LnX_7}\quad\underset{(-1.567)}{}$$

The above equation can be written in CD form as:

$$Y = 71.02\ X_1^{0.1}\ X_2^{0.25}\ X_3^{0.03}\ X_4^{0.07}\ X_5^{0.04}\ X_6^{0.064}\ X_7^{-0.146}$$

$R^2_{(Adj)} = 0.499$, $F^* = 7.69$,
* Significant at 5 per cent.
(Figures in parentheses are t-value)

The powers (coefficients) are the income elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average values of all the variables (from X_1 to X_7) we get

$MPP_{(Labour)} = 0.655$

$MPP_{(Tractor)} = 1.087$

This means that both manual labour and tractor are contributing but manual labour with decreasing return to scale and machinery with increasing return to scale.

All the exogenous (except rent/other) have positive effect and thus improving the income. The rent has an insignificant adverse effect. Nearly 50 per cent of the variations have been justified by the independent variables. The F-value shows significance of the model.

The MPP results of the small and large farms show that for both the key inputs (manual labour and machinery) the value of the estimates are significantly higher on the farms operated by large size. This means that the performances of these inputs are considerably higher on the large farms.

8.3.3 Owner Cultivators

The estimated function (Table 8.4) in log linear form for the owner cultivator category is as:

$$\underset{}{LnY} = \underset{(2.659)^*}{3.7} + \underset{(0.944)}{0.07LnX_1} + \underset{(2.90)^*}{0.35LnX_2} + \underset{(0.200)}{0.02LnX_3} + \underset{(0.245)}{0.01LnX_4} + \underset{(4.011)^*}{0.004LnX_5} + \underset{(0.554)}{0.04\ LnX_6} + \underset{(0.978)}{0.18Ln\ X_7}$$

The above equation can be presented in the CD form as:

$$Y = 38.63\ X_1^{0.07}\ X_2^{0.35}\ X_3^{0.02}\ X_4^{0.01}\ X_5^{0.004}\ X_6^{0.04}\ X_7^{0.18}$$

$R^2_{(Adj)} = 0.40$, $F^* = 15.57$
* Significant at 5 per cent.
(Figures in parentheses are t-value)

The powers (coefficients) are the elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average values of all the variables (from X_1 to X_7) we have:

$MPP_{(Labour)}$ = 0.164

$MPP_{(Tractor)}$ = 0.979

Both the MPPs are contributing positively but with the decreasing return to scale. The value of R^2 shows that 40 per cent of the variations have been covered by the exogenous variables. The F-value also confirms significance of the function. All the coefficients are positively contributing to the income.

8.3.4 Tenants Cultivators

The functional model (Table 8.5) in log linear form for tenant cultivators is as:

$$\underset{}{LnY} = \underset{(7.073)^*}{6.39} + \underset{(3.238)^*}{0.13LnX_1} + \underset{(5.854)^*}{0.24LnX_2} + \underset{(0.684)}{0.021LnX_3} + \underset{(2.538)^*}{0.07LnX_4} + \underset{(4.197)^*}{0.046LnX_5} + \underset{(0.515)}{0.026LnX_6} - \underset{(-3.213)^*}{0.246\,LnX_7}$$

The above functional model in CD form is as:

$$Y = 598.24\, X_1^{0.13}\, X_2^{0.24}\, X_3^{0.021}\, X_4^{0.07}\, X_5^{0.046}\, X_6^{0.026}\, X_7^{-0.246}$$

$R^2_{(Adj)}$ = 0.54, F^* = 22.59.
* = Significant at 5 per cent.
(Figures in parentheses are t-values).

The powers (coefficients) are the income elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average value of all the variables (from X_1 to X_7) we get:

$MPP_{(Labour)}$ = 0.584

$MPP_{(Tractor)}$ = 0.612

The contributions of these inputs are with a decreasing return to scale. Also the MPPs of both the inputs are nearly equal.

The fit is 54 per cent good. The F-value shows the significance of the model. The rent/other has a significant adverse effect on income. It is because the tenants are generally financially weak and the rent is the biggest burden on them to pay.

As far as the MPP of manual labour and tractor is concerned both owner and tenant cultivators are getting decreasing return to scale. However, the MPP of manual labour of the tenant cultivators is higher than that of the owner cultivators. On the other side the MPP of machinery of the owner farms is higher than that of tenant farms.

8.3.5 All sizes and Tenancies

The detail of the production function in log linear form in the case of mechanized farms is given at the end of the chapter in Table 8.6. A brief description is presented below:

$$\underset{}{LnY} = \underset{(4.591)^{*}}{4.61} + \underset{(1.065)}{0.106 LnX_1} + \underset{(3.096)^{*}}{0.6 LnX_2} + \underset{(1.029)}{0.036 LnX_3} + \underset{(1.121)}{0.04 LnX_4} + \underset{(3.811)^{*}}{0.03 LnX_5} + \underset{(0.871)}{0.04 LnX_6} - \underset{(-1.690)}{0.113 LnX_7}$$

The above model in CD form can be written as:

$$Y = 100.58\, X_1^{0.106}\, X_2^{0.6}\, X_3^{0.036}\, X_4^{0.04}\, X_5^{0.03}\, X_6^{0.04}\, X_7^{-0.113}$$

$R^2_{(Adj)} = 0.41, \quad F^* = 16.90$

* Significant at 5 per cent

(Figures in parentheses are t-values)

The result shows that 41 per cent of the variations have been covered by the exogenous variables. The F-value also gives significant result of the model.

The powers (coefficients) are the elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average

value of the variables (from X_1 to X_7) we get respective MPP of manual labour and tractor as:

$MPP_{(labour)}$ = 0.415

$MPP_{(tractor)}$ = 0.664

These values suggest that both manual and tractor are contributing but with a decreasing return to scale. Moreover, the MPP of tractor is comparatively higher than that of the manual labour which means that machinery yields better results when compared to human labour.

8.3.6 Conclusion

In the case of the maize crop grown on the mechanized farms all the inputs have contributed to the income. The rent/other have an adverse (except for the owner cultivators) but insignificant effect on income except in the case of tenant farmers for whom this is significant.

The MPP values of human labour and tractor indicate that they are contributing but with a decreasing return to scale (only for the large farm size the MPP of machinery is giving an increasing return to scale). The highest $MPP_{(trac)}$ values are that of large farms which means that this category comparatively gets more benefits from the farm machinery.

The summations of the coefficients (elasticities) of each of the above functions (the values are as shown in Tables 8.2 to 8.5) of the mechanized farms are 0.32, 0.41, 0.49 and 0.30 for small farms, large farms, owner and tenant cultivators respectively. Each of the estimates is less than one which means that all the mentioned farming communities are producing in decreasing return to scale. They can improve their performance by re-allocating the inputs optimally. The higher value is that of owners which is due to the rent/other costs which are not being paid (imputed cost has been

included for analysis purpose) by them. This factor improves the financial position of this group due to which their performance is comparatively better. It also shows that the owner cultivators can get better return from the farming if the resume own cultivation.

8.4 Traditional Farms

The traditional farmers devoted 478.9 Jareebs of land to the maize crop which is 18.3 per cent of the cropped area and 29.4 per cent of the Kharif area of the selected sample respondents. Total production and gross income per Jareeb arrived at Rs. 3288.24 and Rs. 4910.90 respectively and that gave a net return of Rs. 1622.66 per Jareeb.

The quantity and cost incurred on inputs and value received by all sizes and tenancies of the traditional category are given in Table 8.7 below. As can be seen in the table both manual and animal labour inputs of the tenant cultivators are higher than that of the owner cultivators.

Table 8.7 Per Jareeb Inputs Qty and its Cost and Outputs of the Maize Crop: Traditional Farms

	Manual Labour		Animal labour		Seed		Fertilizer		FYM		Water Cost	Rent/ other costs	All costs	Output				All values	Net income (Rs.)
	Time (Hrs.)	Cost	Time (Hrs.)	Cost	Qty Kg	Cost	Qty Bag	Cost	Qty (Tr)	Cost				Main		By			
														Qty	Val.	Qty	Val.		
OC small	91.43	1043.9	2.80	105.7	5.74	86.05	1.04	432.0	0.15	45.9	69.6	1419.60	3202.75	10.57	4756.10	6.63	72.3	4828.40	1625.65
OC large	87.2	1008.8	2.77	103.60	5.83	87.52	1.14	491.8	0.05	15.3	62.4	1436.70	3206.12	10.45	4700.80	6.75	63.5	4764.3	1558.18
Tenant small	100.3	1148.5	3.43	120.08	5.57	94.60	0.82	346.50	0.26	78.7	115.2	1424.50	3327.76	11.10	4993.30	6.46	71.6	5064.9	1737.40
Tenant large	101.5	1149.20	3.61	126.4	5.50	93.40	0.91	391.84	0.38	115.9	106.4	1431.17	3414.31	11.10	4993.30	4.61	44.66	5037.96	1623.65
All	94.6	108.40	3.12	113.3	5.60	89.98	0.99	431.28	0.19	58.3	85.68	1428.30	3288.24	10.7	4848.60	6.07	62.3	4910.90	1622.66

Source: Based on Appendix Table 22.

Note: OC; stands for owner cultivators; Qty: stands for quantity; seed qty in kg ; fertilizer qty in bags (1 bag = 50 kg); FYM qty in trolley (1 trolley = 50 mounds); Main qty in mounds; By- product qty in bundle; val = values in Rs. ; cost in Rs.

The chemical fertilizers consumption of the owner cultivators is higher than that of the tenant cultivators. However, the FYM application on the tenant cultivators is higher than that of the owners'. The over all net income of the tenant cultivators is higher than that of the owner cultivators which may be attributed to the higher inputs utilization of the former.

As said earlier, the Chow/t tests show significant differences between farm sizes and tenancies for the traditional farms (Chapter 6), therefore, we have estimated our cost functions for each of the category. Here we have adopted the same procedure, as we applied in the case of mechanized farms, and have taken comparison between sizes and tenancies. The estimates of all these categories are given at the end of the chapter in detail in Table 8.8 to Table 8.11. However, brief descriptions of the results are presented below:

8.4.1 Small Farms

The production function (Table 8.8) in log linear form for the small farms is as:

$$\underset{}{\text{LnY}} = \underset{(2.981)^{*}}{4.45} + \underset{(1.767)^{**}}{0.22\text{LnX}_1} + \underset{(3.111)^{*}}{0.16\text{LnX}_2} + \underset{(0.509)}{0.021\text{LnX}_3} + \underset{(1.80)^{**}}{0.04\text{LnX}_4} + \underset{(2.505)^{*}}{0.008\text{LnX}_5} + \underset{(0.116)}{0.004\text{LnX}_6} - \underset{(-1.091)}{0.216\,\text{LnX}_7}$$

In CD form we can present the above function as:

$$Y = 85.798\, X_1^{0.22}\, X_2^{0.16}\, X_3^{0.021}\, X_4^{0.04}\, X_5^{0.008}\, X_6^{0.004}\, X_7^{-0.216}$$

$R^2_{(Adj)} = 0.502, \qquad F^* = 18.57.$

* Significant at 5 per cent,

** Significant at 10 per cent.

(Figures in parentheses are t-values)

Whereas:

- Y = Income (from the produces)
- X_1 = Manual labour cost
- X_2 = Animal labour cost
- X_3 = Seed cost
- X_4 = Chemical fertilizer cost
- X_5 = Farm yard manure cost
- X_6 = Irrigation cost
- X_7 = Rent and other minor costs.

(The variables defined above have been used in all the categories of the traditional farms)

All the powers (coefficients) are the income elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average values of all the variables (from X_1 to X_7), we get MPP of manual labour and animal labour as:

$MPP_{(Labour)} = 0.26$

$MPP_{(Animal)} = 0.54$

This means that these inputs are contributing with decreasing return to scale. The

F-value shows that the cost function model of the small farm size is significant. The value of R^2 shows that over 50 per cent of the variations have been captured by exogenous variables. All the variables (except rent/other) are contributing positively to income. The rent/other has an insignificant negative effect on income.

8.4.2 Large farms

The production function (Table 8.9) in log linear form for large farms has been estimated as:

$$\underset{}{LnY} = \underset{(3.339)^{*}}{4.71} + \underset{(1.991)^{**}}{0.21LnX_1} + \underset{(3.307)^{*}}{0.17\,LnX_2} + \underset{(0.195)}{0.024LnX_3} + \underset{(3.772)^{*}}{0.08LnX_4} + \underset{(3.011)^{*}}{0.006\,LnX_5} + \underset{(2.875)^{*}}{0.07LnX_6} - \underset{(-1.138)}{0.2LnX_7}$$

The above equation in CD form can be presented as:

$$Y = 111.27\, X_1^{0.21}\, X_2^{0.17}\, X_3^{0.024}\, X_4^{0.08}\, X_5^{0.006}\, X_6^{0.07}\, X_7^{-0.2}$$

$R^2_{(Adj)} = 0.553, \qquad F^{*} = 13.6$

* Significant at 5 per cent.

** Significant at 10 per cent.

(Figures in parentheses are t-values)

The powers (coefficients) are the income elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting

the average value of all the variables (from X_1 to X_7) we get MPP for manual labour and animal as:

$MPP_{(Labour)}$ = 0.128

$MPP_{(Animal)}$ = 0.467

Both the inputs are contributing with decreasing return to scale. The F-value shows the significance of the model. Moreover, 55 per cent of the variations in the model have been explained by exogenous variables. All the coefficients (except rent/other) are positively affecting income. The rent/other has an insignificant negative effect.

The estimates of the MPP show that the performances of small farms are comparatively better than that of the large farms. The comparatively lower MPP on the part of large farms may be due to its large size which cannot be operated properly under the traditional methods of cultivation. However, the values show that both the key inputs are giving a decreasing return to scale for both the mentioned sizes.

8.4.3 Owner Cultivators

The log linear estimates (Table 8.10) of the owner cultivators are:

$$LnY=5.01+0.206LnX_1+0.107LnX_2+0.03LnX_3+0.09LnX_4+0.01LnX_5+0.03LnX_6+0.18\ LnX_7$$

(4.807)* (2.943)* (3.242)* (1.391) (4.381)* (2.202)* (1.571) (0.298)

The above equation in CD form can be written as:

$$Y = 151.26\ X_1^{0.206}\ X_2^{0.107}\ X_3^{0.03}\ X_4^{0.09}\ X_5^{0.01}\ X_6^{0.03}\ X_7^{0.18}$$

$R^2_{(Adj)} = 0.509$, $F^* = 17.31$.

* Significant at 5 per cent.

(Figures in parentheses are t-values)

The powers (coefficients) are the elasticities of the respective variables. Taking derivative of the above equation w.r.t X_1 and X_2 and substituting the average values of all the variables (from X_1 to X_7), we get:

$MPP_{(Labour)}$ = 0.114

$MPP_{(Animal)}$ = 0.587

This means that these inputs are contributing with decreasing returns to scale. The independent variables have covered nearby 51 per cent of the variations in the dependent variable. The F-value shows significance of the function. All the coefficient values show that the inputs are contributing positively to the income.

8.4.4 Tenant Cultivators

The estimated model (Table 8.11) for the tenant cultivators in log linear form is as:

$$\underset{}{LnY} = \underset{(1.296)}{4.32} + \underset{(1.778)^{**}}{0.24LnX_1} + \underset{(2.214)^{*}}{0.13LnX_2} + \underset{(0.481)}{0.036LnX_3} + \underset{(2.613)^{*}}{0.06LnX_4} + \underset{(3.02)^{*}}{0.016LnX_5} + \underset{(1.511)}{0.09LnX_6} - \underset{(-2.01)^{*}}{0.32LnX_7}$$

The original CD form of the model is as:

$$Y = 75.57X_1^{0.24}\, X_2^{0.13}\, X_3^{0.036}\, X_4^{0.06}\, X_5^{0.016}\, X_6^{0.09}\, X_7^{-0.32}$$

$R^2_{(Adj)}$ = 0.479, F* = 10.44.

* Significant at 5 per cent

** Significant at 10 per cent.

(t-values are given in parentheses)

The powers (coefficients) are the income elasticities of the respective variables. Differentiating the above equation w.r.t X_1 and X_2 and substituting the average value of all the variables (from X_1 to X_7), we get MPP of manual labour and animals labour as:

$MPP_{(Labour)}$ = 0.194

$MPP_{(Animal)}$ = 0.572

These estimates show that both the inputs are contributing but with a decreasing return to scale. The fit is about 48 per cent good. F-value confirms the significance of the function. All the parameter coefficients (except rent/other) are positively contributing to income. The rent has a significant adverse effect on income.

This means that tenants are more adversely affected by rent/other.

As far as the MPP of animal labour is concerned, there are no significant differences by tenurial status. In the case of manual labour, the MPP of this input is slightly higher on the tenant farms. However, the contribution of both the key inputs is behaving with a decreasing return to scale.

8.4.5 All sizes and Tenancies

The production function in log linear form estimated for all sizes and tenancies for the whole of the traditional farms is given (at the end of the chapter) in Table 8.12 and a summary of the same is presented below:

$$\underset{\quad (3.128)^{*}}{LnY=4.64+0.24LnX_1}\underset{(2.161)^{*}}{+0.107LnX_2}\underset{(2.812)^{*}}{+0.03LnX_3}\underset{(3.875)^{*}}{+0.0767LnX_4}\underset{(3.714)^{*}}{+0.016LnX_5}\underset{(6.125)^{*}}{+0.06LnX_6}\underset{(0.060)}{-0.215LnX_7}\quad\underset{(-0.178)}{}$$

The above model can be given in CD form as:

$$Y = 103.86\, X_1^{0.24}\, X_2^{0.107}\, X_3^{0.03}\, X_4^{0.0767}\, X_5^{0.016}\, X_6^{0.06}\, X_7^{-0.215}$$

$R^2_{(Adj)} = 0.528, \quad F^* = 20.30$

- Significant at 5 per cent.

(Figures in parentheses are t-value)

All the parameters (except rent/other) are contributing positively to the income. The rent/other has an adverse insignificant effect on income. The results show that more than 52 per cent of the variations have been explained by the exogenous variables. The value of F also gives significant result.

The powers (coefficients) are the elasticities of the respective variables. Differentiating the above equation w.r.t X_1 and X_2 and substituting the average values of all the variables (from X_1 to X_7) we have

$MPP_{(Labour)} = 0.191$

$MPP_{(Animal)} = 0.493$

These values show that both manual labour and animal labour are contributing positively at a decreasing return to scale.

8.4.6 Conclusion

All the functions (by sizes & tenancies) of the traditional farms are significant. The exogenous variables have explained the variations in each of the model to a high extent. The summation of the coefficients (values taken from Table 8.8 to Table 8.11) stood at 0.25, 0.36, 0.46 and 0.27 for small and large farms and owner and tenant cultivators respectively.

Each of the summations is less than one which means that all categories are producing with a decreasing return to scale. There is, therefore, a considerable scope for improvement by re- adjusting the inputs optimally. It is to be noted that the summation of the coefficient of the variables of each of the category of the traditional farms is lower than the respective category of the mechanized farms. This means that the situation in the traditional farms is comparatively worse than that of the mechanized farms.

8.5 Pooled Production Function for Mechanized and Traditional Farms

The tests (Chapter 6) show significant difference between mechanized and traditional farms for the maize crop. This means that both the farm groups differ from each other in the overall inputs requirements and as a result their productivity and hence income is different. Here we have taken the combined data for the mechanized and traditional farms for the maize crop by introducing a dummy variable [=1 for mechanized and 0 otherwise (for animal users etc.)]. The detail is given at the end of the chapter in Table 8.13 and a brief of the same is presented below. The production function (in log linear form) is as:

$$\underset{}{LnY} = \underset{(6.54)^{*}}{5.69} + \underset{(3.009)^{*}}{0.2LnX_1} + \underset{(2.90)^{*}}{0.1LnX_2} + \underset{(1.46)}{0.103LnX_3} + \underset{(3.80)^{*}}{0.1LnX_4} + \underset{(1.66)}{0.02LnX_5} + \underset{(3.125)^{*}}{0.005LnX_6} + \underset{(1.37)}{0.02LnX_7} - \underset{(-1.204)}{0.13LnX_8} + \underset{(3.02)^{*}}{2.33LnX_9}$$

$R^2_{(Adj)}$ = 0.44, F* = 16.04

* Significant at 5 per cent.

(Figures in parentheses are t-value)

These estimates show that 44 per cent of the variations have been explained by independent variables. The value of F shows significance of the model.

Whereas:

Y	=	Income (value of the produces)
X_1	=	Manual labour cost
X_2	=	Tractor cost
X_3	=	Animal cost
X_4	=	Seed cost
X_5	=	Fertilizer cost
X_6	=	Farm yard manure cost
X_7	=	Water cost
X_8	=	Rent/other costs
X_9	=	Dummy variable

As the dummy variable is significant so the model for the mechanized farms can be reproduced as:

$$Y = 8.02 + 0.207 X_1 + 0.119 X_2 + 0.10 X_4 + 0.02 X_5 + 0.005 X_6 + 0.02 X_7 - 0.13 X_8$$

Similarly, the model for the traditional farms is:

$$Y = 5.69 + 0.207 X_1 + 0.103 X_3 + 0.10 X_4 + 0.02 X_5 + 0.005 X_6 + 0.02 X_7 - 0.13 X_8$$

The results show that the rate of change of the mechanized farms is higher by 2.33 units than that of the traditional farms.

8.6 Linear Production Model for Mechanized and Traditional Farms: Maize Crops

Here we have used a linear model for the estimation. A dummy variable [=1 for mechanized and zero otherwise (for animal users etc.)] has been introduced in the model. The detail is given at the end of the chapter in Table 8.14 and a brief of the same is as:

$$Y = 1289.4 + 1.14X_1 + 3.856X_2 + 0.86X_3 + 6.105X_4 + 0.128X_5 + 1.07X_6 + 1.1X_7 - 0.096X_8 + 1795.24X_9$$
$$(1.746)\ (3.598)^*\ (1.94)\ \ (2.129)^*\ (3.485)^*\ (0.667)\ \ (9.336)^*\ (1.06)\ (-2.33)^*\ (4.432)^*$$

All the variables have been defined in the preceding section.

$R^2_{(Adj)} = 0.43$, $F^* = 16.0$
* Significant at 5 per cent.
(Figures in parentheses are t-value)

The results show that over 43 per cent of the variations have been explained by the independent variables. F-value also shows significance of the model. The dummy variable is significant so the linear model for mechanized farms is:

$$Y=3048.7+1.14X_1+3.856X_2+6.105X_4+0.128X_5+1.07X_6+1.1X_7-0.096\ X_8$$

The linear model for traditional farms is:

$$Y= 1289.4+1.14X_1+0.86X_3+6.105X_4+0.128X_5+1.07X_6+1.1X_7-0.096\ X_8$$

8.7 Manual Labour Requirements for Mechanized and Traditional Farms for the Maize Crop

In terms of manual labour requirements there are significant differences between mechanized and traditional farms (Chapter 6). The manual labour requirements of the mechanized farms are 46.3 man-hours as against 94.6 for the traditional farms (Table 8.15 below). The manual labour requirements of the mechanized farms are nearly half of that of the traditional farms. As such the mechanization has reduced the manual labour inputs by nearly fifty per cent. Similarly, the animal labour requirement is limited to the traditional farms only. Like the wheat crop, the overall manual labour requirements of the mechanized farms are less than that of the traditional farms for the maize crop.

Table 8.15 Per Jareeb Family and Hired Labour Used by Mechanized and Traditional Farms for the Production of Maize.

Farming sys/ Tenancy & Farm Size	Family Labour				Hired Labour				All	
	Quantity		Cost (Rs.)		Quantity		Cost (Rs.)		No.	Amount (Rs).
	No.	%	Amount	%	No.	%	Amount	%		
Mechanized	18.2	39.3	177.0	42.2	28.1	60.7	242.5	57.8	46.3	419.5
OC Small	10.7	23.6	101.5	270	34.6	76.4	274.8	73.0	45.3	376.3
OC Large	7.9	17.4	75.8	19.9	37.6	82.6	305	80.1	45.5	380.8
Ten Small	32.7	67.6	322.2	64.8	15.7	32.4	175.1	35.2	48.4	397.3
Ten Large	31.7	66.9	309.6	65.0	15.7	33.1	166.6	35.0	47.4	476.2
Traditional	44	46.5	488.6	45.2	50.6	53.5	592.8	54.8	94.6	1081.4
OC Small	28.7	31.4	310.4	29.7	62.7	68.4	733.5	70.3	91.4	1043.9
OC Large	18.4	21.1	205.9	20.4	68.8	78.9	802.9	79.6	87.2	1008.8
Ten Small	71.6	71.4	803.8	70.0	28.7	28.6	344.7	30.0	100.3	1148.5
Ten Large	67.4	66.4	749.7	65.2	34.1	33.6	399.5	34.8	101.5	1149.2

Source: Based on Appendix Tables 21 and 22
Note: Ten: Means tenant cultivators; OC: stands for owner cultivators; and sys means system

As can be seen in the above table, at both mechanized and traditional farms, the manual labour input of the tenant cultivators is higher than that of the respective owner cultivators. The family labour input of the owner cultivators is about 34 per cent of that of the tenant family labour in the traditional farms. In the case of mechanized farms the family labour contribution of the owner cultivators is about 28 per cent of that of the tenant cultivators. This means that family labour contributions at both mechanized and traditional farms are higher on the respective tenant cultivators.

8.8. Manual Labour Requirements Model for Maize

In the case of the maize crop, like that of the wheat crop, both the mechanized and traditional farms have used manual labour. The mechanized farms depend on agricultural machinery and manual labour for the production of the maize crop. The traditional farms, on the other side, depend on animal power and manual labour. The manual labour requirements, therefore, is related to the tractor and animal time, use of

inputs and output. The inputs like seed, fertilizers, farm yard manure, water, rent/other are measured in different units so we take prices of these inputs. Similarly, the main output and by product are measured in different units so we also take price of the entire outputs. A dummy variable [=1 for mechanized and =0 otherwise (for animal users etc.)] has been introduced in the model to capture the mechanization effect. Keeping these criteria we have estimated the model and the detail can be seen in Table 8.16 (given at the end of the chapter) and a brief of the same is as:

$$Y = \underset{(1.78)}{80.02} + \underset{(3.168)^{*}}{0.128\,X_1} - \underset{(-2.683)^{*}}{0.0093X_2} - \underset{(-2.019)^{*}}{1.925X_3} + \underset{(1.883)^{*}}{3.577\,X_4} - \underset{(-2.781)^{*}}{42.095\,X_5}$$

$R^2_{(Adj)} =$ 0.566, $F^{*} =$ 20.8,

- Significant at 5 per cent.

(Figures in parentheses are t-value)

Whereas:

Y	=	Manual labour (time)
X_1	=	Output prices
X_2	=	Input prices
X_3	=	Tractor time
X_4	=	Animal time
X_5	=	Dummy variable

The results show that over 56 per cent of the variations have been explained by the independent variables. The F-value also shows the significance of the model.

As the dummy variable is significant so we have the models for mechanized and traditional farms as:

$$Y = 37.92 + 0.0128\,X_1 - 0.0093\,X_2 - 1.925\,X_3 \text{ (mechanized farms)}$$
$$Y = 80.02 + 0.0128\,X_1 - 0.0093\,X_2 + 3.577\,X_4 \text{ (traditional farms)}$$

From the above models we may safely conclude that signs of all the estimated co-efficients are in conformity with the expectation. The above models show that in both the cases the inputs prices have adverse effects on labour requirements. This shows that the price and quantity demand has inverse relation. As

the inputs prices go up the quantity demanded declines giving a reduction in the manual labour use. The outputs, in both the cases, have a direct effect on manual labour requirements. Any increase in output enhances the manual labour requirements. In the case of traditional farms the use of animal labour increases the manual labour requirements. In the case of mechanized farms the tractor application reduces the manual labour requirements. The model shows that all other factors remains the same (ceteris paribus), the labour requirements of the traditional farms are nearly two times of that of the mechanized farms. This means that in the case of the maize crop the labour requirements of the mechanized farms are nearly half of that of the traditional farms. As such the mechanization has reduced the labour input by 50 per cent.

Table 8.2 Mechanized Farms – Maize Crop Parameter Estimates of Small Farm Size

Variable	Coefficient	Standard Error	t-value
Constant	5.821	1.488	3.911*
Manual labour	0.128	0.051	2.50*
Tractor	0.225	0.091	2.47*
Seed	0.0828	0.075	1.104
Fertilizer	0.0332	0.034	0.976
FYM	0.0478	0.011	4.345*
Water	0.067	0.113	0.598
Rent/other	-0.256	0.214	-1.196

Source: Based on Appendix Table 23
$R^2_{(Adj)} = 0.47$, $F^* = 14.942$.
* Significant at 5 per cent [$t_{(0.025, 86)}$, $F_{(7,86)}$]

Table 8.3 Mechanized Farms–Maize Crop Parameter Estimates of Large Farm Size

Variable	Coefficient	Standard Error	t-value
Constant	4.263	1.747	2.440 *
Manual labour	0.109	0.114	0.954
Tractor	0.254	0.103	2.464 *
Seed	0.033	0.051	0.647
Fertilizer	0.067	0.028	2.396 *
FYM	0.037	0.012	3.083 *
Water	0.064	0.095	0.671
Rent/other	-0.146	0.093	-1.567

Source: Based on Appendix Table 23
$R^2_{(Adj)} = 0.499$, $F^* = 7.69$.
* Significant at 5 per cent [$t_{(0.025, 28)}$, $F_{(7,28)}$]

Table 8.4 Mechanized Farms–Maize Crop Parameter Estimates of Owner Cultivators

Variable	Coefficient	Standard Error	t-value
Constant	3.654	1.374	2.659 *
Manual labour	0.0699	0.074	0.944
Tractor	0.348	0.120	2.90 *
Seed	0.017	0.085	0.200
Fertilizer	0.013	0.053	0.245
FYM	0.004	0.001	3.909 *
Water	0.037	0.067	0.554
Rent/other	0.179	0.183	0.978

Source: Based on Appendix Table 21
$R^2_{(Adj)} = 0.40$, $F^* = 15.57$
* Significant at 5 per cent [$t_{(0.025, 76)}$, $F_{(7,76)}$]

Table 8.5 Mechanized Farms – Maize Crop Parameter Estimates of Tenant Cultivators

Variable	Coefficient	Standard Error	t-value
Constant	6.394	0.904	7.073 *
Manual labour	0.136	0.042	3.238 *
Tractor	0.240	0.041	5.854 *
Seed	0.022	0.032	0.684
Fertilizer	0.079	0.031	2.538 *
FYM	0.046	0.011	4.191 *
Water	0.026	0.050	0.515
Rent/other	-0.246	0.076	-3.213 *

Source: Based on Appendix Table 21
$R^2_{(Adj)} = 0.54$, $F^* = 22.59$.
* Significant at 5 per cent [$t_{(0.025, 38)}$, $F_{(7,38)}$]

Table 8.6 **Mechanized Farms – Maize Crop Parameter Estimates of All Categories**

Variable	Coefficient	Standard Error	t-value
Constant	4.611	1.013	4.551 *
Manual labour	0.106	0.099	1.065
Tractor	0.599	0.083	3.096 *
Seed	0.036	0.034	1.029
Fertilizer	0.043	0.038	1.121
FYM	0.034	0.009	3.811 *
Water	0.049	0.056	0.871
Rent/other	-0.113	0.066	-1.690

Source: Based on Appendix Tables 21 and 23
$R^2_{(Adj)} = 0.41$, $F^* = 16.90$.
* Significant at 5 per cent [$t_{(0.025, 122)}$, $F_{(7,122)}$]

Table 8.8 **Traditional Farms – Maize Crop Parameter Estimates of Small Farm Size**

Variable	Coefficient	Standard Error	t-value
Constant	4.452	1.493	2.981 *
Manual labour	0.228	0.129	1.767 **
Animal labour	0.168	0.054	3.111 *
Seed	0.0214	0.042	0.509
Fertilizer	0.045	0.025	1.80 **
FYM	0.008	0.003	2.505 *
Water	0.004	0.034	0.116
Rent/other	-0.216	0.198	-1.091

Source: Based on Appendix Table 24
$R^2_{(Adj)} = 0.502$, $F^* = 18.57$.
* Significant at 5 per cent [$t_{(0.025, 40)}$, $F_{(7,40)}$]
** Significant at 10 per cent.

Table 8.9 Traditional Farms – Maize Crop Parameter Estimates of Large Farm Size

Variable	Coefficient	Standard Error	t-value
Constant	4.712	1.411	3.339 *
Manual labour	0.215	0.108	1.99 **
Animal labour	0.172	0.052	3.307 *
Seed	0.024	0.123	0.195
Fertilizer	0.083	0.022	3.772 *
FYM	0.006	0.002	3.011 *
Water	0.069	0.024	2.875 *
Rent/other	-0.206	0.181	-1.138

Source: Based on Appendix Table 24
$R^2_{(Adj)} = 0.553$, $F^* = 17.60$.
* Significant at 5 per cent [$t_{(0.025, 14)}$, $F_{(7,14)}$]
** Significant at 10 per cent.

Table 8.10 Traditional Farms – Maize Crop Parameter Estimates of Owner Cultivators

Variable	Coefficient	Standard Error	t-value
Constant	5.019	1.044	4.807 *
Manual labour	0.206	0.070	2.943 *
Animal labour	0.107	0.033	3.242 *
Seed	0.032	0.023	1.391
Fertilizer	0.092	0.021	4.380 *
FYM	0.011	0.005	2.202 *
Water	0.033	0.021	1.571
Rent/other	0.188	0.631	0.298

Source: Based on Appendix Table 22
$R^2_{(Adj)} = 0.509$, $F^* = 17.31$.
* Significant at 5 per cent [$t_{(0.025, 38)}$, $F_{(7,38)}$]

Table 8.11 Traditional Farms–Maize Crop Parameter Estimates of Tenant Cultivators

Variable	Coefficient	Standard Error	t-value
Constant	4.325	3.336	1.296
Manual labour	0.248	0.139	1.778 **
Animal labour	0.135	0.061	2.214 *
Seed	0.036	0.075	0.481
Fertilizer	0.061	0.023	2.613 *
FYM	0.016	0.005	3.02 *
Water	0.099	0.066	1.511
Rent/other	-0.324	0.161	-2.01*

Source: Based on Appendix Table 22

$R^2_{Adj)} = 0.479$, $F^* = 10.44$.

* Significant at 5 per cent [$t_{(0.025, 16)}$, $F_{(7,16)}$]

** Significant at 10 per cent.

Table 8.12 Traditional Farms – Maize Crop Parameter Estimates of All Categories

Variable	Coefficient	Standard Error	t-value
Constant	4.643	1.484	3.128 *
Manual labour	0.241	0.111	2.161 *
Animal labour	0.107	0.038	2.812 *
Seed	0.031	0.008	3.875 *
Fertilizer	0.076	0.0206	3.714 *
FYM	0.016	0.0026	6.125 *
Water	0.061	1.018	0.060
Rent/other	-0.215	1.208	0.178

Source: Based on Appendix Tables 22 and 24

$R^2_{(Adj)} = 0.528$, $F^* = 20.30$.

- Significant at 5 per cent [$t_{(0.025, 62)}$, $F_{(7,62)}$]

Table 8.13 Parameter Estimates of the Maize Crop for Mechanized and Traditional Farms (in log linear form)

Variable	Coefficient	Standard Error	t-value
Constant	5.69	0.87	6.54 *
Manual labour	0.207	0.069	3.009 *
Tractor	0.119	0.041	2.90 *
Animal labour	0.103	0.042	2.46 *
Seed	0.10	0.026	3.80 *
Fertilizer	0.02	0.012	1.66
FYM	0.005	0.0016	3.125 *
Water	0.02	0.015	1.37
Rent/other	-0.128	0.106	-1.204
Dummy	2.33	0.77	3.02 *

Source: Based on Appendix Tables 21, 22, 23 and 24

$R^2_{(Adj)} = 0.4\,4$, $F^* = 16.04$.

* Significant at 5 per cent [$t_{(0.025, 190)}$, $F_{(9,190)}$]

Table 8.14 Parameter Estimates of the Maize Crop for Mechanized and Traditional Farms (In Linear Form)

Variable	Coefficient	Standard Error	t value
Constant	1289.492	738.559	1.746 **
Manual labour	1.143	0.318	3.598 *
Tractor	3.856	1.988	1.940 **
Animal labour	0.860	0.404	2.129 *
Seed	6.105	1.752	3.485 *
Fertilizer	0.128	0.191	0.667
FYM	1.077	0.115	9.336 *
Water	1.113	1.049	1.060
Rent /other	-0.969	0.416	-2.33 *
Dummy	1795.246	405.110	4.432 *

Source: Based on Appendix Tables 21, 22, 23 and 24
$R^2_{Adj)} = 0.431$, $F^* = 16.0$
* Significant at 5 per cent [$t_{(0.025, 190)}$, $F_{(9,190)}$]
** Significant at 10 per cent.

Table 8.16 Manual Labour Requirements for Maize Crop: Regression Estimates

Variable	Coefficient	Standard Error	t-value
Constant	80.02	44.955	1.780
Outputs (Rs)	0.0128	0.004	3.168 *
Inputs (Rs)	-0.0093	0.0034	-2.683 *
Tractor time	-1.925	0.953	-2.019 *
Animal time	3.577	1.899	1.883
Dummy	-42.095	15.136	-2.781 *

Source: Based on Appendix Tables 21, 22, and 24
$R^2_{(Adj)} = 0.566$, $F^* = 20.8$,
Significant at 5 per cent [$t_{(0.025, 194)}$, $F_{(5,194)}$]

CHAPTER 9

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The preceding chapters elaborate the agricultural mechanization and its effect on manual labour input, crop productivity, cropping intensity, livestock holdings and other related issues. The present chapter is designed to form a consolidated picture and to summarize the main ideas and draw conclusions and recommendations therein.

9.1 Summary

In Pakistan, as well as in the NWFP, agricultural is the single largest sector of the economy. This sector provides employment opportunities to nearly half of the labour force and contributes one-fourth to the GDP. The food requirements of the ever increasing population and raw materials for the majority of the manufacturing units are being provided by the agricultural sector.

After Independence of the country in 1947 virtually no attention was given to the development of agricultural sector. As a result the country which had food surplus faced the problem of food deficiency. In the 1960s some attention was given to the improvement of this sector by introducing improved varieties of seed, fertilizers and machinery etc. Mainly because of these measures the productivity of the major crops, particularly of the food crops, considerably increased. However, per acre yields of the major crops of the country are still lower than that of many countries, having more or less similar climatic and socio economic characteristics, and also the world average. Similarly, with the public sector intervention in the 1960s the country with no agricultural machinery at Independence became a producer of some of the major agricultural machinery like Tractor, Thresher, Sheller, Harvester, Drill, Spray machine and Water Pumps. However, the country is still a net importer of the farm machinery.

In all these efforts for agricultural development in Pakistan, mechanization has been a controversial issue. Arguments for and against are advanced in this regard. One school of thought is of the opinion that farm mechanization is essential to cover the power shortage which is the main bottleneck in the increase in agricultural productivity. Also, it is pointed out, that agricultural machinery can help in bringing the waste land under cultivation, performing tillage practices quickly, spare the land which is other wise used for fodder for feeding cattle, and increasing cropping intensity. The other group is of the view that the adoption of mechanization is a labour saving process creating unemployment. It is also argued that in a country like Pakistan, where labour force is in surplus, the use of agricultural machinery will further aggravate the unemployment situation.

It has been pointed out that with in the country the use/application of agricultural machinery is uneven. Most of the literature on the issue under discussion has observed that in Pakistan agricultural mechanization is concentrated in the provinces of the Punjab and Sindh. The present study is designed to address the issue under discussion with particular reference to the manual labour displacement, land use intensity, cropping intensity and livestock holdings in Pakistan in general and in the NWFP in particular which is relatively backward in agriculture than other parts of the country especially the Punjab and Sindh provinces. The yields per acre of the major crops of the NWFP are lower than that of the Punjab and Sindh and even lower than the country's average level. The position of the NWFP in agricultural mechanization can be gauged from the facts that the number of agricultural machinery owners (in percentage terms) of the Province is the lowest in the country. The cultivation with the draught animal in the NWFP is as high as 29 per cent as against 10 per cent at the country level and 4 per cent each in the provinces of Punjab and Sindh. The application of agricultural machinery in

the NWFP is lower than that of the national average level and much lower than that in the Punjab and Sindh provinces. Institutional loan facilities for agriculture in the NWFP are much lower than its agricultural contribution in the country.

For the present study a total of 200 respondents were randomly selected from the irrigated area of Peshawar District. Of the total respondents 130 were mechanized and the rest were traditional farms. The sample size was proportionally distributed in small (less than 5 ha.) and large (5ha. & above) sizes. Each size was proportionally divided in owner and tenant cultivators. For this study the mechanized farms are those where the farmers generally use agricultural machinery and do not use the traditional methods of cultivation or use it but very rarely. Traditional farms in the present case are those who do not use agricultural machinery or use it but very sparsely.

The average family size of the sample respondents was 8.1 per household. The family sizes of the mechanized and traditional farms were 7.4 and 9.7 respectively. Of the total household population, 56 per cent were male and the rest were female. Most of the females were working as house wives. As regard working male population, 45.7 per cent of it was in agriculture, 29.1 in other business and 25.2 per cent were unemployed including students and old age family members.

In respect of all the working male population of the mechanized farms, 37.6 per cent of it was in agriculture, 39.8 per cent in off-farm business and 32.6 per cent were unemployed. In the case of traditional farms the above ratios came to 58.1, 27.9 and 14 per cent respectively. The family labour contribution in agriculture of the tenant cultivators was comparatively higher than the respective owner cultivators of the mechanized and traditional farms.

The off-farm income was considerably higher on the mechanized farms because of their higher educational levels. The overall literacy ratio was 51 per cent

where as it was 55 per cent for the mechanized farms and 43 per cent for traditional farms.

The sample respondents cultivated a total of 2920 Jareebs (591.1 hectares) of irrigated land. Of the total area 67.2 per cent was cultivated by mechanized farms and the rest by traditional farms. The average farm size of the mechanized farms was larger than that of the traditional and there were significant differences in the operated holding. The number of farm fragments of land of the traditional farms was significantly higher than that of the mechanized farms. Per farm land fragment was 1.6 for the mechanized farms as against 3.36 for the traditional farms. The owner cultivators brought over 618 Jareeb waste land under cultivation by using agricultural machinery. Of the total area, 74 per cent was reclaimed by mechanized farms and the rest by traditional farms. The reclaimed area was over 20 percent of the owner's cultivated area. However, machinery application cost of the mechanized farms for the reclamation of land was much lower than that of the traditional farms. One of the main reasons for the high cost of this group was their scattered small pieces of land which increase the machinery movement time and hence cost.

Intensity of land use (ILU) for the mechanized farms was 97.75 per cent as against 96.56 for traditional farms. The ILU of the mechanized farms was insignificantly higher on mechanized farms. The cropping intensity (ICP) of the mechanized farms was 197.8 per cent as against 183.8 per cent for the traditional farms. The cropping intensity was significantly higher on the mechanized farms.

Majority of the respondents maintained contact with the agricultural extension department for guidance. Fellow farmers were also of great help for their community. The suggestions of the agricultural extension department and fellow farmers were of

great help for the respondents.

The sample respondents kept a total of 959 animals (4.80 per farm) like bullock, buffaloes, cows and goats/sheeps with a total investment of Rs. 19.097 millions (about Rs.20,000/animal). The mechanized farms kept only milch animals and got monthly net income of Rs. 1490/animal as against Rs. 1228 per animal in the case of traditional farms. The traditional farms kept both bullock and milch animals. The overall livestock holding between mechanized and traditional farms was insignificantly different. However, mechanized and traditional farms were significantly different in keeping milch animals. The milch animals' population was significantly higher in the mechanized farms.

About 95 per cent of the respondents obtained credit from different sources for fertilizers, livestock and seed etc. Majority of the respondents got loan from informal sources. The main reason was that the formal loans involved a lot of documentation etc.

Chemical fertilizers and farm yard manure (FYM) were used by the respondents. Chemical fertilizers consumption of the mechanized farms was higher than that of the traditional farms. However, the FYM application of the traditional farms was higher than that of the mechanized farms.

A total of 1691.7 and 1629.3 Jareebs of land was devoted to the wheat and maize crops respectively. For the wheat crop, of the total area 72.38 per cent was operated by mechanized farms and the rest by traditional farms. In the case of the maize crop, 70.6 per cent of the land was cultivated by mechanized farms and the rest by traditional farms. There were significant differences between mechanized and traditional farms regarding the inputs use and output for both crops. Also with in each farming

system there were significant differences in inputs use and output by tenurial status and farm sizes in each corp. As such the Cobb Douglas production function was used for each size and tenancy of the mechanized and traditional farms.

The mechanized farmers obtained 18.84 mounds of wheat per Jareeb as against 16.58 by the traditional farms. Similarly in the case of maize crop the mechanized farms received 13.66 mounds per Jareeb as against 10.70 mounds by the traditional farms. As such the productivity is 13.63 per cent and 27.66 per cent significantly higher on the mechanized farms for wheat and maize respectively.

In the following paragraphs we summarize the cost and the results of the production function of wheat and maize. In each of the crop we have mechanized and traditional farms, so each category will briefly be discussed. We, therefore, first discuss the wheat crop to be followed by the maize crop. A comparison in terms of income and labour input between mechanized and traditional farms for each crop is also given. This discussion is followed by tenants' evacuation description.

In the case of the mechanized farms the production cost of the wheat crop stood at Rs. 4365.47/Jareeb giving a net profit of Rs. 5591/Jareebs. The MPP of manual labour and machinery of large farms was higher than that of the small farms. The MPP of manual labour was slightly higher on owner cultivators and that of machinery was considerably higher on tenant cultivators. The income elasticity of machinery of the large farms was higher than that of the small farms. Like wise it was higher for owner than for tenant cultivators. The sum of the income elasticities of each size and tenancy is less than one which means that all these categories of the mechanized farms are producing at stage of decreasing return to scale and shows that there is a sufficient room for improvement by reallocating all the inputs optimally.

The traditional farms production cost of wheat arrived at Rs. 5171.49/Jareeb giving a net return of Rs. 3657.11/Jareeb. The MPP of manual labour, animal labour and tractor of small size were higher than that of the large size. The MPP of manual labour was higher on small farms. The MPP of animal labour was comparatively higher on tenant farms. The income elasticity of owner cultivators was the highest followed by large farms. The lowest income elasticity was observed for tenant cultivators. The sum of income elasticities of each size and tenancy was less than one. Moreover, sum of the income elasticities of each group of the traditional farms was lower than the respective income elasticities of the mechanized farms group. This explains that the situations of the traditional farms are worse than that of the mechanized farms.

In case of the wheat crop the net income of the mechanized farms was much higher than that of the traditional farms. Also the rate of change of the mechanized farm was 2.49 units higher than the traditional farms. The manual labour requirement of the mechanized farms was nearly 23 per cent of that of traditional farms. This means that the application of mechanization has reduced the labour requirements by 77 per cent in the case of the wheat crop. The manual labour requirement is adversely affected by machinery.. The input prices also have inverse relations with human labour requirements. Increases in the use of animal labour and total produce enhance the manual labour requirements.

In the case of the maize crop the production cost of the mechanized farms arrived at Rs. 3360.46/Jareeb giving a net income of Rs. 2844.14/Jareeb. The MPP of manual labour and machinery of large farms was higher than that of small farms. The MPP of manual labour of tenant was higher than that of owner cultivators. However, the MPP of machinery of owner was higher than that of tenant cultivators. The highest

elasticity of 0.49 was observed on owner cultivators followed by large farms. The lowest income elasticity was that of tenant cultivators. However, the sum of the elasticities of each group was less than one. This means that each group is operating with decreasing return to scale and there is considerable scope for improvement.

The traditional farms production cost of the maize crop arrived at Rs. 3288.24/Jareeb whereas the net income stood at Rs. 1622.66/Jareeb. The MPP of manual labour and animal labour of small farms was higher than that of large farms. In the case of owner and tenant cultivators the MPP of the mentioned inputs were nearly equal. The highest income elasticity of 0.46 was noted for the owner cultivators followed by large farms. However, the sum of income elasticities of each group of the traditional farms is less than one. As such there is a considerable scope for the improvement. The income elasticities of each group of the traditional farms are lower than the respective class of the mechanized farms. The traditional farms, therefore, are in worse position as compared to the mechanized farms.

The net income from the maize crop of the mechanized farms was considerably higher than that of the traditional farms. The labour requirement of the mechanized farms was nearly half of that of the traditional farms. The use of mechanization has, therefore, reduced the labour input by nearly 50 per cent in the case of the maize crop. The rate of change of the mechanized farms was 2.33 units higher than the traditional farms. Increase in the application of animal labour and output can enhance manual labour requirements.

Of the total owner cultivators in the mechanized farm category nearly 35.72 per cent entered in the farming profession by evacuating the tenants. As reported by these owners and also by the evacuated tenants (or their relatives/friends) the evacuation of the

tenants has occurred due to owners self cultivation which took place mainly because of mechanization. However, the evacuated tenants have become economically better by adopting other professions and earning more than that they were receiving from farming. The newly inducted owners were mostly idle before farming. However, the farming has become easier with the application of machinery and they don't want to give a good portion of their land income to the tenants. As a result the income of these owners has significantly increased.

9.2 Conclusions

The NWFP of Pakistan is relatively backward in agriculture. Yield per unit land of the Province of the major crops are lower than that of the country level. The bullock users (in percentage terms) in the Province are much more than that of the country level. The farm machinery owners and users (in percentage terms) are the lowest in the NWFP.

Per fragment land of the Province is the lowest one in the country. Also the institutional loan facilities at the provincial level are lower and not at par with other parts of the country.

From the results of the study it can be concluded that both mechanized and traditional methods are applied for the cultivation of the major crops. There are significant differences between mechanized and traditional farms, in terms of manual labour requirements, bullock labour use, family size, cropping intensity, land fragmentation, livestock holdings, input use and output etc. Within each farming system there are significant differences between farm sizes and tenancies.

The MPP of machinery is higher on large farms and owner cultivators which

shows that these categories have comparatively received more benefits from mechanization. As the sum of elasticities of each size and tenancy at mechanized and traditional farms is less than one, so there is considerable scope for improvement. However, the traditional farms are worse as compared to mechanized farms.

Mechanization has helped in increasing yield per Jareeb. The per unit land yield of the mechanized farms is significantly higher than that of the traditional farms. And as a result the net income of the mechanized farms is considerably higher than that of the traditional farms.

The off-farm income is substantially higher on mechanized farms because of their high educational level. The education, thus, helps in increasing the income.

A considerable number of land owners switched to self cultivation. Majority of the evacuated tenants have adopted other economic activities. The owners, who were generally idle, became actively involved in economic activities and on the other side the evacuated tenants got improvement in their income by adopting new professions.

In the case of the wheat crop the labour requirements of the mechanized farms are nearly 23 per cent of that of traditional farms. For the maize crop the labour requirements of the mechanized farms are about 50 per cent of that of traditional farms. The mechanization has, therefore, reduced the manual labour requirements. The use of animal labour is limited to traditional farms. This means that farm machinery is substituted for manual labour and animal power.

A considerable amount of waste land has been brought under cultivation by applying farm machinery in the sample area. Mainly because of their scattered land, the reclamation cost of the traditional farms is higher than that of the mechanized farms.

The mechanization has helped the entire users particularly the large farms and owners. Mechanization has encouraged the milch livestock holdings which helped in increasing in milk output.

9.3 Recommendations

As agriculture is the largest sector of the country, therefore, more attention is to be given to this sector by fulfilling the agricultural input requirements of the farming community at a reasonable price.

Both the mechanized and traditional farms are producing in a decreasing return to scale. However, performance of the mechanized farms is better than that of the traditional farms. The farming community can improve their performance if the inputs are optimally utilized.

The availability of credit for agricultural development through a simple lending procedure is essential for the needy farmers. In order to encourage agricultural mechanization in the Province the loan facilities be made at par with the requirements. All the farmers particularly large size of the traditional category should be encouraged to apply farm machinery as this size can not be properly operated with the traditional methods.

As the presently available machinery can not be applied economically on the scatterer located small pieces of land, so small size machinery be encouraged in the area. The encouragement of mechanization can help in the increase in milch animal population giving increase in milk output and hence income. With the adoption of these measures, it is hoped, the crop productivity and employment opportunities will increase thereby increasing in income and prosperity of cultivating community in the NWP as elsewhere in the country.

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ANNEXURE 1

QUESTIONNAIRE

AGRICULTURAL MECHANIZATION AND LABOUR DISPLACEMENT IN NWFP

Q1 Name of Respondent: _____Village_____No._____
Cat:Trad/Mech.

Q2 Literacy status of the respondent:_____

Q3 Household size composition:

31. Total Household Members_____

32. No. of Family members below 15 year:
Male_____Female_____Total_____

33. Particular of Family members above 15 years.

No	Sex		Age	Education level	Working in Agriculture	Off Farm Income/ Month
	M	F				

Q4. Land Holding/Operated

A: Land Holding: Particulars	Area in Jareeb	B: Operated Area: particular	Area in Jareeb
4.1 Farm Area		4.71 Own Area	
4.2 Cultivable area(4.3+4.4)		4.72 Area rented in	
4.3 Cultivated area (4.31+4.32)		4.73 Percent share (in)	
4.31 Net area sown		4.74 Area rented out	
4.32 Current fellow		4.75 Percent share(out)	
4.4 Culturable waste area		4.76 Net operated area (4.71+4.72+4.73-4.74-4.75)	
4.5 Forest area			
4.6 Not available for cultivation			

4.8 Land rent per Jareeb_____ 4.9 Land fragmentation _____

No. of Fragmentation	Area	Location of fragmentation (this village or other)

Q.5 Crops grown during 2002-2003

Name of Crop	Area (Jareeb)	Name of Crop	Area (Jareeb)

Q.6 For how long do you cultivate this land (given in Q.4-B)

Q.7 Occupation

7.71 Main occupation _____ 7.72 Subsidiary occupation _____
7.73 Main occupation before starting the farming _____

Q.8 Who was cultivating this land previously?

8.1 Do you know the reason due to which the previous cultivator left the land (Y/N)
If yes, please give that reason.

8.2 Do you have any idea about the job/working of the previous cultivator (Y/N)

8.3 If yes, please give detail of his occupation and income.

Q.9 Have you reclaimed any land (Y/N)

9.1 If yes, please give the following information about source of power.

Source of Power	Area reclaimed (Jareeb)	Per Jareeb		Total	
		Time	Cost	Time	Cost
Machinery					
Tractor					
Bulldozer					
Other machinery used					
Bullock					
Other					

Q.10 Do you have any contact with the agri. Extension dept. (Y/N)

10.1 If yes, what type of advice/suggestion did you receive (specify)

Q.11 Do you take any advice/suggestions from your fellow farmers or other person (Y/N)

11.1 If yes, what type advice/suggestion did you receive (specify)

Q.12 Livestock Holding:

Category	No.	Price/unit	Main Purpose	Av. Monthly Exp./animal	Average Income/month
Bullock					
Buffalo					
Cow					
Goat/sheep					
Other					

Q.13 Have you got any credit (Y/N)

Q.14 If yes, please give the following information

Source of Credit	Amount	Purpose	Problem in getting loan
Formal			
Informal			

Q.15 What type of machinery do you use? Please give the detail.

ECONOMICS OF CROP PRODUCTION

Q.16 Name of the crop: Wheat/Maize Q.17 Area of the crop_____ Q.18 Tillage Practices

Name of Activity	Month	No. of Operation	Per Operation work hour									Other Cost	Total Costs
			Human labour			Animal labour			Tractor				
			Own	Hire	Rate Rs/hrs	Own	Hire	Rate Rs/hrs	Own	Hire	Rate Rs/hrs		
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Ploughing													
Planking													
Leveling													
Bund making													
Seeding plough													
Line Sowing													
Broad coasting													
Fertilizing													
FY-Manuring													
Pesticide													
Wedicide													
Weeding/ Hoeing													

Continue next page

Name of Activity	Month	No. of Operation	Per Operation work hour									Other Cost	Total Costs
			Human labour			Animal labour			Tractor				
			Own	Hire	Rate Rs/hrs	Own	Hire	Rate Rs/hrs	Own	Hire	Rate Rs/hrs		
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Irrigation													
Canal													
Tubewell													
Harvesting/ Bundling													
Assembling													
Detaching													
De-covering													
Drying													
Threshing/ Sheller													
Winnowing													
Cleaning													
Carriage to thres/shel													
Carriage to store													

Concluded

No.	Input Name	Unit of Measurement	Total quantity used	Price per unit	Total cost
	Seed				
	FYM				
	Urea				
	DAP				
	SSP				
	Nitropas				
	TSP				
	SOP				
	Am.Sulp				
	Other Che.Fer				
	Pesticide				
	Wedicide				
	Irrigation				

APPENDIX TABLE 1

Area, Production and Yield of the Major Crops in theNWFP and Pakistan Area in "000" Hectares ,Production in "000" Tonnes and Yield in Tonnes							
Sr.No	Crops	1990-95			1995-2000		
		NWFP	Pakistan	%*	NWFP	Pakistan	%*
1	Wheat Area	845.1	8058.5	10.48	858.2	8306.6	10.33
	Production	1161.9	15724.2	7.39	1182.5	18237.6	6.48
	Yield	1.4	2.0	70.48	1.4	2.2	62.75
2	Rice Area	62.7	2098.9	2.98	66.1	2333.8	2.83
	Production	117.9	3212.2	3.60	126.9	4486.7	2.83
	Yield	1.9	1.6	118.7	1.9	1.9	100
3	Maize Area	519.8	865.6	60.05	533.9	944.6	56.52
	Production	781.2	1220.5	64.0	818.2	1565.8	52.25
	Yield	1.5	1.4	107.1	1.5	1.7	88.2
4	Bajra Area	11.5	420.4	2.73	7.5	389.1	1.93
	Production	6.9	180.7	3.82	4.0	177.4	2.25
	Yield	0.6	0.4	150.0	0.5	0.5	100
5	Jowar Area	18.7	401.1	4.66	11.2	383.6	2.92
	Production	13.2	235.5	5.61	7.2	230.7	3.12
	Yield	0.7	0.6	116.7	0.6	0.6	100
6	Barly Area	59.6	156.2	38.15	53.2	149.4	35.6
	Production	62.4	150.0	41.67	55.2	150.7	36.62
	Yield	1.0	0.9	111.1	1.0	1.0	100
7	All cereals Area	1517.5	12000.8	12.64	1530.1	12507.2	12.23
	Production	2143.4	20923.1	10.24	2194.0	24848.9	8.83
	Yield	1.4	1.7	82.3	1.4	2.0	70.0

Continue

Area, Production and Yield of the Major Crops in the NWFP and Pakistan Area in "000" Hectares, Production in "000" Tonnes and Yield in Tonnes							
Sr.No	Crops	1990-95			1995-2000		
		NWFP	Pakistan	%*	NWFP	Pakistan	%*
8	S. cane Area	102.2	927.3	11.02	105.8	1029.7	14.64
	Production	4509.2	40901.6	11.02	4803.5	48371.2	9.93
	Yield	44.1	44.1	100	45.4	47.0	96.5
9	Tobacco Area	31.6	52.1	60.65	31.1	52.4	59.35
	Production	64.1	91.0	70.43	69.4	97.3	71.32
	Yield	2.0	1.4	142.9	2.2	1.9	115.8
10	S.Beet Area	8.4	8.5	99.0	5.5	5.6	98.2
	Production	260.4	261.2	99.6	149.1	150.0	99.4
	Yield	31.0	30.7	101.0	27.1	26.8	101
11	Guarseed Area	7.7	238.4	3.22	5.6	157.9	3.55
	Production	10.0	210.3	4.75	7.4	150.7	4.91
	Yield	1.3	0.9	144.4	1.3	0.9	144.4
12	Gram Area	105.7	1041.1	10.15	92.4	1074.0	8.60
	Production	43.8	472.1	9.28	37.2	660.7	5.63
	Yield	0.4	0.4	100	0.4	0.6	66.7
13	Mung Area	8.8	152.4	5.77	8.7	197.8	4.39
	Production	4.9	63.8	7.68	5.2	90.8	5.73
	Yield	0.6	0.4	150.0	0.6	0.5	120.0
14	Mash Area	3.1	70.9	4.37	2.2	50.8	4.33
	Production	2.5	31.9	7.83	1.7	26.3	6.46
	Yield	0.8	0.5	160.0	0.8	0.5	160.0
15	Masoor Area	8.2	59.6	13.75	6.7	62.5	10.72
	Production	4.4	27.5	16.0	3.3	35.9	9.19
	Yield	0.6	0.4	150.0	0.6	0.5	120.0

Continue

Area , Production and Yield of the Major Crops in the NWFP and Pakistan Area in "000" Hectares, Production in "000" Tonnes and Yield in Tonnes							
Sr.No	Crops	1990-95			1995-2000		
		NWFP	Pakistan	%*	NWFP	Pakistan	%*
16	Mattar Area	2.4	139.7	1.72	2.2	139.6	1.57
	Production	1.5	72.1	2.08	1.4	81.9	1.71
	Yield	0.6	0.5	120.0	0.6	0.6	100
17	Other Kharif Area	2.8	13.5	20.74	2.5	9.6	26.04
	pluses Production	1.5	6.4	23.43	1.4	5.2	26.92
	Yield	0.5	0.5	100.0	0.5	0.5	100.0
18	Other Rabi Area	0.6	3.6	16.67	0.4	3.2	12.50
	pluses Production	0.2	1.6	12.50	0.2	1.6	12.50
	Yield	0.3	0.4	75.0	0.4	0.5	80.0
19	All pluses Area	131.6	1480.8	8.09	115.2	1537.6	7.49
	Production	58.7	675.4	8.69	50.4	902.4	5.58
	Yield	0.4	0.4	100	0.4	0.6	66.7
20	Rapeseed &						
	Mustard Area	35.9	288.7	12.43	30.7	333.4	9.21
	Production	17.1	216.3	7.91	15.6	281.7	5.54
	Yield	0.5	0.8	62.5	0.5	0.8	62.5
21	Groundnut Area	10.7	91.0	11.75	14.2	101.0	14.05
	Production	17.0	97.6	17.41	22.4	109.1	20.53
	Yield	1.6	1.1	145.4	1.6	1.1	145.5
22	Sesamum Area	0.9	71.6	1.25	1.0	85.6	1.17
	Production	0.3	30.5	0.98	0.5	38.9	1.28
	Yield	0.3	0.4	75.0	0.5	0.5	100.0

Continue

Area, Production and Yield of the Major Crops in the NWFP and Pakistan Area in "000" Hectares, Production in "000" Tonnes and Yield in Tonnes							
Sr.No	Crops	1990-95			1995-2000		
		NWFP	Pakistan	%*	NWFP	Pakistan	%*
23	Onion Area	6.4	67.1	9.53	7.7	87.1	8.84
	Production	83.4	857.9	9.72	107.2	1218.3	8.80
	Yield	13.0	12.8	101.6	13.9	14.0	99.3
24	Garlic Area	2.7	7.5	36.0	2.8	8.8	31.81
	Production	27.0	65.1	41.47	30.2	79.5	37.98
	Yield	10.0	8.7	114.9	10.4	9.0	115.5
25	Chillies Area	0.3	72.3	0.41	0.4	87.9	0.45
	Production	0.4	111.0	0.36	0.4	133.6	0.30
	Yield	1.3	1.5	86.7	1.1	1.5	73.3
26	Coriander Area	0.2	6.6	3.0	0.2	6.8	2.94
	Production	0.1	3.0	3.3	0.1	3.3	3.03
	Yield	0.5	0.5	100.0	0.5	0.5	100.0
27	Turmeric Area	1.4	4.2	33.3	0.9	4.3	20.93
	Production	12.0	37.9	31.6	7.6	39.4	19.29
	Yield	8.6	9.0	95.6	8.4	9.2	91.3
28	Potato Area	8.2	76.4	10.7	9.4	97.9	9.60
	Production	88.1	941.0	9.4	111.1	1426.3	7.79
	Yield	10.7	12.3	87.0	11.8	14.6	80.8
29	Vegetable Area	36.2	224.8	16.1	30.5	218.0	13.99
	Production	436.8	3032.2	14.4	332.8	2889.3	11.52
	Yield	12.1	13.5	89.6	10.9	13.3	81.9
30	Tomato Area	8.8	23.3	37.8	12.5	29.3	42.66
	Production	86.8	244.9	35.44	127.1	311.6	40.79
	Yield	9.9	10.5	94.3	10.2	10.6	96.2

Area, Production and Yield of the Major Crops in the NWFP and Pakistan Area in "000" Hectares, Production in "000" Tonnes and Yield in Tonnes							
Sr.No	Crops	1990-95			1995-2000		
		NWFP	Pakistan	%*	NWFP	Pakistan	%*
31	Fodder crops Area	119.0	2698	4.4	136.2	2649.9	5.14
	Production	2645.6	57704.7	4.5	2908.0	60215.1	4.83
	Yield	22.2	21.4	103.7	21.3	22.7	9308
32	Citrus Fruit Area	3.9	180.3	2.2	4.5	195.8	2.30
	Production	33.2	1737.3	1.9	38.1	1960.8	1.94
	Yield	8.5	9.6	88.5	8.5	10.0	85.0
33	Guava Area	2.8	50.8	5.5	3.1	57.4	5.40
	Production	27.1	387.0	7.0	30.3	461.4	6.57
	Yield	9.7	7.6	127.6	9.8	8.0	122.5
34	Apricot Area	1.6	9.2	17.4	1.8	12.1	14.88
	Production	17.3	128.5	13.5	19.4	175.8	11.03
	Yield	10.8	14.0	77.1	10.8	14.5	74.5
35	Peach Area	0.8	3.1	25.8	1.1	4.4	25.0
	Production	8.8	32.4	27.2	12.5	43.7	28.60
	Yield	11.0	10.5	104.8	11.4	9.9	115.2
36	Pears Area	2.2	2.6	84.6	2.4	2.8	85.71
	Production	30.5	33.2	91.9	33.2	36.2	91.71
	Yield	13.9	12.8	108.6	13.8	12.9	106.9

Continue

Area, Production and Yield of the Major Crops in the NWFP and Pakistan Area in "000" Hectares, Production in "000" Tonnes and Yield in Tonnes							
Sr.No	Crops	1990-95			1995-2000		
		NWFP	Pakistan	%*	NWFP	Pakistan	%*
37	Plums Area	3.2	5.5	58.2	3.4	6.7	50.74
	Production	34.7	63.7	54.5	37.1	74.4	49.87
	Yield	10.8	11.6	93.1	10.9	11.1	98.2
38	All fruit Area	29.2	500.5	5.83	44.9	639.0	7.02
	Production	307.3	4412.1	6.4	516.4	6152.6	8.39
	Yield	10.5	8.8	119.3	11.5	9.6	119.8

Note: * Means NWFP as % of Pakistan Concluded

Source: Govt of Pakistan (2003), *Agricultural Statistics of Pakistan 2002 -2003*

APPENDIX TABLE 2

General Information About the Sample Households

Farming-System Farms/Size & Tenency	Respondents			Below 15 Years Family Members			Family members 15 years and above		
	All	Educated	Un Educated	Male	Female	All	Male	Female	All
Mechanized									
OC Small	64	37	27	93	74	167	148	99	247
OC Large	20	12	8	42	42	84	50	32	82
All OC	84	49	35	135	116	251	198	131	329
Tenant Small	30	14	16	50	45	95	68	42	110
Tenant Large	16	9	7	43	39	82	53	38	91
All Tenant	46	23	23	93	84	177	121	80	201
All Mechanized	130	72	58	228	200	428	319	211	530
Traditional									
OC Small	32	14	18	61	59	120	74	62	136
OC Large	14	7	7	42	36	78	53	42	95
All OC	46	21	25	103	95	198	127	104	231
Tenant Small	16	6	10	36	33	69	50	34	84
Tenant Large	8	3	5	25	22	47	31	20	51
All Tenant	24	9	15	61	55	116	81	54	135
All Traditional	70	30	40	164	150	314	208	158	366
G. Total	200	102	98	392	350	742	527	369	896

Source: Survey

APPENDIX TABLE 3

Economic Activities of the Male Population of age 15 Years & Above of the Sample Households

Farming System Tenancy & Size	Not Working		Working in Agriculture		Off Farm Working & Income			All
Mechanized	No	Percent	No	Percent	No	Percent	Income(000)	
OC Small	64	43.3	52	35.1	32	21.6	135.0	148
OC Large	7	14	23	46	20	40	293.0	50
All OC	71	35.9	75	37.9	52	26.2	428	198
Tenant Small	19	27.9	27	39.7	22	32.4	91.5	68
Tenant Large	14	26.4	18	34.0	21	39.6	168.3	53
All Tenant	33	27.3	45	37.2	43	35.5	259.8	121
All Mechanized	104	32.6	120	37.6	95	29.8	687.8	319
Traditional								
OC Small	10	13.5	44	59.5	20	27.0	63.0	74
OC Large	7	13.2	29	54.7	17	32.1	137.4	53
All OC	17	13.4	73	57.5	37	29.1	200.4	127
Tenant Small	7	14.0	31	62.0	12	24.0	34.3	50
Tenant Large	5	16.1	17	54.9	9	29.0	34.0	31
All Tenant	12	14.8	48	59.3	21	25.9	68.3	81
All Traditional	29	13.9	121	58.2	58	27.9	268.7	208
G. Total	133	25.2	241	45.7	153	29.1	956.5	527

Source: Survey

APPENDIX TABLE 4

Land Utilization of the Mechanized Farms

Size & Tenancy	Farm Area (Jareeb)			Operated Area (Jareeb)				Fragmentation No.
					Rented			
	Total	Waste	Net	Own	In	Out	Net Operated	
OC Small	1162.2	22.7	1139.5	1139.5	-	-	1139.5	100
OC Large	755.9	22.2	733.7	733.7	-	-	733.7	41
All OC	1918.1	44.9	1873.0	1873.2	-	-	1873.2	141
Tenant Small	524	12.2	511.8	-	511.8	-	511.8	39
Tenant Large	545	10	535	-	535	-	535	26
All Tenant	1069	22.2	1046.8	-	1046.8	-	1046.8	65
All	2987.1	67.1	2920.0	1873.2	1046.8	-	2920.0	206

Source: Survey

APPENDIX TABLE 5

Land Utilization of the Traditional Farms

Size & Tenancy	Farm Area(Jareeb)			Operated Area (Jareeb)				Fragmentation
					Rented			
	Total	Waste	Net	Own	In	Out	Net Operated	No.
OC Small	618	13	605.0	605.0	-	-	605	98
OC Large	402.7	18.8	383.9	383.9	-	-	383.9	48
All OC	1020.7	31.8	988.9	988.9	-	-	988.9	146
Tenant Small	224.2	7.4	216.8		216.8	-	216.8	52
Tenant Large	227.8	11.4	216.4		216.4	-	216.4	30
All Tenant	452	18.8	433.2		433.2	-	433.2	82
All	1472.7	50.6	1422.1	988.9	433.2	-	1422	228

Source: survey

APPENDIX TABLE 6

Area Under Rabi Crops (in Jareeb) in the Sample Area (Mechanized Farms)

Category	Wheat	S.Beet	Tobacco	Vegetable	Fodder	All
OC Small	501.6	80.9	21.3	137.4	76.7	817.9
OC Large	280	71.2	36.2	77.5	78.8	543.7
All OC	781.6	152.1	57.5	214.9	155.5	1361.6
Tenant Small	197.8	27.2	22.5	76.9	46.9	371.3
Tenant Large	245	29	23	70	44	411.0
All Tenant	442.8	56.2	45.5	146.9	90.9	782.3
All	1224.4	208.3	103	361.8	246.4	2143.9

Source: Survey, S - Beet means Sugar Beet

APPENDIX TABLE 8

Area Under Kharif Crops (in Jareeb), Cropped Area & Cropping Intensity in the Sample Area (Mechanized Farms)

Size & Tenancy	Maize	Sugar cane	Vegetable	Fodder	Nursery	All Kharif	Cropped Area*	Cropping Intensity**
OC Small	510.1	200.2	244.9	365.3	115	1435.5	2253.4	197.7
OC Large	263.1	140.6	215	228.7	49.4	896.8	1440.5	196.3
OC All	773.2	340.8	459.9	594.0	164.4	2332.3	3693.9	197.2
Tenant small	192.2	82.5	143.4	178.1	58.1	654.3	1025.6	200.0
Tenant Large	185	81	159	178	43	646	1057	197.5
All Tenant	377.2	163.5	302.4	356.1	101.1	1300.3	2082.6	198.9
All	1150.4	504.3	762.3	950.1	265.5	3632.6	5776.6	197.8

* Cropped Area = Rabbi and Kharif Area,
** Cropping Intensity = (Cropped Area / cultivated area) X 100
Source: Survey

APPENDIX TABLE 9

Area Under Kharif Crops (in Jareeb), Cropped Area & Cropping Intensity in the Sample Area (Traditional Farms)

Size & Tenancy	Maize	Sugarcane	Vegetable	Fodder	Nursery	All Kharif	Cropped Area*	Cropping Intensity**
OC Small	205	112	120	190	86	713	1120	185.1
OC Large	119.5	83.5	71.9	110.2	47.5	432.6	685.5	178.5
All OC	324.5	195.5	191.9	300.2	133.5	1145.6	1805.5	182.5
Tenant Small	86.4	33.30	51.9	55.2	16.00	242.8	410.4	189.2
Tenant Large	68.00	37.6	40.3	74.6	19.8	240.3	399.3	184.4
All Tenant	154.4	70.90	92.2	129.80	35.80	483.1	8097	186.6
All	478.9	266.4	284.1	430.0	169.3	1628.7	2615.2	1.84

* Cropped Area = Rabbi and Kharif Area,
** Cropping Intensity = (Cropped Area / cultivated area) X 100
Source: Survey

APPENDIX TABLE 9

Area Under Kharif Crops (in Jareeb), Cropped Area & Cropping Intensity in the Sample Area (Traditional Farms)

Size & Tenancy	Maize	Sugarcane	Vegetable	Fodder	Nursery	All Kharif	Croppe d Area*	Cropping Intensity**
OC Small	205	112	120	190	86	713	1120	185.1
OC Large	119.5	83.5	71.9	110.2	47.5	432.6	685.5	178.5
All OC	324.5	195.5	191.9	300.2	133.5	1145.6	1805.5	182.5
Tenant Small	86.4	33.30	51.9	55.2	16.00	242.8	410.4	189.2
Tenant Large	68.00	37.6	40.3	74.6	19.8	240.3	399.3	184.4
All Tenant	154.4	70.90	92.2	129.80	35.80	483.1	8097	186.6
All	478.9	266.4	284.1	430.0	169.3	1628.7	2615.2	1.84

* Cropped Area = Rabbi and Kharif Area,
** Cropping Intensity = (Cropped Area / cultivated area) X 100
Source: Survey

APPENDIX TABLE 10

Machinery Time & its Cost for Area Reclamation by the Respondents

Category	Area (Jareeb)	Time (Hrs.)	Cost(000) (Rs.)
Mechanized	271.6	1028.8	143.1
OC small			
OC Large	183.6	566.3	67.80
OC All Mechanized	455.2	1595.1	210.9
Tenant small	-	-	-
Tenant Large	-	-	-
All Tenant			
All Mechanized	455.2	1595.1	210.9
Traditional	88.2	415.5	58.5
OC Small			
OC Large	74.6	224.4	31.6
All OC Traditional	162.8	639.9	90.1
Tenant Small	-	-	-
Tenant Large	-	-	-
All Tenant	-	-	-
All	618	2235	301

Source: Survey

APPENDIX TABLE 11

Live Stock Holdings of the Sample Respondents: Mechanized Farms

	Bullock		Buffalow				
Category	No	Price (000)	No	Price (000)	Expenditure (000)	Income (000)	Net income (000)
OC Small	-	-	75	2076.7	175.2	246.2	71.0
OC Large	-	-	95	3025.0	257.4	674.3	416.9
OC All	-	-	170	5101.7	432.6	920.5	487.9
Tenant small	-	-	38	1026.6	88.9	120.8	31.9
Tenant Large	-	-	92	2856	255.8	416.0	160.2
All Tenant	-	-	130	3882.6	344.7	536.8	192.1
All	-	-	300	8984.3	777.3	1457.3	680.0

Cont.

Live Stock Holdings of the Sample Respondents: Mechanized Farms

	Cow				
Category	No	Price (000)	Expenditure (000)	Income (000)	Net income (000)
OC small	68	1018.2	89.7	131.8	42.1
OC Large	49	895	82.7	139.0	56.3
OC All	117	1913.2	172.4	270.8	98.4
Tenant small	32	489.4	40.3	64.9	24.6
Tenant Large	62	977.0	96.7	169.4	72.7
All Tenant	94	1466.4	137.0	234.3	97.3
Total	211	3379.6	309.4	505.1	195.7

Cont.

Live Stocks Holding of the Sample Respondents: Mechanized Farms

	Goat					All Live Stock		
Category	No	Price (000)	Expenditure (000)	Income (000)	Net Income (000)	No	Price (000)	Net Income (000)
OC Small	53	145.3	17.0	29.4	12.4	196	3240.3	125.6
OC Large	20	48.0	5.9	9.0	3.1	164	3967.9	476.2
OC All	73	193.3	22.9	38.4	15.5	360	7208.2	601.8
Tenant Small	26	60.6	7.6	11.7	4.1	96	1576.5	60.6
Tenant Large	23	60.6	6.5	9.8	3.3	177	3893.6	236.1
Tenant All	49	121.2	14.1	21.5	7.4	273.0	5470.1	296.7
All	122	314.5	37	59.9	22.9	633	12678.3	898.5

Source: Survey

Concluded

APPENDIX TABLE 12

Live Stocks Holding of the Sample Respondents: Traditional Farms

	Bullock		Buffalos				
Category	No	Price (000)	No	Price (000)	Expenditure (000)	Income (000)	Net Income (000)
OC Small	52	1108.0	38	1054.0	88.8	132.1	43.3
OC Large	28	727.3	24	719.2	63.0	173.0	110.0
All OC	80	1835.3	62	1773.2	151.8	305.1	153.3
Tenant Small	20	487.4	16	450.9	38.8	56.0	17.20
Tenant Large	16	406.6	12	438.9	33.7	63.5	29.8
All Tenant	36	894.0	28	889.8	72.2	1195	47
All	116	2729.3	90	2663.0	224.3	424.6	200.3

Cont.

Live Stocks Holding of the Sample Respondents: Traditional Farms

	Cow				
Category	No	Price (000)	Expenditure (000)	Income (000)	Net Income (000)
OC Small	28	389.1	35.6	62.0	26.4
OC Large	15	218.1	18.8	29.2	10.4
All OC	43	607.2	54.4	91.2	36.8
Tenant Small	11	149.0	12.8	20.5	7.7
Tenant Large	8	139.9	13.8	18.3	4.5
All Tenant	19	288.9	26.6	38.8	12.2
All	62	896.1	81.0	130.0	49

Cont.

Live Stocks Holding of the Sample Respondents: Traditional Farms

	Goat / Sheep					All Live Stock		
Category	No	Price(000)	Expenditure (000)	Income (000)	Net Income (000)	No	Price (000)	Net Income (000)
OC Small	26	55.4	7.6	11.3	3.7	144	2606.5	73.4
OC Large	12	29.8	3.2	4.8	1.6	79	1694.4	122.0
All OC Trade	38	85.2	10.8	16.1	5.3	223	4300.9	195.4
Tenant Small	16	34.8	4.50	7.0	2.5	63	1122.1	27.4
Tenant Large	4	10.7	1.0	1.7	0.7	40	996.1	35.0
All Tenant	20	45.5	5.5	8.7	3.2	103	2118.2	62.4
All	58	130.7	16.3	24.8	8.5	326	6419.1	257.8

Source: Survey

Concluded

APPENDIX TABLE 13

Consumption of Fertilizers by Types and Nutrients (Kg/Jareeb) by Mechanized Farms: Wheat Crop

Farm/Tenancy/ Size	Area	Types of Fertilizer				Nutrient	
		Urea	DAP	A.Sulphate	All	N	P
OC Small	51.16	51.59	16.98	-	68.57	26.79	7.81
OC Large	280.0	50.22	23.21	-	73.43	27.28	10.68
All OC	7814.6	50.92	20.02	-	70.94	27.03	9.21
Tenant Small	197.8	40.76	9.00	-	49.76	20.37	4.14
Tenant Large	245.0	43.06	5.92	2.04	51.02	21.30	2.72
All Tenant	442.8	42.37	6.85	1.42	50.64	21.02	3.15
All	1224.4	47.22	14.32	0.62	62.16	24.43	6.59
Small	699.4	48.24	14.51	-	62.75	24.80	6.68
Large	525.0	46.48	14.18	1.07	61.73	24.15	6.52
All	1224.4	47.22	14.32	0.62	62.16	24.43	6.59

Source: Survey

APPENDIX TABLE 14

Consumption of Fertilizers by Types and Nutrients (Kg / Jareeb) by Traditional Farms: Wheat Crop

Farm/Tenancy/ Size	Area	Types of Fertilizer				Nutrients	
		Urea	DAP	A.Sulphate	All	N	P
OC Small	191.0	50.26	3.66	3.14	57.06	24.44	1.69
OC Large	120.6	47.11	8.65	5.29	61.06	24.34	3.98
OC All	311.6	48.62	6.26	4.26	59.14	24.39	2.88
Tenant Small	87.8	43.94	0.76	4.54	49.24	21.30	0.35
Tenant Large	67.9	49.51	-	-	49.51	22.77	-
Tenant All	155.7	47.34	0.29	1.77	49.40	22.2	0.14
All	467.3	48.03	3.52	3.12	54.67	23.39	1.62
Small	278.8	47.68	2.47	3.71	53.86	23.16	1.14
Large	188.50	48.31	4.35	2.65	55.31	23.56	1.99
All	467.3	48.03	3.52	3.12	54.67	23.35	1.62

Source: Survey

APPENDIX TABLE 15

Consumption of Fertilizers by Types and Nutrients (Kg / Jareeb) by Mechanized Farms: Maize Crop

Farm/Tenancy/ Size	Area	Types of Fertilizer				Nutrients	
		Urea	DAP	A.Sulphate	All	N	P
OC Small	510.1	55.74	1.46	4.17	16.37	26.78	0.67
OC Large	26.31	50.12	3.56	8.31	61.99	25.44	1.64
OC All	773.2	53.11	2.44	6.11	61.66	26.15	1.12
Tenant Small	192.2	50.24	-	-	50.24	23.11	-
Tenant Large	185.0	50.0	-	-	50.0	23.0	-
Tenant All	377.2	50.08	-	-	61.66	23.03	-
All	1150.4	51.93	1.49	3.73	57.15	24.94	0.69
Small	702.3	54.09	1.02	2092	58.03	25.68	0.47
Large	448.1	50.06	1.90	4.42	56.38	24.30	0.87
All	1150.4	51.93	1.49	3.73	57.15	24.94	0.69

Source: Survey

APPENDIX TABLE 16

Consumption of Fertilizers by Types and Nutrients (kg / Jareeb) by Traditional Farms: Maize

Farm/Tenancy/ Size	Area	Types of Fertilizer				Nutrients	
		Urea	DAP	A.Sulphate	All	N	P
OC Small	205	55.44	-	-	55.44	25.50	-
OC Large	119.5	54.37	-	2.43	56.80	25.52	-
OC All	324.5	54.88	-	1.25	56.14	25.51	-
Tenant Small	86.4	40.76	-	-	40.76	18.75	-
Tenant Large	68.0	47.09	-	-	47.09	21.66	-
Tenant All	154.4	44.64	-	-	44.64	20.54	-
All	478.9	50.20	-	0.68	50.88	23.23	-
Small	291.40	49.53	-	-	49.33	22.78	-
Large	187.50	50.73	-	1.21	51.94	23.59	-
All	478.9	50.20	-	0.68	50.88	23.23	-

Source: Survey

APPENDIX TABLE 17

Per Jareeb FYM Used by Sample Respondents for the Wheat Crop (Mechanized and Traditional Farms)

Category/size/tenancy	Area (Jareeb)	Qty Used (Per Jareeb) in monds
Mechanized		
OC Small	501.6	25.05
OC Large	280.0	28.12
ALL OC	781.6	26.55
Tent Small	197.8	24.17
Tent Large	245.0	25.71
Tent All	442.8	25.25
All Tenancies Mechanized	1224.4	25.98
Small Size	699.4	24.78
Large Size	525.0	26.86
All Sizes Mechanized	1224.4	25.98
Traditional		
OC Small	191.0	37.17
OC Large	120.6	47.11
ALL OC	311.6	42.35
Tent Small	87.8	31.82
Tent Large	67.9	28.64
Tent ALL	155.7	29.88
All Tenancies Traditional	467.3	36.63
Small Size	278.8	34.98
Large Size	188.5	37.92
All Traditional	467.3	36.63

Source: Survey; Note: Ten: means Tenant; OC: means Owners cultivator

APPENDIX TABLE 18

Per Jareeb FYM Used by Sample Respondents for the Maize Crop (Mechanized and Traditional Farms)

Category/size/tenancy	Area (Jareeb)	Qty Used (Per Jareeb) monds
Mechanized		
OC Small	510.1	16.11
OC Large	263.1	13.77
ALL OC	773.2	15.02
Tent Small	192.2	15.61
Tent Large	185.0	17.84
Tent ALL	377.2	17.04
All Tenancies Mechanized	1150.4	15.80
Small Size	702.3	15.96
Large Size	448.1	15.67
All Sizes Mechanized	1150.4	15.80
Traditional		
OC Small	205.0	0.51
OC Large	119.5	0.48
ALL OC	324.5	0.50
Tent Small	86.4	13.07
Tent Large	68.0	18.93
Tent ALL	154.4	16.67
All Tenancies Traditional	479.9	7.89
Small Size	291.4	5.57
Large Size	187.5	9.70
All Sizes Traditional	479.9	7.89

Source: Survey; Note: Ten: means Tenant; OC :means Owners cultivator

APPENDIX TABLE 19

Per Jareeb Inputs, its Costs & net Income of the Wheat Crop (Mechanized Farms)

Category	Own labour		Hired Labour		Total Labour		Tractor		Rent & other
	Time	Cost	Time	Cost	Time	Cost	Time	Cost	
OC Small	3.58	40.92	13.32	107.60	16.90	148.52	2.11	856.80	2173.7
OC Large	2.68	27.24	10.09	80.89	12.77	108.13	1.92	820.69	2144.48
All OC	3.14	34.25	11.75	94.58	14.89	128.83	2.02	839.18	2159.48
Tenant Small	12.37	164.8	5.77	40.06	18.14	204.86	2. 64	947.9	2082.66
Tenant Large	12.14	157.60	2.17	27.92	14.31	185.52	1.74	757.15	2111.40
All Tenant	12.21	159.56	3.25	31.58	15.46	191.14	2.01	814.58	2102.72
All	7.06	88.50	8.07	67.3	15.13	155.80	2.01	828.50	2134.90

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Wheat Crop
(Mechanized Farms)

Category	Seed		FYM		Fertilizer		Irrigation	Out Put				
	Qty	Cost	Qty	Cost	Qty	Cost	Cost	Main		By		All Price
								Qty	Price	Qty	Price	
OC small	21.03	252.40	0.51	212.06	1.37	808.80	48.44	18.73	8430.6	1.13	1410.60	9841.20
OC large	21.91	263.03	0.56	204.05	1.47	938.90	43.20	19.86	8937.0	1.12	1520.90	10457.90
All OC	21.46	257.60	0.53	208.16	1.41	872.24	45.99	19.28	8677.82	1.12	1464.41	10142.23
Tenant small	21.04	273.50	0.48	204.17	1.0	578.40	45.07	18.27	8219.6	1.06	1499.0	9718.60
Tenant large	20.79	270.34	0.51	191.50	1.02	545.60	43.18	18.27	8221.0	0.92	1489.70	9710.70
All Tenant	20.87	271.31	0.50	195.32	1.01	555.43	43.75	18.27	8220.5	0.96	1492.58	9713.08
All	21.20	263.50	0.52	202.60	1.24	735.15	45.02	18.84	8480.0	1.05	1476.60	9956.60

Note: - Seed Qty in KG.; Fertilizer Qty in bags (1 bag = 50 kg); FYM Qty in Trolley (1 Trolley = 50 mounds); Main out put Qty in mounds ,by product Qty in Bosara (1 bosara is from 25 to 30 mounds)

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Wheat Crop (Mechanized Farms)

Category	Input Costs	All Costs	Net Income
OC small	1321.70	4500.72	5340.48
OC large	1449.18	4522.48	5935.42
All OC	1383.99	4511.48	5630.75
Tenant small	1101.14	4336.56	5382.04
Tenant large	1050.62	4104.69	5606.01
All Tenant	1065.81	4174.25	5538.83
All	1246.27	4365.47	5591.13

Source: Survey

Concluded

APPENDIX TABLE 20

Per Jareeb Inputs, its Costs & Net Income of the Wheat Crop
(Traditional Farms)

Category	Own Labour		Hired Labour		Total Labour		Animal		Tractor		Rent & other Cost
	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Time	Cost	
OC small	29.74	163.0	40.4	584.04	70.14	747.04	3.63	127.17	0.88	1082.8	2005.08
OC large	29.4	104.8	45.13	597.36	74.53	702.16	3.67	128.56	0.88	1116.5	2005.7
All OC	29.56	151.98	42.81	590.92	72.37	742.90	3.65	127.89	0.88	1060.34	2005.4
Tenant small	60.68	636.5	11.50	144.67	72.18	781.17	4.08	142.65	0.92	942.8	2111.97
Tenant large	58.69	622.10	10.55	133.8	69.24	755.90	3.74	130.8	0.87	1003.6	2012.44
All tenants	59.46	627.71	10.92	138.04	70.38	765.75	3.87	135.44	0.89	979.85	2051.3
All	43.28	370.1	28.2	383.2	71.48	753.30	3.75	131.35	0.89	1045.11	2026.45

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Wheat Crop
(Traditional Farms)

Category	Seed		FYM		Fertilizer		Irrigation cost	Out Put				
								Main		By		All Price
	Qty	Cost	Qty	Cost	Qty	Cost		Qty	Price	Qty	Price	
OC small	21.73	315.05	0.74	339.02	1.13	539.80	71.44	16.36	7364.4	0.93	1502.6	8867.0
OC large	21.63	313.7	0.94	445.40	1.13	641.75	67.20	16.65	7491.4	0.86	1432.4	8923.8
All OC	21.67	314.34	0.87	394.47	1.13	586.21	69.22	16.51	7430.58	0.89	1465.99	8896.57
Tenant small	21.36	427.2	0.64	310.52	0.98	440.30	114.50	16.94	7621.7	0.95	1456.0	9077.7
Tenant large	21.46	429.13	0.57	269.70	0.99	431.40	114.80	16.47	7410.00	1.02	1484.4	8894.4
All Tenant	21.42	428.40	0.59	285.64	0.99	428 .71	114.73	16.65	7493.25	0.99	1473.37	8966.62
All	21.56	366.65	0.73	344.56	1.06	513.98	90. 09	16.58	7459.3	0.94	1469.30	8928.60

Note: - Seed Qty in KG.; Fertilizer in bags (1 bag = 50 kg); FYM in Trolley (1 Trolley = 50 mounds); Main out put in mounds ,by product in Bosara (1 Bosara is from 25 to 30 mounds)

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Wheat Crop (Traditional Farms)

Category	Input Costs	All Costs	Net Income
OC small	1265.31	5227.40	3639.60
OC large	1468.05	5420.97	3502.83
All OC	1364.24	5300.77	3595.80
Tenant small	1292.52	5271.11	3806.59
Tenant large	1245.03	5147.77	3746.63
All Tenant	1257.48	5189.82	3776.80
All	1315.28	5271.49	3657.11

Concluded

APPENDIX TABLE 21

Per Jareeb Inputs, its Costs & Net Income of the Maize Crop
(Mechanized Farms)

Category	Own Labour		Hired Labour		All Labour		Tractor		Rent & Other
	Time	Cost	Time	Cost	Time	Cost	Time	Cost	Cost
OC Small	10.72	101.50	34.62	274.80	45.34	376.30	2.05	859.10	1377.10
OC large	7.96	75.80	37.63	305.00	45.50	380.80	1.94	822.80	1381.50
OC all	9.38	89.48	36.02	288.98	45.40	378.46	2.00	842.16	1379.17
Tenant Small	32.70	322.20	15.70	175.10	48.40	497.30	1.91	829.30	1399.30
Tenant large	31.70	309.60	15.70	166.60	47.40	476.20	1.81	807.80	1375.70
Tenant all	32.13	314.12	15.70	169.62	47.83	483.74	1.84	815.51	1384.14
All	18.20	177.00	28.10	242.50	46.30	419.50	1.94	831.77	1381.10

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Maize Crop
(Mechanized Farms)

Note: Seed Qty in Kg, fertilizer Qty in Bags (1Bag = 50 Kg), FYM Qty in Trolley (1 Trolley = 50 Maunds), Main Output Qty in Maunds, By Products Qty in Bundle.

Category	Seed		Fertilizer		FYM		Water cost	Output				
								Main		By		Price All
	Qty (Kg)	Cost	Qty bag	Cost	Qty traley	Cost		Qty	Price	Qty	Price	
OC Small	5.50	137.3	1.23	537.80	0.33	80.38	48.11	13.71	6170.3	4.81	55.39	6225.69
OC Large	5.40	135.0	1.24	568.64	0.27	68.88	45.35	13.41	6035.30	4.51	56.41	6091.71
OC All	5.45	136.22	1.24	552.22	0.30	75.00	46.82	13.57	6107.20	4.67	55.82	6163.02
Tenant Small	5.64	67.6	1.00	422.00	0.31	78.00	35.68	13.95	6276.10	5.26	55.60	6331.70
Tenant Large	5.46	65.58	1.00	420.00	0.36	89.20	25.73	13.73	6178.20	5.03	57.20	6235.40
Tenant All	5.52	66.32	1.00	420.73	0.34	85.21	29.28	13.81	6213.13	5.10	56.61	6269.74
All	5.47	108.97	1.14	500.96	0.31	78.18	39.98	13.66	6148.50	4.84	56.10	6204.60

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Maize Crop
(Mechanized Farms)

Category	Input Costs	All Costs	Net Return
OC Small	803.59	3416.09	2809.60
OC Large	817.87	3402.97	2688.74
OC All	810.26	3410.05	2752.97
Tenant Small	603.28	3329.18	3002.52
Tenant Large	600.51	3260.21	2975.19
Tenant All	601.55	3284.95	2984.79
All	728.09	3360.46	2844.14

Source: Survey

Concluded.

APPENDIX TABLE 22

Per Jareeb Inputs, its Costs & Net Income of the Maize Crop (Traditional Farms)

Cont.

Category	Own Labour		Hired Labour		All Labour		Animal		Rent & Other Costs
	Time	Cost	Time	Cost	Time	Cost	Time	Cost	
OC Small	28.73	310.40	62.70	733.50	91.43	1043.90	2.80	105.70	1419.60
OC large	18.14	205.90	68.80	802.90	86.94	1008.80	2.77	103.60	1436.70
OC all	23.55	258.40	65.77	768.32	89.32	1026.72	2.78	104.65	1428.15
Tenant Small	71.60	803.48	28.70	399.50	100.30	1148.18	3.43	120.08	1424.50
Tenant large	67.40	749.70	34.10	344.70	101.50	1149.20	3.61	126.40	1431.17
Tenant all	69.01	770.64	32.03	378.29	101.04	1148.93	3.54	123.96	1428.57
All	44.00	488.60	50.60	592.80	94.60	1081.40	3.12	113.30	1428.30

Per Jareeb Inputs Its Costs & Net Income of the Maize Crop
(Traditional Farms)

Category	Seed		Fertilizer		FYM		Water Cost	Output				
								Main		By		Price All
	Qty (kg)	cost	Qty bag	Cost	Qty Traly	Cost		Qty	Price	Qty	Price	
OC Small	5.74	86.05	1.04	432.00	0.15	45.90	69.60	10.57	4756.10	6.63	72.30	4828.40
OC Large	5.83	87.52	1.14	491.80	0.05	15.30	62.40	10.45	4700.80	6.75	63.50	4764.30
OC All	5.78	86.79	1.09	461.99	0.07	28.25	67.89	10.51	4728.46	6.69	68.13	4796.59
Tenant Small	5.57	94.60	0.82	346.50	0.26	78.70	115.20	11.10	4993.30	6.46	71.60	5064.90
Tenant Large	5.50	93.40	0.91	391.84	0.38	115.90	106.40	11.10	4993.30	4.61	44.66	5037.96
Tenant All	5.52	93.90	0.88	374.29	0.33	90.83	110.80	11.10	4993.30	5.33	55.11	5048.41
All	5.60	89.98	0.99	431.28	0.19	58.30	85.68	10.70	4848.60	6.07	62.30	4910.90

Note: Seed Qty in Kg, fertilizer Qty in Bags (1Bag = 50 Kg), FYM Qty in Trolley (1 Trolley = 50 Maunds), Main Output Qty in Maunds, By Products Qty in Bundle.

Cont.

Per Jareeb Inputs, its Costs & Net Income of the Maize Crop (Traditional Farms)

Category	Input Costs	All Costs	Net Return
OC Small	633.55	3202.75	1625.65
OC Large	657.02	3206.12	1558.18
OC All	644.92	3204.44	1592.15
Tenant Small	635.00	3327.76	1737.40
Tenant Large	707.54	3414.31	1623.65
Tenant All	669.82	3371.28	1677.13
All	665.24	3288.24	1622.66

Source: Survey

Concluded

APPENDIX TABLE 23

Per Jareeb Inputs, its Costs & Net Income of Wheat and Maize: Size Wise
(Mechanized Farms)

Crop/Size	Own Labour		Hired Labour		All Labour		Animal Labour		Tractor		Rent & other Costs
	Time	Cost	Time	Cost	Time	cost	Time	Cost	Time	Cost	
Wheat											
Small	6.30	79.03	10.98	86.70	17.28	165.73			2.27	884.98	2145.56
Large	7.62	95.35	5.95	53.22	13.57	148.57	-----	-----	1.83	787.50	2127.19
Maize											
Small	17.34	167.64	28.91	304.36	46.25	472.00			2.01	850.18	1383.68
Large	19.11	196.60	27.64	283.78	46.75	480.38	-----	----	1.83	815.84	1379.00

Cont.

Per Jareeb Inputs, its Costs & Net Income of Wheat and Maize: Size Wise (Mechanized Farms)

Crop / Size	Seed		FYM		Fertilizer		Irrigation cost	Out Put					Inputs Cost	All Cost	Net Income
								Main		By		All Price			
	Qty Kg	Cost	Qty Tralley	Cost	Qty bag	Cost		Qty	Price	Qty	Price				
Wheat															
small	21.04	258.97	0.49	209.62	1.26	737.50	47.54	18.58	8365.30	1.11	1437.98	9803.27	1253.63	4449.90	5353.37
Large	21.33	266.86	0.53	197.50	1.23	733.44	43.19	19.03	8563.30	1.02	1504.69	10067.99	1240.99	4304.25	5763.74
Maize															
Small	5.53	83.02	0.33	82.60	1.16	503.09	90.87	13.78	6202.04	4.95	51.39	6257.43	759.6	3465.48	2791.95
Large	5.43	65.17	0.35	88.50	1.12	499.11	62.76	13.55	6101.97	4.75	56.76	6158.73	715.54	3390.76	2767.96

Source: survey

Concluded

APPENDIX TABLE 24

Per Jareeb Inputs, its Costs & Net Income of Wheat and Maize: Size Wise
(Traditional Farms)

Crop/Category	Own Labour		Hired Labour		All Labour		Animal Labour		Tractor		Rent & other Costs
	Time	Cost	Time	Cost	Time	cost	Time	Cost	Time	Cost	
Wheat											
Small	42.38	356.49	28.59	404.48	70.97	760.97	3.81	133.50	0.89	1025.60	2048.76
Large	43.98	380.83	27.91	366.64	71.89	747.47	3.70	129.69	0.87	1060.34	2009.03
Maize											
Small	45.35	501.85	49.50	582.63	94.85	1084.48	3.04	111.26	----	----	1421.46
Large	42.90	477.84	51.48	601.22	94.38	1079.07	3.18	115.02			1433.3

Cont.

Per Jareeb Inputs, its Costs & Net Income of Wheat and Maize: Size Wise (Traditional Farms)

Crop / Category	Seed		FYM		Fertilizer		Irrigation Cost	Out Put					Inputs Cost	All Cost	Net Income
								Main		By		All Price			
	Qty	Cost	Qty	Cost	Qty	Cost		Qty	Price	Qty	Price				
Wheat															
Small	21.58	360.91	0.70	327.36	1.07	493.41	89.6	16.59	7469.54	0.94	1483.59	8953.13	1270.75	5330.08	3623.5
Large	21.55	371.13	0.75	357.97	1.06	530.02	90.90	16.55	7451.34	0.93	1458.29	8909.64	1350.04	5296.57	3613.7
Maize															
Small	5.67	89.35	0.19	45.07	0.96	398.81	92.21	10.77	4848.20	6.57	72.36	4920.56	625.48	3242.68	1677.86
Large	5.66	90.47	0.18	39.32	1.02	441.84	84.4	10.78	4848.88	5.68	54.08	4902.95	656.03	3312.96	1589.99

Source: survey
Concluded

APPENDIX TABLE 25

Area Irrigated by Different Sources in Pakistan and the NWFP (Million Hectares)

	Year/Locality	Total	Canal		Tube well	Wells	Cannal tube well	Canal wells	Other
			Govt.	Private					
	1	2	3	4	5	6	7	8	9
	1990-91								
1	Pakistan	16.75	7.47	0.42	2.56	0.13	5.87	0.08	0.22
2	NWFP	0.84	0.32	0.37	0.05	0.04	-	-	0.06
3	%	5.01	4.28	88.1	1.95	30.76	-	-	27.27
4	1991-92								
5	Pakistan	16.85	7.42	0.43	2.59	0.16	5.93	0.11	0.21
6	NWFP	0.85	0.31	0.38	0.06	0.04	-	-	0.06
7	%	5.04	4.18	88.37	2.32	25.0	-	-	28.57
8	1992-93								
9	Pakistan	17.33	7.47	0.44	2.67	0.18	6.23	0.10	0.24
10	NWFP	0.85	0.31	0.38	0.06	0.04	-	-	0.06
11	%	4.90	4.15	86.36	2.24	22.22	-	-	25.0
12	1993-94								
13	Pakistan	17.33	7.25	0.48	2.78	0.14	6.22	0.09	0.17
14	NWFP	0.89	0.34	0.40	0.08	0.04	-	-	0.03
15	%	5.13	4.67	83.3	2.88	28.57	-	-	17.6
16	1994-95								
17	Pakistan	17.20	7.06	0.45	2.83	0.17	6.41	0.10	0.18
18	NWFP	0.85	0.32	0.37	0.09	0.04	-	-	0.03
19	%	4.94	4.53	82.22	3.18	23.53	-	-	16.66
20	1995-96								
21	Pakistan	17.58	7.15	0.45	2.89	0.18	6.58	0.11	0.22
22	NWFP	0.88	0.35	0.37	0.09	0.04	-	-	0.03
23	%	5.0	4.90	82.22	3.11	22.2	-	-	13.64

Cont.

Area Irrigated by Different Sources in Pakistan and the NWFP

Sr.No.	Year/Locality	Total	Canal		Tube well	Wells	Canal tube well	Canal wells	Other
			Govt.	Private					
	1	2	3	4	5	6	7	8	9
	1996-97								
1	Pakistan	17.83	7.35	0.46	2.90	0.18	6.61	0.11	0.22
2	NWFP	0.89	0.35	0.38	0.09	0.04	-	-	0.03
3	%	4.99	4.76	82.60	3.10	22.2	-	-	13.63
4	1997-98								
5	Pakistan	18.0	7.31	0.48	3.0	0.16	6.74	0.13	0.18
6	NWFP	0.94	0.38	0.40	0.09	0.04	-	-	0.03
7	%	5.22	5.20	83.3	3.0	25.0	-	-	16.66
8	1998-99								
9	Pakistan	17.95	7.20	0.47	2.98	0.17	6.88	0.09	0.16
10	NWFP	0.94	0.39	0.39	0.09	0.04	-	-	0.18
11	%	5.24	5.41	82.98	3.03	23.53	-	-	18.75
12	1999-00								
13	Pakistan	18.11	7.10	0.46	3.11	0.18	6.99	0.09	0.18
14	NWFP	0.92	0.39	0.37	0.09	0.04	-	-	0.03
15	%	5.08	5.49	80.42	2.89	22.2	-	-	16.66
16	2000-01								
17	Pakistan	17.82	6.55	0.43	3.19	0.16	7.22	0.10	0.17
18	NWFP	0.93	0.41	0.35	0.09	0.04	-	-	0.04
19	%	5.22	6.26	81.39	2.82	25.0	-	-	23.53
20	2001-02								
21	Pakistan	18.04	6.38	0.43	3.45	0.20	7.24	0.16	0.18
22	NWFP	0.93	0.41	0.35	0.09	0.04	-	-	0.04
23	%	5.15	6.43	81.39	2.60	20.0	-	-	22.22

Source: Government of Pakistan (2003) *Agricultural Statistics of Pakistan* 2001-2002

Note: % means NWFP as per cent of Pakistan.

Concluded.