Economic and Social Commission for Asia and the Pacific

CGPRT Centre WORKING PAPER No. 66

Prospects of Feed Crops in Pakistan: the Role of CGPRT Crops

Abdul Gaffar Khan

United Nations

The CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UNESCAP.

Objectives

In co-operation with ESCAP member countries, the Centre will initiate and promote research, training and dissemination of information on socio-economic and related aspects of CGPRT crops in Asia and the Pacific. In its activities, the Centre aims to serve the needs of institutions concerned with planning, research, extension and development in relation to CGPRT crop production, marketing and use.

Programmes

In pursuit of its objectives, the Centre has two interlinked programmes to be carried out in the spirit of technical cooperation among developing countries:

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(Continued on inside back cover)

Prospects of Feed Crops in Pakistan: the Role of CGPRT Crops

"CGPRT Centre Works Towards Reducing Poverty Through Enhancing Sustainable Agriculture in Asia and the Pacific Region"

WORKING PAPER 66

Prospects of Feed Crops in Pakistan: the Role of CGPRT Crops

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Regional Co-ordination Centre for
Research and Development of Coarse Grains,
Pulses, Roots and Tuber Crops in the
Humid Tropics of Asia and the Pacific

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Foreword

Coarse grains, pulses, roots and tuber (CGPRT) crops are a very important component of the farming system in Asia and the Pacific region, particularly in marginal areas where economically, ecologically and socially less favorable conditions prevail, and many farmers' activities and lives rely on CGPRT crops. Therefore, it is crucial to promote the sustainable production of CGPRT crops and to expand the income generation opportunities through expanding market opportunities of CGPRT crops.

CGPRT crops are versatile crops and they can provide an extraordinary range of end uses, not only as foods for direct human consumption but also as materials for a diverse range of end products, including industrial uses. Feed is one of the alternative end products of CGPRT crops.

In developing countries, there has been a dramatic rise in the consumption of animal origin food products. It was a result of demand changes caused by changes in the diets of billions of people in the region, through population growth, urbanization, and income growth in these countries.

As animal-product demand increases, feed grain utilization also increases. Animal feeds are dominated by coarse grains, pulses, roots and tuber crops or the products of these CGPRT crops. Therefore, this provides an expansion of market opportunity for CGPRT crops.

The development of animal husbandry and demands for feed vary greatly from country to country. Therefore, we need to analyze them comparing among countries within the region. Responding to this need, the CGPRT Centre has implemented a research project, "Prospects of Feed Crops in South Asia", in collaboration with partners from four countries: India, Nepal, Pakistan and Sri Lanka.

It is my pleasure to publish **Prospects of Feed Crops in Pakistan: the Role of CGPRT Crops** as one of the results of the project. This volume covers topics such as historical overviews of the animal industry, agricultural policies, trading policies and prospects of feed demand and supply in Pakistan.

I thank Dr. Abdul Ghaffar Khan for his earnest and fruitful work. This study could only be accomplished with the continuous support from the Animal Science Institute, Pakistan and the Agricultural Research Center, Pakistan. Dr. S.S.E Ranawana, professor of Wayamba University, Sri Lanka, and Dr. Budiman Hutabarat provided useful comments and guidance at various stages of the study as the Regional Advisor and Programme Leader respectively. I also thank Mr. Matthew Burrows for his editing services throughout the publication of the report. Finally, I would like to express my sincere appreciation to the Government of Japan for its support in funding the project.

September 2003

Nobuyoshi Maeno
Director
CGPRT Centre

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The ESCAP, CGPRT Centre, Bogor, Indonesia in collaboration with the Pakistan Agricultural Research Council, Islamabad planned a study entitled “Prospects of Feed Crops in Pakistan: the Role of CGPRT Crops” as part of larger study which looked into prospects of feed crops in Pakistan, India, Sri Lanka and Nepal. This study was conducted to generate information on historical dynamics, future trends of demand and supply for feed crops/products; evaluation of potentials, weaknesses, opportunities and constraints for expanding feed crop farming in Pakistan; proposing possible schemes for trade and development of feed crops among Asian countries and the formulation of policy options to promote sustainable development of feed crop farming in Pakistan.

The UNESCAP CGPRT Centre, Bogor, Indonesia provided the financial support to conduct this study and prepare this report. The author is grateful to Dr. Nobuyoshi Maeno, Director, CGPRT Centre, who played a key role in structuring and organizing these studies. Valuable guidance and comments from Dr. Budiman Hutabarat, Program Leader, Research and Development, CGPRT Centre, for this project are sincerely acknowledged. The inspiring behaviour and logical suggestions of Professor Dr. S.S.E. Ranawana, University of Wayamba, Gonawila, Sri Lanka, Regional Advisor of this project were of immense importance and greatly acknowledged.

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Executive Summary

The agricultural sector in Pakistan plays an important role in the national economy by contributing 25.7 per cent of the total Gross Domestic Product (GDP) and employs 44 per cent of the total work force of the country. This sector contributed Rs 158.8 billion of the total GDP in 1999-2000. The contribution of the agricultural sector in the overall economy has a slightly decreasing trend compared to the industrial sector, which is gradually progressing. The share of major crops in the total agricultural GDP is the highest, however, its contribution is decreasing, whereas the contribution of livestock is increasing gradually, accounting for 36.4 per cent of the total agricultural GDP in 1999-2000. The ever increasing human population and moderately increasing per capita income has resulted in the increased per capita availability of wheat. This is also complemented by increased consumption of most feed crops in the livestock and poultry industry as the number of almost every livestock species has progressively increased during the last twenty years.

This study was conducted under the CGPRT sponsored project on "Prospects of Feed Crops in South Asia-Pakistan (Feed)" to generate information on historical dynamics, future trends of demand and supply for feed crops/products, evaluation of potentials, weaknesses, opportunities and constraints for expanding feed crop farming in Pakistan, proposing possible schemes for trade and development of feed crops among Asian countries and the formulation of policy options to promote sustainable development of feed crop farming in Pakistan.

In Pakistan, feed crops, which are being used in livestock and poultry feeding as grains, are mainly wheat, maize, sorghum and millet. These cereal crops are basically grown to meet human dietary requirements with a primary focus on wheat and rice. Wheat and rice are mainly used for human consumption, however, their milling by-products i.e. brans, rice polish and rice tips are used in animal feeding.

In 2000, wheat production in Pakistan was 21,081 thousand tons, which was achieved with an average growth rate of 3 per cent during the last twenty years. Wheat harvested area and yield was 8,463 thousand hectares and 2,491 kg/hectare respectively and their growth rates where 1.15 and 3.07 per cent respectively during the last twenty years. The projections for wheat production, area and yield are 23,123 and 27,097 thousand tons, 9,177 and 9,680 thousand hectares, and 2,520 and 2,790 kg/hectare for 2005 and 2010 respectively.

In the case of maize, in the year 2000, maize production, area and yield was 1,652 thousand tons, 962 thousand hectares and 1,718 kg/hectare respectively. The growth rates of maize production, area and yield were 2.91, 1.22 and 1.68 per cent respectively during the last twenty years. Projected maize production, area and yield is 1,801 and 2,083 thousand tons, 1,010 and 1,072 thousand hectares and 1,783 and 1,942 kg/hectare for 2005 and 2010 respectively.

In the year 2000, sorghum production, area and yield was 220 thousand tons, 357 thousand hectares and 617 kg/hectare respectively. The growth rates of sorghum production, area and yield were 0.22, -0.05 and 0.28 per cent respectively during the last twenty years. Projected sorghum production, area and yield is 249 and 261 thousand tons, 400 and 413 thousand hectare and 624 and 633 kg/hectares for year 2005 and 2010 respectively.

Millet production, area and yield, in 2000, was 156 thousand tons, 313 thousand hectares and 497 kg/hectare respectively. Growth rates of millet production, area and yield were -2.12, -1.73 and 0.39 per cent respectively during the last twenty years. Projected millet production, area and yield is 169 and 159 thousand tons, 333 and 300 thousand hectares and 506 and 529 kg/hectare for 2005 and 2010 respectively.

The projected results of the model show that there will be a gap between demand and supply of wheat and thus, there will be a need to import wheat to the tune of 4,768 and 7,309 thousand tons in 2005 and 2010 respectively. However, increasing local wheat production can minimize the gap and imports. This has already been achieved in 2000-2001 by applying better production technologies such as improved high yielding varieties, better utilization of the current combination of required fertilizers, minimizing post harvest loses and better land preparation and timely sowing. Above all, the timely announcement of procurement prices by the government encouraged the farming community to apply better production technologies for increased wheat production.

In the case of maize, there will also be a gap between demand and supply but it is only 2.2 per cent of the total projected maize production. This gap can be easily met by increasing local production through improved production technologies. There is also a gap of about 18-28 per cent in demand and supply of sorghum. However, this gap can be met through local enhanced production, especially by cultivating better and improved seed varieties and the application of other production technologies.

In 2000, the buffalo, cow, goat, sheep and poultry population was 22.7, 22.0, 47.4, 24.1 and 282 million respectively. The growth rates of the buffalo, cow, goat, sheep and poultry population were 3.45, 1.68, 3.45, 2.43 and 8.39 per cent respectively, during the last twenty years.

In 2000, milk, beef, mutton, poultry meat and egg production was 25,566, 986, 649, 322 thousand tons and 8,463 million units respectively. The growth rates of milk, beef, mutton, poultry meat and egg production were 4.68, 4.18, 428, 10.92 and 8.07 per cent respectively, during the last twenty years.

The livestock sector is very important to the agricultural economy of Pakistan. With the changing scenario in the dietary consumption style in Pakistan, the demand for livestock products i.e. milk, meat and poultry is increasing significantly. The annual per capita consumption of milk, all types of meat and eggs was 82.4, 14.23 kg and 61.54 units respectively in 2000. During the last twenty years, the growth rates for milk, all types of meat and eggs were 2.06, 2.19 and 2.85 per cent respectively.

Feed crop grains contribution to total poultry feed consumed ranged between 31-33 per cent, whereas the contribution of all other ingredients was 66-69 per cent in poultry feed. The contribution of feed crop grains ranged between 5-11 per cent only and the contribution of other feed ingredients was between 89-95 per cent in livestock feeding. In summary, it can be concluded that most of the feed crop grains as feed are consumed in poultry feeding, whereas all other feed ingredients are mainly consumed in livestock feeding.

From the preceding facts and conclusions of the study, it can be concluded that to achieve self-sufficiency in feed crops, there is a strong need to accelerate research and development to evolve appropriate and cost effective technologies.

1. Introduction

1.1 Background and justification

The agricultural sector in Pakistan plays an important role in the national economy by contributing about 25.7 per cent of the total Gross Domestic Product (GDP). This sector contributed Rs 158.8 billion to the GDP in 1999-2000 (Economic Survey, 1999-2000). It provides employment to 44.1 per cent of the labor force of the country. The contribution of agriculture to GDP has remained almost stagnant during the last fifteen years (Table 1.1).

Table 1.1 Agriculture's contribution to Gross Domestic Products (GDP)

Year	Total GDP	Agricultural GDP	Agriculture total of GDP	Agricultural contribution to GDP					Total
				Major crops	Livestock	Minor crops	Fishery	Forestry	
	Billion Rs		(per cent)		per cent share of total agriculture				
1985-86	342.2	93.4	27.3	49.5	27.7	17.9	3.8	1.1	100
1990-91	446.0	114.5	25.0	47.8	29.8	17.3	3.9	1.2	100
1991-92	480.4	125.4	26.1	50.4	28.8	16.2	3.7	0.9	100
1992-93	491.3	118.8	24.2	44.9	32.3	17.8	4.1	0.9	100
1993-94	513.6	125.0	24.3	43.2	32.6	18.9	4.3	1.0	100
1994-95	540.5	133.2	24.6	44.1	32.1	19.1	3.8	0.9	100
1995-96	577.1	148.8	25.8	41.8	36.4	17.9	3.3	0.6	100
1996-97	588.2	149.0	25.3	39.9	37.9	18.1	3.4	0.7	100
1998-99	600.1	155.7	25.9	41.5	36.0	18.6	3.4	0.5	100
1999-00	619.1	158.8	25.7	40.6	36.4	19.2	3.4	0.4	100

GDP in billion Rs. at constant factor.
Source: Economic Survey, 1993-94 and 1999-2000.

Its contribution to the overall economy has observed a slow decreasing trend compared to industries, which are progressing slowly. The share of the major crops in the total agricultural GDP is the highest, however, its contribution has been decreasing slightly for the last five years. The livestock contribution is increasing slowly and gradually and during 2000-2001 it accounted for about 35.4 per cent of the total agricultural GDP. The contribution of fisheries and minor crops has also increased slightly. However, the contribution of forestry has gradually declined.

In Pakistan, feed crops, which are being used in livestock and poultry feeding as grains to meet the energy requirement are wheat, maize, sorghum and millet. These cereal crops are basically grown in the country to meet human dietary needs with a primary focus on wheat and rice, which in Pakistan are mainly used for human consumption. However, their milling by-products, brans, rice polish and rice tips are used in livestock and poultry feeding.

Wheat production in Pakistan was 11,475 thousand tons in 1981 increasing to 21,081 thousand tons in 2000. Average wheat production was 11,556, 13,470, 15,724 and 18,238 thousand tons during 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively. Maize production in Pakistan was 970 thousand tons in 1981 and 1,652 thousand tons in 2000. Average maize production was 989, 1,126, 1,221 and 1,566 thousand tons during 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively. Production of sorghum was 230 thousand tons in 1981 and 221 thousand tons in 2000. Average sorghum production was 226, 229, 235 and 231 thousand tons during 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively. Production of millet was 214 thousand tons in 1981 and 156 thousand tons in 2000. Average millet production was 249, 206, 181 and 178 thousand tons during 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively (Agricultural Statistics of Pakistan, 2000-2001).

In Pakistan, from 1981-2000, the production of livestock products i.e., milk, beef and mutton increased with an overall average growth rate of 4.46 per cent per annum, whereas the egg and poultry meat production growth rate was 8-11 per cent per annum, which is appreciably high (Table 1.2).

Table 1.2 Production of livestock products

Year	Milk ('000 tons)	Beef ('000 tons)	Mutton ('000 tons)	Poultry Meat ('000 tons)	Eggs (millions)
1981-85	9,898	469	414	74	3,179
1986-90	13,353	663	545	149	4,074
1991-95	17,175	848	767	238	5,247
1996-2000	24,241	941	618	332	6,847
Overall growth rate	4.68	4.18	4.28	10.92	8.07

Source: 1) Economic Survey (GOP) 1993-1994; 1999-2000.
2) Livestock Census of Pakistan, 1986.

Annual per capita consumption of milk was 53.01 kg in 1981 but this had increased to 82.4 kg by 2000. The overall growth rate in per capita consumption of milk was 2.06 per cent during the period of 1981-2000. The annual per capita consumption of all types of meat was 10.21 kg in 1981 increasing to 14.23 kg in 2000. The annual per capita consumption of eggs was 27.66 units in 1981 and this number had increased to 61.54 by 2000 (Agricultural Statistics of Pakistan, 1983-1984 and 2000-01). The overall increase in the per capita consumption of animal food products due to population growth was 2.56 per cent per annum during the last twenty years. Moreover, the increase in per capita income has also encouraged the consumption of animal food products because of the change in dietary patterns, particularly in favor of animal food products. Rosegrant *et al*. (1995) predicted that Asian countries will consume more meat, milk and eggs in the next two decades. The projected per capita demand in South Asia is shown in Table 1.3.

Table 1.3 Projected per capita demand for livestock products in South Asia (kg/year)

Livestock products	1990	2010	2020
Beef	1.2	1.4	1.5
Sheep meat	1.0	1.1	1.2
Poultry meat	0.5	0.6	0.7
Eggs	1.3	1.6	1.8
Milk	63.4	84.9	95.3

Source: Rosegrant *et al*., 1995.

A study conducted by Vercoe *et al.* (1997), while forecasting per capita demand of ruminant meat, indicated a deficit in ruminant meat production in every Asian country. The study further suggested that more animal products are needed to be produced in Asia, either through expanded or increased production.

To meet the ever increasing demand for animal food products, animal production systems are in a continuous shift from conventional to commercial systems. Commercialized activities of animal production systems essentially require nutritionally balanced feeding, which in ultimate analysis, requires more feed grains to be incorporated in the feeding rations. Keeping in mind the increased demand for livestock products, the productivity of livestock, particularly poultry, has to be increased, which essentially demands balanced feeds in the future, which can only be achieved with the appropriate inclusion rate of grains in their rations. The importance of feed crops to supply grains for the increasing human population and for future increases in livestock productivity necessitates examining the supply and demand of feed crops in Pakistan.

1.2 Objectives

The present study is part of a larger study for the South Asian region initiated by the United Nations, ESCAP, CGPRT Centre, Bogor, Indonesia. This study has been conducted in four South Asian countries including India, Sir Lanka, Nepal and Pakistan. The overall objective of this study is to elucidate and analyze potentials, weaknesses, opportunities, constraints and policy options for the development of feed crop farming in Pakistan.

The study objectives are:

- To analyze historical dynamics and future trends of demand and supply for feed crop products in Pakistan.
- To evaluate potentials, weaknesses, opportunities and constraints for expanding feed crop farming in Pakistan.
- To propose possible cooperation schemes for trade and development of feed crops/products among Asian countries.
- To formulate policy options to promote the sustainable development of feed crop farming in Pakistan.

1.3 Scope of the study and commodity coverage

The present study is focused on the production and consumption of feed crops such as wheat, maize, sorghum and millet. Milled rice was not included in this study because it is not fed to livestock or poultry. Commodity coverage in this study is shown in Table 1.4.

Table 1.4 Commodity coverage in different parts of the study

	Study	Commodity
1.	Consumption/demand (Food and feed)	Wheat, maize, sorghum, millet, cereal grains, oilseed and other agro-industrial by-products. Livestock products.
2.	Production/supply	Wheat, maize, sorghum, millet, milk, meat (beef, mutton and poultry) and eggs.
3.	Strengths, weaknesses, opportunities and threats	Wheat, maize, sorghum and millet.

1.4 Organization of the report

The first chapter includes the background and justification, objectives, scope of the study and commodity coverage. The second chapter explains the conceptual framework, which includes the definition, analytical framework, model formulation and sources of data. Chapter 3 presents a review of the current status of livestock production, aquaculture and inland fisheries, the historical development of the animal feed sector, feed crops and feed ingredients, agro-based industries and their by-products and livestock feed industries, agricultural policies, marketing, trade policies and policy reform initiatives.

Chapter 4 examines the demand for feedstuffs and feed crops and their consumption projections. Chapter 5 explains the supply of feedstuffs and feed crops including their projections. Chapter 6 suggests measures for closing the supply and demand gap. Conclusions and recommendations are presented in Chapter 7.

2. Methodological Approach

2.1 Conceptual framework

2.1.1 Definition

In Pakistan, livestock feeds primarily consist of available feedstuffs such as green fodder, dry roughages and concentrates. Traditionally, the large ruminant feeding system is based on grazing and green and dry fodder in the rural areas, whereas in the mixed production system, the lactating animals are fed on some of the concentrated feeds such as cereal by-products and oil seed cakes. Small ruminants are largely grazed and supplemented with green fodder, tree foliage and occasionally grains. The most common feedstuffs used for stall fed dairy animals are green and dry fodder and concentrates, which include cereal by-products, oilseed by-products and very little grains. In very well established commercial poultry feed industries, various types of required rations are blended and marketed by commercial feed mills. Poultry rations usually contain 50 to 55 per cent grains, which also includes rice tips, vegetable and animal protein sources and other feed additives (Pakistan Poultry Industry Yearbook, 1998). However, the ruminant feed industry is quite new and is still in the process of development. These industries only produce rations for lactating animals. Feed crops such as wheat, maize, sorghum and millet are the crops which are usually cultivated for grain production to be utilized as food for humans and feed for livestock and poultry.

2.1.2 Analytical framework

The annual growth trends of demand and supply of feed crops such as wheat, maize, sorghum and millet from 1981 to 2000 have been analyzed. The projections from 2001 to 2010 have been made with the help of formulae provided by the CGPRT Centre, Bogor, Indonesia. The model analyzes empirically the impact of price mechanisms and other determinants such as technological factors, population and income in the production and consumption of feed crops. The role of price mechanisms of the crops and inputs in determining the area allocation for cultivation and yield prospects in the production process has been employed in the model.

The study has been complemented using SWOT analysis as a management tool to identify the strengths, weaknesses, opportunities and threats to make decisions for production, marketing and processing. The SWOT analysis was undertaken in a group or in individual meetings with the researchers, industrial managers and extentionists.

2.2 Model formulation

Domestic production

Crop production is assumed as the product of estimated harvested area and yield response functions.

Acreage function

Harvested area is specified as a function of the crop's own price, price of other competing crops or relative prices, the price of some important inputs and a trend growth factor:

$$AHit = \alpha i \, PP_{it}^{\varepsilon ji} \prod_j \left(PPj_t \right)^{\varepsilon ji} (1+g_{it}) \quad (1)$$

Yield function

Yield is the function of the price of the crop/commodity, prices of some inputs (such as fertilizer and labour) and a trend growth factor reflecting technological improvements.

$$YHit = \beta i \, PP_{it}^{\varepsilon ji} \prod_k \left(PIk_t \right)^{\varepsilon ji} (1+g_{it}) \quad (2)$$

Hence production is

$$QH_{it} = AH_{it} \times YH_{it} \quad (3)$$

For i,j = all cereals included in the model

AH	=	crop area
YH	=	crop yield
QH	=	quantity produced
PP	=	producer price/ procurement prices
PI	=	price of factor or input k
i, j	=	commodity index
it	=	time index
g	=	growth rate
ε	=	price elasticity

Total demand

Total demand is the function of the use of the commodity as food, feed or other uses.

$$QC_{it} = QF_{it} + QL_{it} + QE_{it} \quad (4)$$

Demand for food use

$$QF_{it} = \gamma i \, PC_{it}^{\varepsilon^{ji}} \prod_j \left(PCj_t \right)^{\varepsilon^{ji}} \times (INC_t)^{\eta i} POP_t \quad (5)$$

Demand for feed use

$$QL_{it} = \gamma i \, \Pi PPj_t^{\varepsilon^{ji}} \, G.AC_t \, (1+g_{it}) \quad (6)$$

Where

$G.AC_t = \Sigma \, m \, Wm \, QH_{it}$

for m = all meats in the model and milk

w's = use of feed cereal per unit of meat

Demand for other uses

$$QE_{it} = \gamma i \, (QF_{it} + QL_{it})^{\alpha i} \, QH_{it}^{\delta i} \, (1+g_{it}) \quad (7)$$

Ending stock

For a net importing country

$$ESit = ai\ (QCit/PCit)^{\beta} \quad (8)$$

Trade

Gross imports

$$Mit = a_0\ Qcit^{\alpha 1}\ (PWit/PPit)^{\alpha 2}\ \gamma_t^{n} \quad (9)$$

Gross exports

$$Xit = a_0\ QHit^{\beta 1}\ (PWit/PPit)^{\beta 2}\ \gamma_t^{n} \quad (10)$$

Where

M = import volume

X = export volume

Equilibrium

SUPPLY = DEMAND

$$QHit + ESit + Mit = QCit + ESit + Xit \quad (11)$$

The annual growth rate and trend projections of the exogenous variables of the model have been determined with the semi log model as follows (Gujrati, 1992 and Akhtar, 1997):

$$Ln\ (Yt) = a + \beta T \quad (12)$$

Where Ln (Yt) = natural log of dependent variable (Y) at time t

β = slope coefficient

T = time

Two stages least squares was applied to correct auto correlation problems. First order auto regressive scheme - AR (1) was used to control auto correlation from the model in time series data. Trend variables were used to see increasing or decreasing trends in variable data (Gujrati, 1992 and 2000).

2.3 Future trends in production and consumption

The supply and demand models estimated previously, produce elasticity estimates that were employed to forecast changes in production and consumption in the future. By further investigating the general form of the previous functions,

$$Y = f(X,X2,X3, ...Xn) \quad (13)$$

Where

Y = dependent variable

X, = explanatory or pre-determined variable; I..., n

The average growth rates of all the independent variables were taken for future trends in the variables. Then it was possible to obtain changes in Y, which is caused by changes in each of the explanatory variables and the elasticity with respect to each of these variables. This is shown through equation (13).

$$DY = \varepsilon 1\, dX1 + \varepsilon 2\, dX2 + \varepsilon 3\, dX3 + \ldots\ldots\ldots + \varepsilon n\, dXn \quad (15)$$

Where

εI = the elasticity of each of the independent variables with respect to Y in the equation being considered,

dY = percentage change in Y

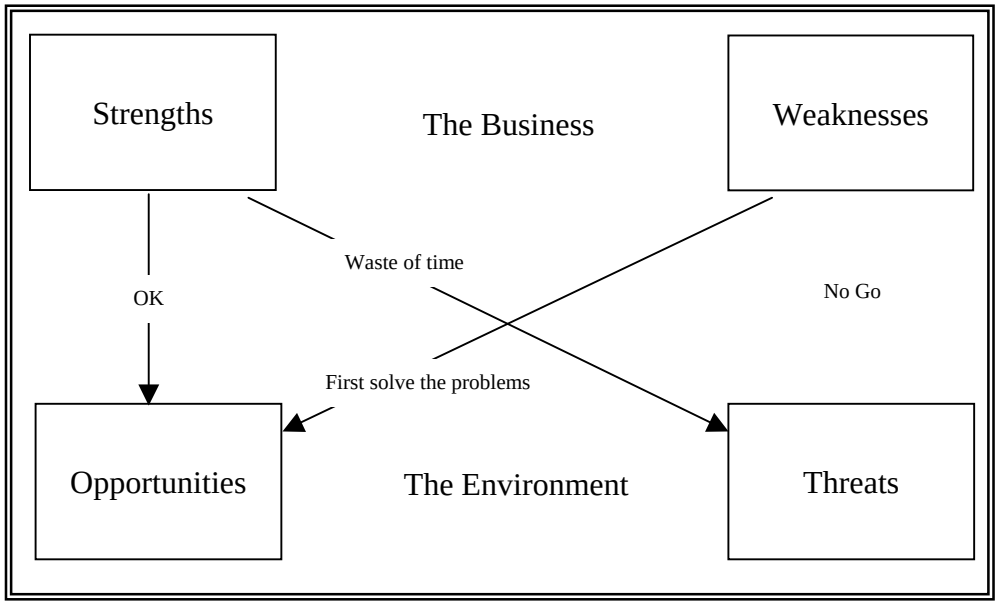
dXi = percentage change in the exogenous variable i

By using the formula (15), the change in supply and demand was estimated by combining point elasticity estimates with a forecast of the change in the explanatory variable.

2.4 SWOT analysis

SWOT analysis was used to measure the *Strengths and Weaknesses* and to identify *Opportunities and Threats*. The expansion of technology and its adoption as shown in area and production increases is not determined by solely technical matters. Often it is also curtailed by management problems at the farms, the market and processing industry, and the various administrative levels. This can be identified and analyzed in the SWOT (strengths, weaknesses, opportunities, and threats) analysis. The analyst will place the business and the environment in one "frame" and draw lines between the four squares:

Figure 2.1 Decision-making through SWOT analysis



2.5 Sources of data

To the empirically estimate the models proposed earlier, it was necessary to collect data from various sources as listed below:

Table 2.1 Sources of data

Data and Parameters	Source
Feed crop (wheat, maize, sorghum and millet) Production (area, yield and production)	Agricultural Statistics of Pakistan, 1999-2000 and 2001 FAO Agrostat database, 1981-2000.
Import and stock change of wheat	FAO Agrostat database, Agricultural Statistics of Pakistan
Feed crop consumption (food, feed and other)	Food Balance Sheet FAO Agrostat database, 1981-2000.
Per capita consumption of feed crops	Agricultural Statistics of Pakistan (various issues) Household Integrated Economic Survey 1996-99 Federal Bureau of Statistics of Pakistan
Livestock population and products	Livestock Census of Pakistan 1986, 1996 Economic Survey of Pakistan, 1993-94 and 1999-00
Population and income	Economic Survey of Pakistan 1993-94, 1999-2000 and 2000-01. Agricultural Statistics of Pakistan
Various prices of feed crops for food and feed (producer and consumer)	Agricultural Statistics of Pakistan (various issues) Economic Survey of Pakistan (various issues) FAO Agrostat database, 1981-2000. Pakistan Statistical Yearbook
Prices of livestock products	Economic Survey of Pakistan (various issues)
Commercial poultry feed production	Pakistan Poultry Industry Yearbook, 1992, 1998.

3. Review of Current Status

3.1 Livestock production

3.1.1 Livestock resources

Pakistan is endowed with various types of livestock such as buffalo, cattle, sheep, goat and poultry. There is quite a large indigenous livestock population, which is well adapted to local environmental conditions. The world's best dairy buffalo breeds i.e. Nili Ravi and Kundi are present in Pakistan. Among the cows, the Sahiwal breed is one of the local best dairy breeds in Asia. There are a number of sheep and goat breeds, which are localized in different ecologies according to their suitability and the availability of feed resources. The livestock population of Pakistan is presented in Table 3.1.

Table 3.1 Livestock population (millions) in Pakistan

Year	Cattle	Buffalo	Sheep	Goat	Poultry
1981-85	16.12	12.44	23.52	27.72	89
1986-90	17.14	16.54	24.46	32.8	140
1991-95	17.76	18.74	27.76	40.34	211
1996-2000	21.20	21.44	23.8	44.24	314
Overall annual growth rate %	1.68	3.45	0.43	3.24	8.39

Source: Agriculture Statistics of Pakistan, 1999-2000.

The total buffalo population in 1981 was 11.9 million but this increased to 22.7 million in 2000, with an overall growth rate of 3.45 per cent in 1981-2000. The projected number of buffalo will be 32 million in 2010. The total cow population in 1981 was 15.8 million, increasing to 22 million in 2000, with an overall growth rate during last twenty years of 1.68 per cent. The projected cow population will be 26 million in 2010. The recorded growth rate in buffalo is higher than cow mainly due to the people of Pakistan preferring buffalo milk compared to cow milk because of the comparatively high butterfat content in it.

The sheep population was 22.1 million in 1981, increasing to 24.1 million in 2000. The overall growth rate of the sheep population was 2.43 per cent during the last twenty years. The projected population of sheep will be 25 million in 2010. The goat population was 25.8 million in 1981, increasing to 47.4 million in 2000, with an overall growth rate of 3.24 per cent during 1981-2000. The projected goat population in 2010 will be 65 million. The goat population increased on a much higher scale compared to sheep because the people of Pakistan prefer goat meat to sheep. Moreover, the increased growth rate in goat compared to sheep can also be attributed to their suitability to the environment and availability of more feed resources as more area is being brought under cultivation.

Poultry is making progress at a significantly higher rate because of the introduction of commercial poultry and the establishment of scientific and commercial entrepreneurship in Pakistan. The population of poultry was only 67 million in 1981 but it had increased to 282 million by 2000 with an average growth rate of 8.39 per cent during the last twenty years. The negative growth rate in poultry population during 1996-2000 was due to government restrictions imposed on serving meals at marriage ceremonies. It was common practice to serve poultry products as part of the meal in marriage ceremonies. The projected poultry population will increase to the tune of 631 million by 2010.

3.1.2 Livestock products

Milk production was 9,267 thousand tons in 1981, increasing to 25,566 thousand tons in 2000, which was obtained with an overall average growth rate of 4.18 per cent (Table 3.2).

Table 3.2 Production of livestock output unit

Years	Milk ('000 tons)	Beef ('000 tons)	Mutton ('000 tons)	Poultry Meat ('000 tons)	Egg (million)	LOU*
1981-85	9,898	469	414	74	3,179	2,108
1986-90	13,353	663	545	149	4,074	2,895
1991-95	17,175	848	767	238	5,247	3,830
1996-2000	24,241	941	618	332	6,847	4,657
Overall annual growth rate %	4.68	4.18	4.28	10.92	8.07	4.83

Source: 1) Economic Survey (GOP) 1993-1994; 1999-2000.
2) Livestock Census of Pakistan, 1986.
*LOU was calculated by adding total production of meat (beef + mutton + poultry meat) one tenth of total milk production and eggs (assuming average weight of 50 grams per egg). Akhtar, M.R. (1997).

In spite of a reasonable growth rate in milk production, Pakistan is still importing milk and milk products by spending huge foreign exchanges. For example, during 1995-2000 Pakistan imported milk and milk products (dry milk) totaling Rs 1,063.21 million per annum.

Beef is commonly obtained from buffalo and cattle, primarily without any feedlot fattening. Beef production is considered to be a by-product of dairy activities. Beef production in 1981 was 434 thousand tons, increasing to 986 thousand tons in 2000 with a 4.18 per cent overall growth rate. Projected beef production will be 1,460 thousand tons in 2010. Mutton is obtained from sheep and goat, which are usually raised on conventional production systems and so far, no feedlot fattening has been introduced for systematic increases in mutton production. Mutton production was 370 thousand tons in 1981, increasing to 649 thousand tons in 2000, which was achieved with an overall growth rate of 4.28 per cent. Projected mutton production will be 971 thousand tons in 2010.

Poultry meat production was only 52 thousand tons in 1981 but it increased to 322 thousand tons in 2000. This significant increase in poultry meat production was achieved with the advent of hybrids in broiler strains coupled with balanced feeding, proper management and healthcare. Projected poultry meat production in 2010 will be 8.46 thousand tons. Egg production was 2,319 million units in 1981, increasing to 8,463 million in 2000. This increase was achieved with a 8.07 per cent growth rate during 1981-2000. Egg production is projected at 17,849 million units in 2010.

Livestock products were converted to livestock output unit (LOU) by the formula given in Table 3.2 and it is calculated that LOU in 1981 was 1,899 whereas the LOU increased to the tune of 4,937 in 2000 with an overall growth rate of 4.83 per cent. The projected LOU will be 8,134 in 2010.

3.1.3 Consumption of livestock products

Per capita consumption of various livestock products in Pakistan is given in Table 3.3.

Table 3.3 Per capita consumption of livestock products

Products	1981-85	1985-90	1991-95	1996-2000
Milk (kg)	54.72	61.86	63.89	76.31
Meat (kg)	10.71	12.96	15.68	14.41
Beef (kg)	5.25	6.34	7.16	7.18
Mutton (kg)	4.62	5.18	6.52	4.70
Poultry (kg)	0.80	1.42	2.01	2.53
Egg (no)	35.40	39.11	43.30	52.75

Source: Agricultural Statistics of Pakistan, 1983-1984 and 1999-2000.

Per capita milk consumption was 53 kg in 1981, increasing to 82.4 kg in 2000 with an overall growth rate of 2.06 per cent during the last twenty years. Projected per capita consumption will be 101 kg in 2010. Per capita beef consumption in 1981 was 5.15 kg, increasing to 7.2 kg in 2000 and this was achieved with an overall growth rate of 2.08 per cent. The projected per capita consumption of beef will be 8.8 kg in 2010. Per capita mutton consumption was 4.39 kg in 1981, which increased to 4.7 kg in 2000 with an overall growth rate of 0.7 per cent. Per capita consumption of mutton is projected at 5 kg in 2010.

Per capita consumption of poultry meat was only 0.6 kg in 1981 but this had increased to 2.34 kg by 2000. Per capita consumption of poultry meat will be 4.9 kg in 2010. Per capita egg consumption was 27.66 eggs in 1981, more than doubling to 61.54 eggs in 2000. The growth rate of per capita egg consumption was appreciably high and consistent throughout the past twenty years. The projected per capita egg consumption in 2010 will be 81.5 eggs.

3.2 Aquaculture and inland fisheries

3.2.1 Fish production

Endowed with vast marine and inland fishery resources, the fisheries sector plays an important role in the economy of Pakistan. Fish provide not only a source of protein to the ever-increasing population of Pakistan, but are also an important source of foreign exchange earnings as well.

Total fish production in 1999 was 654,500 mt, of which about 474,700 mt were marine fish and 179,800 mt were inland fish (Agricultural Statistics of Pakistan, 1999-2000).

Table 3.4 Inland and marine fish production in Pakistan ('000 tons)

	Year					
	1976	1986	1996	1997	1998	1999
Inland						
Punjab	8.4	32.5	69.3	64.1	56.0	65.7
Sindh	19.5	50.8	91.4	102.5	106.6	113.1
NWFP	5.7	0.7	1.5	0.9	0.9	1.0
Balochistan	-	-	-	-	-	-
Pakistan	**33.6**	**84.0**	**162.2**	**167.5**	**163.5**	**179.8**
Marine						
Sindh	127.8	240.4	270.2	291.8	302.7	351.6
Balochistan	49.3	91.3	125.1	130.4	130.8	123.1
Pakistan	**177.1**	**331.7**	**395.3**	**422.2**	**433.5**	**474.7**
Total	210.4	415.7	555.5	589.7	597.0	654.5

Source: Agricultural Statistics of Pakistan, 1983-1984 and 1999-2000.

The fisheries sector's contribution to GDP is about 1 per cent. The foreign exchange earned from the fisheries sector amounted to $ 89.8 million in 2000. Per capita consumption of fish in the country is very low, about 1.8 kg/annum. The sector is also important as it employs 0.4 million people, about 1 per cent of the total national labor force.

3.2.2 Inland fisheries and aquaculture resources

The extent of inland fisheries resources in the country is given in Table 3.5.

Table 3.5 Inland water areas of Pakistan

	Area (ha)
Rivers/Tributaries	**2,958,408**
Lakes and reservoirs	2,008,600
Canals	34,226
Waterlogged (ponds) and depressions	228,000
Fish culture ponds	**35,000**
Total	**4,332,214**

Source: FAO, 2001, Agricultural Statistics of Pakistan, 1999-2000.

It is estimated that 20 per cent of total inland fish production comes from aquaculture. The overall contribution of inland fish to total fish production in Pakistan is over 25 per cent. Accordingly, statistics for 1999-2000 for total aquacultural production were estimated to be about 35,000 mt.

3.2.3 Rivers and man-made reservoirs

The characteristics of capture fisheries are dominated by the Indus River system, which starts from the mountains of northern Pakistan and is joined by four large rivers that flow through the extent of Punjab and finally drain into the Arabian Sea in Sind Province. The fish fauna of the Indus River system in the northern part is of cold-water type, while the greater middle and southern part of the system represents warm water fishery zones. Capture fisheries dominate inland fisheries and the rivers and reservoirs account for more than 80 per cent of the total inland fish production. There is a continuing decline in commercial catches. The major reasons for this development are intensive fishing pressure combined with more difficult access to the flood plains for the migrating brood stock, young fishes due to canalization and damming and the influence of extrinsic factors. However, currently, environmental degradation has the most negative impact on fish stock. The reverie fishery management system is mainly based on the enforcement of regulatory laws of the provincial fisheries departments pertaining to restrictions on species catch by size and the observance of closed seasons for fishing.

In Pakistan, six large man-made reservoirs were created in the past four decades through the construction of dams and barrages over rivers, which provided about a 0.25 million ha area for fish production. In addition to this, there are also several small dam reservoirs.

3.2.4 Aquacultural resources

Aquaculture is a relatively new activity in Pakistan and started just twenty years ago. Its contribution to overall fish production is totally insignificant. However, things have dramatically changed in the past 20 years or so and this is developing as an industry now. More people are attracted to fish farming and marginally productive lands are being converted at a greater pace for this endeavor. The technology of fish production has improved over the passage of time, though at a slower pace. Despite all the positive trends in the fish farming sector, there is still a great need for tapping the aquacultural resources in a befitting manner, making use of all the possible resources available. Marine and coastal aquaculture has yet to get ready and there is an immense need for providing a knowledge base and other infrastructure facilities for the uplift of these sub-sectors of Pakistan’s aquaculture.

3.2.5 Feeding practices and commercial availability of feed

The fish production system is mostly based on the exploitation of natural food present in the water bodies and its augmentation by fertilization. The carrying capacity of these ponds therefore, is directly proportional to the availability of natural food in that system. The ample and cheap source of fertilizer in Pakistan is organic manure. Traditionally, all farmers keep their own herd of cattle for milking and so invariably all farmers provide their farmyard manure for fish farming. The improvement in the use of fertilizers, both in quality as well as quantity, has been further fortified, but in rare cases, with the use of supplementary feed (mainly composed of rice polish and oilseed cakes). These practices have shown improvement in fish production on a per unit area basis.

Based on the results of a gradual improvement in production due to the use of quality fertilizer and supplementary feeding, a range of farmers started working towards more nutritious pelleted feeds. Some farmers are using pelleted feed, particularly during the fattening period of fish prior to marketing, which may last for 2-3 months. These pelleted feeds are made at the farmyard by using mechanized meat-mincing machines. Some are already using high protein

diets using fish meal. The cutting point, however, is that the feeds are not commercially available as the feed costs are expensive. As far as the availability of feed is concerned, most of the major feed ingredients are abundantly available in Pakistan, including fish meal. Recently, the country has seen imports of soybean meal and cake for use in poultry feed; the same could be used for fish culture as well, if needed. There is a need to prepare commercial fish feed according to weight, size and physiological needs. To obtain proper weight gain, floating feeds should also be introduced to make available more feed to the fish.

3.3 Historical development of the animal feed sector

3.3.1 Feed crops and feed ingredients

Feed crops in Pakistan are not specific only to feed but are cultivated mainly to meet human dietary needs. Wheat, maize, sorghum, millet and barley are the crops, which are basically grown for human dietary needs but are also used as components of animal feed. Even before the development of the commercial poultry feed industry, the grains of these crops were used for livestock and rural poultry. However, with the advancement of the poultry industry, the use of grains as feed ingredients is being effectively utilized in commercially prepared rations more precisely in poultry feeds. Maize grains are usually used up to 20 per cent in poultry rations, however, when the maize price increases it is substituted with other cereal grains or their by-products (Alvi, 2002). Wheat is also being used in poultry rations and also in commercial dairy farming systems. However, poultry feed formulators are careful not to exceed the wheat use beyond 15 per cent in poultry rations because it has adverse effects. These adverse effects contribute towards a lowered growth rate and increased fat content in the dropping commonly known as pasting. Sorghum is also used in commercial poultry feed but its inclusion level usually does not exceed 5 per cent. Millet is not usually fed to commercial poultry but it is commonly used for poultry and livestock domestically. Although milled rice is not incorporated in livestock and poultry rations, its by-products, such as rice polish, rice bran and rice tips, are a hundred per cent utilized either in commercial poultry rations or in livestock feeding

The consumption of feed crop grains in animal feeding, studied in this report, is presented in Table 3.6.

Table 3.6 Consumption of cereal grains in poultry and livestock feeding ('000 tons)

Parameter	Wheat	Maize	Millet	Sorghum	Total
1981-85	230.6	197.4	124.6	11.2	563.8
1986-90	260.0	226.4	103.2	11.4	601
1991-95	314.4	244.2	90.6	11.8	661
1996-2000	385.4	344.2	88.8	11.6	830
Overall annual growth rate %	3.41	3.45	2.11	0.31	2.53

The projected quantity of wheat as feed will be 654 thousand tons in 2010. Maize used as feed was 22 per cent of its total consumption. The projected maize use as feed will be 489 thousand tons in 2010. Millet used as feed is very conventional but contributes 50 per cent of total millet consumption. The projected quantity of millet as feed will be 88.7 thousand tons in 2010. Sorghum used as feed is also very conventional but contributes 5 per cent of total sorghum consumption. The projected quantity of sorghum as feed will be 10.5 thousand tons in 2010.

Nutritional profile of feed crops

The nutritional value of feed crop ingredients, as analyzed in Pakistan, is explained in Table 3.7.

Table 3.7 Nutritional value of feed crop ingredients in Pakistan

Crop	Nutritional value						
	Crude protein %	Crude fibre %	Crude extract %	Nitrogen free extract %	Gross energy kcal/kg	Methionine %	Lysine %
Wheat	13.8	3.5	1.75	79.47	4,213	0.22	0.42
Maize	13.63	3.36	2.78	78.71	4,281	0.27	0.45
Sorghum	13.76	3.45	1.11	79.46	4,124	0.23	0.28
Millet	10.55	10.21	4.67	72.00	4,100	0.25	0.45

Source: Malik *et al*., 1996 and Nadeem, 1998.

Commercial poultry feed formulators, while formulating rations, consider the availability of nutrients in grains based on their price and also some favourable and unfavourable factors for growth and egg production. Substitution of one cereal for another on the basis of the above said factors is also taken into account.

3.3.2 Agro-based industries and by-products

In Pakistan, the agro-based industries related to feed resources can be classified as follows:

1. Cereal processing industries.
2. Oilseed extraction industries.
3. Sugar industries.

Industrial cereal by-products

Cereal processing industries consist basically of flour mills and rice processing industries. Moreover, maize is also processed through wet milling but their numbers are very few (3-4 industries). Wheat flour mills, after processing, produce wheat flour as a principal food for human consumption, whereas wheat bran is produced as a by-product which is mainly used as a ruminant feed ingredient, however, its use in poultry is not uncommon. The total consumption of wheat and rice milling by-products in livestock and poultry is shown in Table 3.8.

Table 3.8 Total consumption of wheat and rice milling by-products in livestock feeding ('000 tons)

Parameter	Wheat bran	Rice tips	Rice bran	Rice polish	Total
1981-85	1,271.2	225	449.5	199.4	2,145.2
1986-90	1,481.8	217.6	435.2	193.2	2,327.8
1991-95	1,729.4	230.4	459.8	204.6	2,624.2
1996-2000	2,006.4	302.6	594.6	264.2	3,168
Overall annual growth rate %	3.0	1.92	1.82	1.83	2.56

Source: Sattar, 2002. Personal Communication.

Rice bran is another by-product of the rice milling industries and is used in both livestock and poultry feeding. In summary, it is stated that more then 60 per cent of the total consumption of wheat and rice milling products comes from wheat bran.

Maize industrial by-products include maize oil cake, maize gluten 20 per cent and maize gluten 60 per cent. Total consumption of maize industrial by-products in livestock and poultry feed is given in Table 3.9.

Table 3.9 Consumption of maize industrial by-products in livestock and poultry feeding ('000 tons)

Parameters	Maize oil cake	Gluten 20 per cent	Gluten 60 per cent	Total
1981-85	8.42	25.32	8.42	42.16
1986-90	8.00	27.68	8.00	43.68
1991-95	8.18	30.50	8.18	46.88
1996-2000	12.12	36.40	12.12	60.64
Overall annual growth rate %	2.11	2.31	2.11	2.24

Source: Sarwar, 2002. Personal Communication.

Maize oil cake and gluten 20 per cent are exclusively used in livestock rations, whereas gluten 60 per cent is mainly used in poultry rations. The overall growth rate of maize industrial by-products in livestock and poultry feeding was 2.24 per cent during 1981-2000.

Industrial oilseed by-products

The oilseed extraction industry has basically two types of plants:

1. Expeller extraction plants are driven mechanically.
2. Solvent extraction plants which have dehulling and solvent extraction components.

The by-products of the expeller extraction plants are called oilseed cake with more oil and fibre. Solvent extraction plants produce oilseed meals, which are comparatively low in fibre and oil but high in protein. The most commonly available oilseed cakes and meals used in livestock and poultry feeding are cottonseed cake/meal, rapeseed cake/meal, sesame cake/meal, sunflower cake/meal and soybean meal. The cakes are mainly used in livestock feeding whereas the meals are used in poultry feeding. The consumption of oilseed cake and meals is presented in Table 3.10.

Table 3.10 Consumption of oilseed (meal/cake) in livestock and poultry feeding ('000 tons)

Parameter	Cottonseed	Rapeseed	Sesame	Sunflower	Soybean	Total
1981-85	1,122.4	129.4	6.8	5.3	2.9	1,266.6
1986-90	2,113.2	128.2	5.0	16.7	4.3	2,267.4
1991-95	2,548.8	122.2	7.5	31.0	51.5	2,761.0
1996-2000	2,685.8	167.2	14.7	52.7	112.4	3,032.8
Overall annual growth rate %	5.48	1.47	5.37	15.62	26.2	5.5

Source: NODP, 1995 and FAO Agro-stat Database, 1981-2000.

About 89 per cent of the total consumption of cake and meal is represented by cottonseed cake/meal. The others, oilseed cake/meal used in livestock and poultry feeding, contributed only 11 per cent. Soybean meal, which is a good source of protein and amino acid and is the preferred meal of poultry feed millers, is mainly imported from India and is exclusively used in poultry rations.

Miscellaneous industrial by-products

The other miscellaneous industrial by-products are molasses, fish meal, guar meal and pulses. The total average consumption of miscellaneous feed ingredients is presented in Table 3.11.

Table 3.11 Consumption of miscellaneous feed ingredients in livestock and poultry feeding ('000 tons)

Parameter	Guar meal*	Pulses**	Molasses**	Fish meal**	Total
1981-85	102.38	109.8	29.2	143.6	384.98
1986-90	129.34	130.8	73.60	165.4	499.1
1991-95	100.98	136.8	90.80	185.2	513.78
1996-2000	73.06	174.75	138.44	190.8	577.1
Overall growth rate %	-2.09	3.09	9.69	2.03	2.65

Source: *Rizvi, 2002. Personal Communication.
**FAO Agro-stat Database, 1981-2000.

3.3.3 Livestock feed industry

The feed industry for livestock and poultry serve as an intermediary between various disciplines and functions related to animal production and marketing of animal food products. The feed industry forms an integral part of the food chain and as such is closely linked to primary agricultural production. As a supplier of compound feed, it makes important contributions in the field of livestock and poultry farming. As a customer, it not only consumes products such as cereals from arable farms, but also uses by-products of the food industry, such as oil extraction meals for ingredients in compound feed. In Pakistan, the feed industry is not very old and was established in late 1970.

Poultry feed industry

About 92-95 per cent of commercial feed mills are producing poultry feed. In 1976, the number of feed mills in Pakistan was only 17 but this had increased to 150 by 1996.

Feed production grew at 30 per cent per annum from 1976-1996. The feed mills are primarily concentrated in Punjab and Sindh provinces of Pakistan and are producing layer feeds, broiler feeds and breeder feeds.

The manufacture of feeds is carried out by the feed mills and is sold either directly to the farmers or through their sales agents. During the last decade, the poultry feed industry entered into an era of modern and scientific production through the establishment of huge feed mills equipped with extruders, pelletizers, crumbling machines and environmental control silos. Moreover, these industries have developed their own research and development programmes with the support of laboratories and experimental sheds (Nadeem, 2002).

Table 3.12 Production capacity, production and capacity utilization of feed mills in Pakistan ('000 tons)

Year	Total production capacity	Total feed produced	Utilization of production capacity (%)
1976	287	143	49.82
1986	1,200	740	61.66
1987	1,320	818	61.96
1988	1,320	952	72.12
1989	1,764	1,142	64.73
1990	2,116	1,070	50.57
1991	2,291	867	37.86
1992	2,441	980	40.15
1993	2,515	1,040	40.94
1994	2,540	1,085	42.72
1995	2,650	1,190	44.91
1996	2,700	1,290	47.78

Source: Pakistan Poultry Industry Yearbook, 1992 and 1998.

Livestock feed industry

Although there is a large population of large and small ruminants in the country, the number of feed mills engaged in commercial ruminant feed production is only 10-15. The research and development efforts of the Pakistan Agricultural Research Council (PARC) for ruminant feed development and its role model led to the establishment of the small to medium scale ruminant feed mills. The trend of utilization of commercial feeds for dairy animals is increasing year by year. Research and development programs of PARC have also resulted in the industrial manufacture of urea molasses blocks for ruminants with special reference to rainfed livestock. There are varieties of recipes/formulas for livestock feeds including the blocks to cater for the needs of any target ruminant.

3.4 Agricultural policies

3.4.1 Production policies

The National Agricultural Policy of Pakistan (GOP, 1991) focuses on the following goals:

i) Social equity.
ii) Self-reliance.
iii) Export orientation.
iv) Sustainable agriculture.
v) Enhanced productivity.

These goals are designed primarily to be achieved through the plan of action which is aimed at:

- Obtaining growth rates higher than population growth to ensure food security, self-sufficiency and export surpluses.
- Increasing productivity in crop, livestock, fisheries and forestry sectors.
- Evolving an export oriented strategy to exploit export potential.
- Conservation and development of natural resources.
- Institutionalizing reforms, promoting institutional development and bringing social and economic equity to the agrarian structure.
- Focusing on small farmers and barani area development.
- Achieving full employment in rural areas through rural agro-based industrialization.

The main elements of the plan of action are the following:

- Provide modern agricultural inputs including the latest appropriate technology.
- Give balanced emphasis to all aspects of agricultural production, including livestock, fisheries (inland and marine), and forestry.
- Develop land and water for the sustained growth of agriculture.
- Improve marketing infrastructure and storage facilities.
- Promote the application of new technology for raising productivity per unit of land and animal.
- Establish remunerative output prices to accelerate the transition of subsistence farming to commercial farming with high levels of productivity.

In 1997, the Government of Pakistan undertook a review of the declining trends of the production of major crops, as witnessed during 1996-1997, in order to provide a boost to this important sector.

Consequently, the Government of Pakistan announced a package of incentives for the farming community in April 1997 and a growth rate of 5.1 per cent for 1997-1998 was projected. Salient features of the package were as follows:

- Support prices of wheat, rice, canola and sunflower were increased.
- Prices of seeds, weedicides, tractors and reconditioned harvesters were reduced through fiscal measures.
- The availability of agricultural credit was increased to an all time high of Rs 30 billion of which 80 per cent was targeted for small framers.
- Irrigation facilities were to be improved in order to increase the water supply at the farm level.
- For the betterment of land-less workers on farms, a system would be developed under which cows and buffalo would be given to them on personal guarantees.

- An agricultural research fund was proposed to be established to coordinate and disseminate research results to farmers.

Although the share of agriculture in GDP has been declining over the years because of relatively higher growth of other sectors such as industry, infrastructure, services etc., it is still a leading sector of the economy. It has maintained an average annual growth rate of 3.9 per cent during the last decade. However, this growth is threatened by the persistent drought conditions in recent years, the poor and the less endowed being its major affectees. To combat the effects of drought, the government launched various drought mitigation programmes.

The Government of Pakistan has fixed the production targets of various crops, keeping in mind the domestic demand, population growth, and industrial and export requirements as well as the technical feasibility to achieve them. The availability of inputs like water, fertilizer, machinery and seeds were also kept in mind while fixing the targets (Table 3.13).

Table 3.13 Future targets of various feed crops and livestock products in Pakistan

Crops	Benchmark 2001	Target 2011	AGR per cent 2001-2011
Wheat	18,535	29,000	4.5
Maize	1,731	3,129	6.1
Others (millet and sorghum)	655	1,202	6.3
Livestock products			
Milk	26,284	35,857	3.2
Beef	1,010	1,434	3.6
Mutton	666	974	3.9
Poultry	342	583	2.3
Eggs (million no.)	8,677	14,446	5.2

Source: GOP (2001).

The government has planned various strategies for agricultural development for the next decade, keeping in view the following objectives:

- To achieve self-reliance in agricultural commodities.
- To ensure food security.
- To provide export orientation by promoting the production of high value crops, fruits and vegetables.
- To promote import substitution by increasing the production of tea, milk and dairy products.
- To improve crop, livestock and fishery productivity and improve management practices. The agricultural sector will be transformed from self-sufficiency to export high value agricultural products.

3.4.2 Agro-processing policies

Agricultural commodities such as wheat, rice, maize, cotton and sugarcane are processed at an industrial level to make them suitable for consumption. The major agro-based industries and their products in Pakistan are shown below (Table 3.14).

Table 3.14 Agro-based industries of Pakistan

Agro based industries	Input	Output	By-products
Flour mills	Wheat	Wheat flour	Wheat bran, etc
Sugar industry	Sugarcane	Sugar	Molasses
Rice milling industry	Rice paddy	Clean rice	Rice bran, husks, rice polish, rice tips, rice germs
Cotton industry	Cotton	Cotton lint and oil	Cotton seed cake/meal
Commercial poultry feed industry	Wheat, maize, sorghum, millet, etc	Commercial poultry feed	-
Ruminant ration industry	Various by-products of cereals, oil cakes and sugarcane, etc	Ruminant rations	-
Milk industry	Raw milk	Standardized milk, butter, and cheese	-

There was no tariff imposed by the government on wheat flour mills. Instead the government subsidized the wheat flour to keep its price down. The by-products of flour mills have no sales tax and excise duty. The main aim of this policy was to ensure wheat flour availability to every citizen of the country.

The Government of Pakistan is promoting a farmer friendly policy of imposing no tariffs on the produce of the farmers to encourage production.

The Government of Pakistan have also not imposed any tariffs on processed outputs as well as by-products of agro-based industries whose output is mainly utilized by the poor with the objective to increase agricultural production in the country. There is no sales tax on the ingredients used in poultry and ruminants' feeds or their finished products (different kinds of feeds).

3.4.3 Pricing policies

The government is pursuing a Support Price Policy for selected agricultural crops (GOP, 1988). The main objectives of this policy are:

- To safeguard the interests of farmers in the post harvest period when the price of a farm commodity tends to fall.
- To raise the production of crops through inter alia price intervention, particularly, those which are either exported or need import substitution.
- To stabilize the price of farm commodities.

Prices of major agricultural commodities are influenced by two mechanisms in the country. The floor prices are normally set through the support price mechanism on the recommendation of the Agricultural Prices Commission (APCom). The ceiling prices are set by trade interventions executed through government policies. There are ten commodities i.e. wheat, rice, gram, sugarcane, cotton, sunflower, soybean, canola, onion and potato, for which the support prices are set through the support price system. Prices of other commodities are left free to float under market supply and demand forces.

APCom, while determining support prices, takes a number of factors into consideration, i.e. the cost of production, domestic demand, supply and stock position, export or import parity price, fertilizer and the commodity price parity, comparative advantage of crops, real price of the commodity, impact of the suggested prices on other sectors of the economy and the cost of living and changes in the purchasing power of the farmers. APCom has developed a well-organized consultative mechanism in the form of standing committees on crops. These committees have been set up for all the commodities covered under the price support policy and comprise of growers, provincial and federal experts, mill owners, associations and the chambers of agriculture, trade and industry. Before finalizing price recommendations to the government, meetings of these committees are convened to discuss various matters relating to the cost of production, marketing and other related matters.

The price recommendations, finalized by APCom, are sent to the Ministry of Food, Agriculture and Livestock who, after consultation with provincial governments and other concerned Federal Ministries, forward the recommendations to the Cabinet/Economic Coordination Committee for a final decision. The implementation of the support price programme has, on the whole, worked satisfactorily for some crops like wheat, rice and cotton and to some extent sugarcane, in the past.

3.5 Marketing and trade policies

An efficient marketing system is a prerequisite for sustained agricultural development. It affects both producer's income (through the prices farmers receive for their products) and consumer welfare (via prices consumers eventually pay for agricultural commodities). The efficiency of the farm sector depends not just on farm production costs and yields, but also

equally on marketing opportunities and the rate of return to the farmers. Although the bulk of agricultural marketing in Pakistan is in the private sector, the government intervenes extensively in the agricultural marketing system through a system of support prices for nearly all-major crops. The government also regulates the marketing of agricultural commodities and physically procures a large proportion of wheat for sale to flour mills.

Generally, the physical and institutional marketing infrastructure for agricultural commodities is weak and increasingly regarded as inadequate to meet the needs of a growing modern economy. The main inadequacies and constraints in this respect are:

- Shortage of farm-to-market roads: Less than 50 per cent of villages are presently connected with all-weather roads. As a result, marketing opportunities for farmers are abridged and marketing costs for the entire agribusiness economy are excessively high.
- Fragmented markets: At present, there are about 650 markets serving approximately 45,000 villages. The markets are generally fragmented and situated far from the producing areas. This causes hardships for farmers.
- Lack of storage, transportation and processing facilities.
- Lack of market information: A lack of reliable and timely market information on prices, available quantities, forecasts of future supplies etc. discourages efficient decision-making and weakens the farmers bargaining power.
- Limited grading and standardization.
- Stop-go export policies: Such policies normally generate losses for exporters, inhibit investment and production and discourage the development of sustained business relations with foreign buyers.

3.5.1 Monetary and exchange rate policies

Monetary and exchange rate policies are major components of liberalized trade policies in a country. Pakistan's monetary policy refers to the measures which the State Bank of Pakistan (SBP) takes in controlling the money and credit supply to bring about desired changes in the economy. During the early 1990s, the government introduced market oriented monetary and credit policies to achieve the planned growth, anticipate inflation, and bring about expected changes in net foreign assets of the banking system. One of the main problems created in financial markets has been the lack of autonomy of the SBP. The principle financing entity in the system has often been held captive to the political governments. Under the Financial Sector Reform Program of the government, the SBP was given full authority to conduct the monetary policy of the country in May 1997 and it was further strengthened during 1999-2000. It is expected that the increased autonomy of the SBP will bring greater economic stability to the country and help to further liberalize the trading sector in Pakistan. Very recently the government gave full authority to SBP under an ordinance.

Before 1981, like many other countries, Pakistan's rupee was linked to the US dollar, for a long time it was constant (fixed by the government) at a rate of Rs 4.76/US$. In May 1972, the rupee was devalued by 131 per cent from Rs 4.76/US$ to Rs 10.59/US$. Subsequently, when the US dollar was devalued against all other currencies the new rate was fixed at Rs 9.97/US$ in March 1973. Pakistan maintained a constant nominal exchange rate throughout the 1970s. In January 1982, the rupee was de-linked from the US dollar and the government followed a managed floating exchange rate policy. Initially the government planned to peg the value of the rupee to an index, which was a weighted average of currencies of Pakistan's major trading partners. This policy allowed the exchange rate to fluctuate against the US dollar. However, this resulted in a gradual devaluation of the rupee in terms of the US dollar. Since then, the rupee has been steadily devalued significantly over time. The government mainly devalued the rupee to improve the persistent negative trade balance. However, this policy did not help much improve the negative trade balance. From 1980-1981 to 1990-1991, again, the rupee was devalued by another almost 100 per cent. Up to May 1998, the exchange rate arrangements were

very liberal and the country followed a managed floating system. Under this system the SBP set the daily exchange rate, which it used to purchase and sell US dollars (the intervention currency) in business with other authorized banks and foreign exchange authorized dealers. Considering the competitiveness of the tradable sector and to control inflationary pressures, SBP was adjusting the exchange rate on a frequent basis for various currencies. The official exchange rate of Pakistan rupees to other major trading partners is given in Table 3.15.

The government took a number of measures to move towards the ultimate goal of having market-determined rates of foreign exchange during 1997-1998. For example, the SBP abolished the mandatory control of exchange rate determination on foreign currencies with effect from February 5, 1998. All commercial banks and authorized foreign exchange dealers were allowed to determine and undertake transactions of their own exchange rates for various currencies (other than the US dollar), in terms of the rupee, depending on the demand and supply situation in the market. However, the US dollar to rupee exchange rate was still being determined by the SBP. Subsequently, from May 24, 1998, banks and authorized dealers were also permitted to fix their own buying/selling rates for US dollars from international financial transactions, Pakistan had made changes in its exchange rate and payment policy, and imposed certain restrictions on foreign transactions. With effect from May 29, 1998, in order to conserve foreign exchange in the country, withdrawals from foreign currency accounts (FCAs) were suspended except accounts of diplomatic missions, independent power projects, etc. Withdrawals from FCAs were only allowed in Pakistan rupees at the official rate of Rs 46.00/US$. So far, FCA holders are still not allowed to withdraw in US$ and other major currencies including the British pound, German mark and Japanese yen. The payment of profit in foreign exchange was also suspended until further notice. However, FCA holders were allowed to cash profit in rupees at the rate of Rs 46.00/US$. The government announced a number of incentives for FCA holders if they convert their accounts into rupees at the official rate, including exemption from probe by tax authorities, banking confidentiality, and six year wealth tax exemption from income tax on interest or profit earned on dollar accounts before conversion.

Table 3.15 Official average exchange rates of major currencies in terms of Pakistan rupees

F/Year	US Dollar	British Pound	Japan Yen	German Mark	French Franc	Indian Rupee
1986/87	17.18	26.21	0.11	8.92	2.7	1.34
1987/88	17.60	30.85	0.13	10.19	3.02	1.33
1988/89	19.21	32.91	0.15	10.36	3.05	1.26
1989/90	21.44	34.92	0.15	12.12	3.58	1.26
1990/91	22.42	41.58	0.16	14.12	4.18	1.28
1991/92	24.84	43.74	0.19	15.08	4.44	0.96
1992/93	25.96	42.03	0.22	16.57	4.89	0.94
1993/94	30.16	45.16	0.28	17.90	5.20	0.96
1994/95	30.85	48.69	0.33	20.68	5.96	0.98
1995/96	33.57	51.92	0.33	22.97	6.69	0.98
1996/97	38.53	62.05	0.33	24.69	7.29	1.08
1997/98	43.10	70.42	0.35	23.89	7.12	1.14
1998/99	46.79	76.81	0.37	26.7	7.96	1.09
1999/00	51.77	82.49	0.48	26.54	7.12	1.19

Source: Economic Survey, 2000-01.

Spillover effects of the currency turmoil contributed to the more than 10 per cent depreciation of Pakistan's currency against the US dollar during 1997-1998. However, the massive devaluation of East Asian currencies did not threaten Pakistan's exports beyond manageable limits because Pakistan mainly exports value added cotton products to these countries. Pakistan did not suffer severely from the contagion effects of Asian financial turmoil mainly because its foreign capital inflows consisted of direct investment, limited portfolio inflows and a build-up of foreign short-term debt, which was mainly concentrated in the public sector (SBP, 1998). During 1998, Pakistan's economy was mainly affected by the nuclear test

sanctions of the G-7 countries and international financial institutions. However, the economic situation improved in 1999 as developed country's exchange reserves in Pakistan had increased to over US$ 1.6 billion by March 1999 (Akhtar, 1999).

3.5.2 State trading enterprise

Pakistan has many state trading enterprises in agriculture. The reasons for establishing them include a wrongly perceived need for the government to intervene in some markets to control prices and distribution. The public enterprises have not yielded tangible benefits, and they have inhibited the development of an efficient market in agricultural services, besides costing alot to the public exchequer. The long-term cost of price intervention on agricultural producers has been substantial. Estimated transfer out of agriculture due to price intervention, as a percentage of producer value, was around 10 per cent during 1981-87. These transfers have adversely affected farmers' incentives for agricultural investment. Furthermore, the government's strategy of stabilizing prices year-round and imposing uniform geographical pricing have held back the development of private storage and distribution capacity, in addition to imposing unnecessary fiscal burdens as noted.

Major problems generally encountered with public enterprises; economic, financial, and managerial are all present in Pakistan. From an economic perspective, pursuit of noncommercial goals, noncommercial pricing, and a drive for import protection have led to operating inefficiency, high cost structure and inadequate capitalization to meet potential demand. From a financial perspective, low profitability, heavy debt, over reliance on government bailouts and preferred credit have contributed to a poor return on investment, driving many public enterprises to the brink of insolvency. On the management side, overstaffing and loose control over human resources, lack of incentives for productivity enhancement and inadequate accounting and cost control procedures have led to considerable administrative inefficiency (Faruqee *et al*., 1995).

Applying the standard norms for judging organizational performance — profitability, operating efficiency, creditworthiness, marketing achievements, and so on — to the agricultural public enterprises in Pakistan reveals many deficiencies. Among the production parastatals, only the Paksaudi and Pakarab Fertilizer Corporations have shown any real commercial viability, but Paksaudi's income growth has been extremely low. Others, like Pakamerican and Hazara Fertilizer Corporations, had negative income and negative growth between 1986-93. The returns on assets in this period for Hazara (-0.8 per cent) and Pakamerican (-17.8 per cent) are also a strong indication of the economic nonviability of these institutions. The overall fertilizer market share of the combined state corporations is relatively small, about 31 per cent for urea and only 15 per cent for phosphate, the rest belonging to the private sector. The production at Pakarab, Paksaudi, and Pakamerican declined by 5-12 per cent between 1988-93.

The marketing parastatals have fared worse. The market share of National Fertilizer Marketing Limited has gone down steadily and its financial losses, on average, were Rs 13.8 million a year between 1987-1993 (0.2 per cent of operating income). Other enterprises selling seed and fertilizer, like the Punjab Seed Corporation and the Punjab Agricultural Development and Supplies Corporation, have also lost market share over the years. The Punjab Seed Corporation had an average yearly after-tax profit of Rs 13.2 million (3 per cent of operating income) during the 1987-1993 period, but its true performance (taking into account subsidies to the corporation) would not be as favorable as these figures indicate. The financial performance of the Punjab Agricultural Development and Supplies Corporation has been extremely poor. It had losses in each of the seven years (1987-1993) averaging Rs 64.4 million (7 per cent of operating income). The Pakistan Agricultural Storage and Services Corporation (PASSCO), the chief instrument of the government's price stabilization policy, has also shown losses in recent years. In FY1992/1993 the loss was Rs 89 million. Its procurement of wheat has also declined steadily over the years, which speaks strongly for its redundancy.

Among the prominent exporting parastatals, both the Rice Export Corporation and Cotton Export Corporation have seen a rapid decline in market share over the years. For

example, the Rice Export Corporation of Pakistan's export share declined from 32 per cent to 19 per cent between 1988-1993. Likewise, the Cotton Export Corporation's export of raw cotton fell from 50 per cent to 35 per cent between 1990-1994. The steady growth of private sector exports has made these parastatals unnecessary and redundant. There is a particular urgency to divest them because they are causing huge losses to the government. During 1987-1993, the average after-tax loss of RECP was over Rs 347 million a year (7 per cent of operating income), and for CEC Rs 421 million a year (6 per cent of operating income). The principal adverse effects on agriculture of public enterprises have been the negative impact of price intervention, the crowding out of the private sector from the market, and the high cost to the public exchequer. The controlled price system in Pakistan, for both inputs and outputs, has inhibited growth of marketing services. State enterprises, acting as large public monopolies with substantial government patronage, have arrogated financial resources from the market and held back the development of an efficient private sector.

3.5.3 Policies most affected by WTO agreement

Pakistan has been a founding member of the General Agreement on Tariffs and Trade (GATT) since 1948. It has participated in most of the rounds of multilateral trade negotiations and formally signed the Final Act Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations in Marrakesh on April 15, 1994. The UR provided substantial new trading opportunities, strengthened international trading rules, and reinforced the institutional foundation of the world trading system. The establishment of the WTO as an "umbrella institution" is assigned the responsibility of administering and implementing the new GATT charter (GATT, 1994). Being a founding member of GATT, Pakistan is a member of WTO and consequently, a signatory to all of the major accords established under the aegis of the UR, and now it is in the process of implementing the UR agreements. The UR obligations have set a number of challenges and opportunities for countries like Pakistan. The specific implications for Pakistan can be analyzed in the following four major areas (Schott, 1994):

- Trade liberalization including tariffs and changes in agriculture and textiles.
- New issues related to services, investment, and intellectual property.
- Trade rules.
- Institutional, or systematic issues.

The negotiations resulted in four main portions of the Agreement (Ahmad, 2000),

- The Agreement on Agriculture itself.
- The concessions and commitments members are to undertake in terms of market access, domestic support and export subsidies.
- The agreement on sanitary and phytosanitary measures.
- The Ministerial Decision concerning least-developed and net food-importing developing countries.

The agricultural package also addresses many other issues of vital economic and political importance to many members. These include provisions that encourage the use of less trade distorting domestic support policies to maintain the rural economy. The agreement covers three main areas (Abrar, 2000 and Ahmad, 2000):

- Market access.
- Domestic support.
- Export competition.

Market access

In the area of market access, non-tariff border measures are replaced by tariffs that provide substantially the same level of protection. Tariffs resulting from this "tarrification"

process, as well as other tariffs on agricultural products, are to be reduced by an average 36 per cent in the case of developed countries and 24 per cent in the case developing countries with minimum reductions for each tariff line being required. Reductions are to be undertaken over six years in the case of developed countries and over ten years in the case of developing countries. Least-developed countries are not required to reduce their tariffs.

The provisions under the UR apply to a primary agricultural product that is the predominant staple in the traditional diet of the developing country, which invokes this clause of the agreement.

Domestic support

Domestic support is regulated through the Aggregate Measure of Support (AMS). The total AMS quantifies the aggregate value of domestic support or subsidy given to each category of agricultural product. Commitments made by a member require a 20 per cent reduction in total AMS for developed countries over six years and l3.3 per cent for developing countries over 10 years. LDCs are exempt. The base period for the calculation of reduction is 1988-89.

Export subsidies

Members are required to reduce the value of direct export subsidies to a level 3 per cent below the 1986-90 base period levels over the six year implementation period. The quantity of subsidized exports is to be reduced by 21 per cent over the same period. In the case of developing countries, the reductions are two thirds those of developed countries over a ten year period (with no reductions applying to the least developed countries).

The Agreement on Agriculture provides for some limited flexibility in terms of export subsidy reduction commitments and contains provisions aimed at preventing the circumvention of the export subsidy commitments and sets out criteria for food aid donations and the use of export credits.

Pakistan has put a ceiling binding of 100-150 per cent on agricultural items in its offer on agriculture submitted to the WTO. It was necessary because agriculture plays an important role in the economy. Its Aggregate Measure of Support is negative for wheat cotton and other basic commodities. It has also declared to be a net food importing country.

3.6 Policy reforms initiatives

Pakistan has taken a number of policy initiatives for the development of agriculture in the country. Given the problems facing agriculture in Pakistan, what policies and programs should the government adopt to sustain and improve agricultural growth? Before specific strategies are adopted, the role of the government should be clearly defined as limited to the encouragement of a smoothly functioning market through institutional and regulatory reforms that facilitate private sector activities and market efficiency. In cases where market failure is not an issue and intervention has led to market inefficiency, the best strategy is to reduce the government's role through policy reforms and the strengthening of market liberalization. Thus, intervention failures should not result in a situation that is worse than one without intervention. Salient features of policy initiatives that the Government of Pakistan has to take are as follows:

- A key component of the government's strategy must be to reshape investment and public expenditure on agriculture. Spending should be focused on the provision of public goods and the correction of market failures, not on activities better suited to the private sector, even if such activities may be profitable. In terms of poverty alleviation and environmental protection, where the government has a legitimate role to play, market-friendly policy reforms should be adopted to ensure economic efficiency and growth and to achieve the government's social goals.

- Policies that affect incentives distort both input and output markets and result in a sub-optimal allocation of resources. Changes in price policy, trade policy and fiscal policy are needed if agriculture in Pakistan is to continue to grow.
- The government should also consider ending the subsidy on wheat imports. Such a policy change would likely have little effect on consumers, because the price of flour is already determined by the market and is close to import parity.
- All special agricultural tax exemptions should be eliminated.
- The government should consider reducing its level of intervention in the agricultural input market, like it has begun to do so in privatizing urea production and distribution. Additional efficiency could be achieved by making the National Fertilizer Corporation more commercially oriented or by divesting in the private sector.
- Privatizing the import of phosphatic fertilizer should be accelerated.
- The irrigation system should be decentralized.
- A careful study of the costs and benefits of land reforms should be initiated.
- The land title process should be modernized and streamlined through the establishment of a system of permanent title deeds to land.
- Directed credit in any form should be eliminated.
- The role of the public sector needs to be recognized.
- Support for research should continue, but expenditure needs to be restructured so that salaries do not absorb most of the available funds and give research institutions more autonomy.
- Greater importance should be attached to research on cropping systems.
- Adaptive research, which should be a part of the extension service, should provide site and season-specific recommendations and information to individual farmers.

Both productivity and sustainability can be enhanced by improvements in crop and resource-management research.

4. Demand for Feedstuffs and Feed Crops

Demand/consumption of food and feed grains in terms of their consumption behaviour, consumption structure, consumer price behaviour, consumption response to market forces, development of their products and projections for their future consumption will be presented in this chapter. Since these grains are utilized for food, feed and other purposes, the detailed discussion is undertaken on the pattern of their consumption.

4.1 Consumption behaviour

4.1.1 Wheat

Wheat is a primary food crop because it is the staple food and represents the largest cereal crop in terms of its production in Pakistan. Total consumption of wheat, which includes food, feed and other uses, was 10,292 thousand tons during 1981, increasing to 26,187 thousand tons in 2000. This increase in total wheat consumption was achieved with an overall growth rate of 4.22 per cent during 1981-2000 (Table 4.1).

Table 4.1 Consumption of wheat in Pakistan ('000 tons)

Parameter	Total domestic consumption	Food	Feed	Other uses
1981-85	11,283	10,051	231	1,001
1986-90	13,582	12,248	260	1,074
1991-95	16,607	15,085.8	314	1,207
1996-2000	20,739	18,915	385	1,438
Overall annual growth rate %	4.22	4.28	3.41	-

Source: FAO, Agro-stat Database, 1981-2000; Agricultural Statistics of Pakistan, 1983-84 and 2000-01.

The share of wheat as food in total wheat consumption was 88 per cent in 1981 and it increased progressively to 91 per cent in 2000. It is worth mentioning here that the share of wheat consumption as feed in the total wheat consumption remained stagnant and was only 2 per cent throughout the last two decades. Wheat grain is used in poultry and livestock feeding after crushing to a suitable particle size and it is economically feasible at certain levels in total feed. Wheat consumption as other (seed and wastage) uses was 978 thousand tons in 1981, which increased to 1,830 thousand tons in 2000. The share of other uses in the total consumption of wheat ranged from 6 to 10 per cent during the last twenty years.

4.1.2 Maize

After wheat and rice, maize is the most important cereal crop in Pakistan. Maize is used as food, feed and for other uses, which includes the seed, industrial uses and wastage (Table 4.2).

Table 4.2 Consumption of maize in Pakistan ('000 tons)

Parameter	Total domestic consumption	Food	Feed	Other uses
1981-85	988	570	197	220
1986-90	1,126	662	226	238
1991-95	1,226	721.8	244	260
1996-2000	1,556	907	344	314
Overall annual growth rate %	2.9	2.97	3.45	2.27

Source: FAO, Agro-stat Database, 1981-2000.

The share of maize as food ranged between 55 and 60 per cent of the total maize consumption during the last twenty years. The growth rate of maize utilization as feed has increased at a much higher rate than its uses as food and others. The share of maize used as feed from the total consumption of maize during the last 5 years was 22 per cent, whereas it was 19-20 per cent during 1981-1995. The share of maize use as other uses in total consumption was about 21 per cent.

4.1.3 Sorghum

Sorghum grain is predominantly used as food but some of the sorghum grain is utilized as animal feed and for other purposes such as seed, etc. (Table 4.3).

Table 4.3 Consumption of sorghum in Pakistan ('000 tons)

Parameter	Total domestic consumption	Food	Feed	Other uses
1981-85	220	190	11.2	25.2
1986-90	229	198	11.4	19.4
1991-95	235	204	11.8	19.8
1996-2000	231	200	11.6	19.0
Overall annual growth rate %	-	0.44	0.31	-

Source: FAO, Agro-stat Database, 1981-2000.

The growth rate of total feed consumption was -2.51 per cent from 1996-2000, indicating that the total consumption of sorghum has a decreasing trend in the last five years. The use of sorghum as food has declined progressively during the last decade as wheat and maize might be replacing it in the human diet. The share of sorghum as food in the total consumption of sorghum remained almost stagnant as 85-87 per cent during the last twenty years. Sorghum used as feed for livestock and poultry was 11 thousand tons in 1981 and it was almost the same in 2000. The share of sorghum as feed in the total consumption of sorghum remained at 5 per cent during the last twenty years. The share of sorghum for other uses from total consumption remained between 8 and 10 per cent during 1981-2000.

4.1.4 Millet

Total consumption of millet in Pakistan was 214 thousand tons in 1981 and 156 thousand tons in 2000 (Table 4.4). The total domestic consumption of millet has gradually declined during the last twenty years.

Table 4.4 Consumption of millet in Pakistan ('000 tons)

Parameter	Total domestic consumption	Food	Feed	Other uses
1981-85	249	106.8	124.6	18.9
1986-90	206	87	103.2	15.8
1991-95	181	76	90.6	13.8
1996-2000	178	74	88.8	14.4
Overall annual growth rate %	-	-2.18	2.11	-

Source: FAO, Agro-stat Database, 1981-2000.

The share of millet as food from total consumption was 42-44 per cent during the years 1981-2000. The use of millet as food and feed has gradually declined during the last two decades. The share of millet as feed in total millet consumption remained at about 50 per cent throughout the last twenty years. There is a decline in the use of millet for other uses during the past twenty years, however, its share in the total consumption of millet remained between 7 and 10 per cent.

Among these feed grains, maximum consumption was of wheat followed by maize, millet and sorghum. The overall growth rate in the consumption of these grains in poultry and livestock feeding was 2.53 per cent.

4.2 Consumption structure

4.2.1 Wheat

Wheat being the staple diet of the people of Pakistan, 90 per cent is utilized as food, whereas the remainder is used as feed and for seed purposes. Per capita consumption of wheat was 108 kg in 1981, increasing to 173 kg in 2000. Per capita consumption of wheat progressively increased throughout the last twenty years. Per capita consumption of wheat, maize, sorghum and millet is shown in Table 4.5.

Table 4.5 Per capita per annum consumption of various food grains (kg) in Pakistan

Year	Population (millions)	Per capita consumption			
		Wheat	Maize	Sorghum	Millet
1981-85	89.0	112.5	6.2	2.1	1.2
1986-90	104.0	117.6	6.2	1.9	0.8
1991-95	117.0	129.3	6.0	1.7	0.6
1996-2000	131.0	143.5	7.0	1.5	0.4

Source: Economic Survey 2000-2001.

Annual per capita consumption of wheat is higher in the rural population compared to the urban population. Per capita consumption of maize in Pakistan was 6 kg per annum during 1981 and it was 7 kg per annum in 2000. Per capita consumption of maize remained almost stagnant from 1981-1989, whereas it increased by only one kg per annum during the last five years.

4.2.2 Sorghum

Per capita consumption of sorghum gradually decreased every year. The decrease in per capita consumption of sorghum may be due to the preference of people to use more wheat in their diets.

4.2.3 Millet

Millet is casually used by the rural community as part of their diet. The per capita consumption of millet was 1.1 kg in 1981, which decreased to 0.6 kg per annum in 2000.

4.2.4 Cereal grain utilization as feed

Wheat, maize, sorghum and millet grains are utilized in poultry and livestock feeding, however, millet is not utilized in commercial poultry rations. The amount of maize used in commercial poultry rations was 82, 173, 259 and 307 thousand tons during 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively. The utilization of maize in total feed consumption was 42, 77, 100 and 89 thousand tons during the above mentioned periods, wheat was used in poultry rations to the tune of 62, 130, 208 and 230 thousand tons during 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively. The percentage of wheat used in the commercial poultry rations out of total wheat as feed was 27, 50, 60 and 60 per cent for the same period.

The amount of sorghum used in poultry feeding was 11,11, 12 and 12 thousand tons in 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively and almost a hundred per cent of the sorghum is calculated to be utilized in poultry rations. Total use of maize, wheat and sorghum in commercial poultry rations was 150, 315, 478 and 449 thousand tons during the period 1981-1985, 1986-1990, 1991-1995 and 1996-2000 respectively. The share of above mentioned grains in commercial poultry rations was 27, 52, 72 and 66 per cent over the same period.

Maize, wheat and millet are also used for dairy animals, however, casual feeding is also practiced for small ruminants. For the same time period, the percentage of these grains utilized in ruminants feeds was 73, 48, 28 and 34 per cent.

Synthesization of the overall utilization of the grain situation, revealed that with the passage of time, more grains were utilized in poultry rations compared to ruminant feeding.

4.3 Consumer price behaviour

Cereal grains are consumed predominantly as food or feed, for livestock and poultry. The consumer price for wheat as food was taken as retail price, whereas the price of wheat used in poultry and livestock industries as wholesale price. There is no data available on the retail price of maize, sorghum, and millet, therefore, the consumer prices for these cereals for food and feed are taken as wholesale prices. The trend in consumer price behaviour of feed crops is presented in Table 4.6.

Table 4.6 Consumer prices of different feed crops (Rs/tons)

Period	Wheat		Maize	Sorghum	Millet
	Food	Feed			
1981-85	1,946	1,866	2,245.00	2,025.6	2,997.4
1986-90	2,514	2,308	3,074.42	2,912.2	3,585.6
1991-95	3,978	3,860	5,347.48	4,043.8	6,241
1996-2000	7,120	6,764	9,022	8,629	10,556
Overall annual growth rate %	8.59	8.71	9.32	9.10	8.39

Wheat = Retail price (Economic Survey, various issue).
Wheat, Maize, Sorghum and Millet = Wholesale price (Agricultural Statistic of Pakistan various issues) and Khan *et al*., 1996.

It can be concluded that the consumer prices of all of the above mentioned food and feed crops increased steadily and progressively during the last 20 years.

A comparison of consumer price behaviour of wheat, maize, sorghum and millet suggested that during the last twenty years the consumer prices of millet were highest followed by maize, sorghum and wheat. The reason for the minimal consumer price of wheat is the government subsidies. The consumer price of wheat is actually controlled by the government support price.

4.4 Consumption response to market forces

4.4.1 Wheat demand for food

Ln WheatFOODt = C0 + C1 Ln WheatPCt + C2 Ln RicePCt + C3 Ln POPt + C4 Ln INCt
Estimation method: OLS
Number of observations: 20 (1981-2000)
PC= consumer price, POP= human population and
INC= per capita income

Table 4.7 Wheat demand for food

Coefficients	Estimates	t-statistics
C0	1.17	0.32
C1	-0.23	-0.97
C2	0.38	1.45
C3	1.44	1.99
C4	0.01	0.01

R-squared = 0.96; D-W statistics = 1.94.

The price response to demand for wheat as food is negative and statistically non-significant. The results of the model show that when consumer prices of wheat increase by one per cent the corresponding demand for wheat for food use decreases by 0.23 per cent. However, in the case of wheat, consumer prices are not the major driving force determining consumption in the country as wheat is a staple food of Pakistan.

The price of substitutes present in the market also affects the demand of the commodity. Rice substitutes wheat for food use. When consumer prices of rice increase, wheat demand for food use increases but the results are non-significant. The results indicate that a one per cent increase in the rice consumer price, would increase the demand of wheat for food use by 0.38 per cent.

Population elasticity of wheat demand for food is elastic, indicating a one per cent increase in population would result in a 1.44 per cent increase in wheat demand for food. The data shows that the population of the country grew at an average annual growth rate of 2.56 per cent from 1981 to 2000, the corresponding demand of wheat for food use increased by 4.28 per cent. When the population of Pakistan was 84.3 million in 1981, wheat demand for food use was 9,098 thousand tons. In 1991, the population of the country had increased to 110.8 million and the corresponding wheat demand for food had increased to 13,096 thousand tons. The population of the country further increased to 137.5 million by 2000 and the consumption of wheat increased to 23,830 thousand tons.

Wheat demand for food use was positively responsive to per capita income of the country. The demand of wheat for food is income inelastic. A one per cent increase in per capita income of the country would result in a corresponding increase of 0.01 per cent in wheat demand for food.

4.4.2 Wheat demand for feed

Ln WheatFEEDt = D0 + D1 Ln (WheatPCt/SorghumPCt) + D2 Ln EGGProdt + D3 Ln Poultrymeatprodt

Estimation method: OLS

Number of observations: 20 (1981-2000)

PC = consumer price of commodity for feed

Table 4.8 Wheat demand for feed

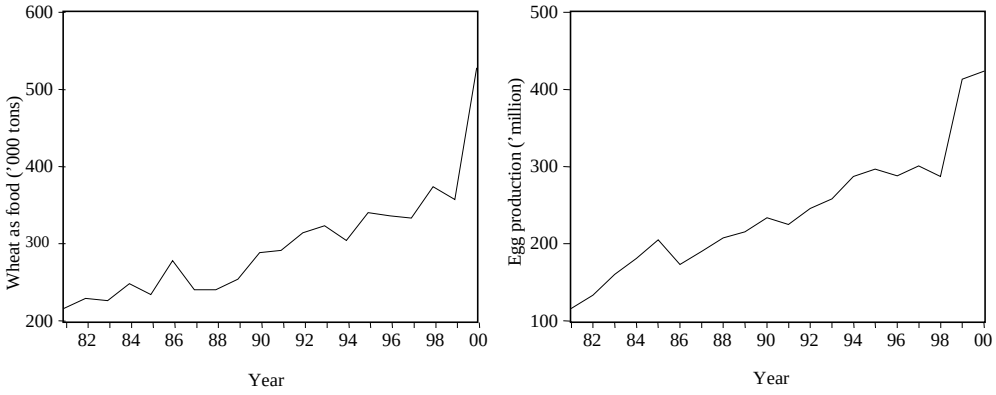
Coefficients	Estimates	t-statistics
D0	-3.039906	-1.212569
D1	-0.081184	-0.539664
D2	0.563652	2.883861
D3	0.010422	0.099239

R^2 = 0.79; Adjusted R^2 = 0.76; D-W statistics = 2.11

The results suggest that wheat demand for feed declines with an increase in relative prices of wheat to sorghum, but coefficient estimates are not statistically significant. The estimates show that when relative prices of wheat with respect to sorghum increase by one per cent, the demand of wheat for feed use declines by 0.08 per cent.

The results show that the main factor influencing demand of wheat for feed is poultry production in the country. The results of the model indicate that an increase in egg production would result in a significant increase in wheat demand for feed. The estimate of egg production is positive and significant. The estimates of coefficient show that a one per cent increase in egg production would lead to a 0.56 per cent increase in wheat demand for feed. Egg production increased at an average annual growth rate of 8.07 per cent and in response to it, the use of wheat as feed increased at a rate of 8.64 per cent in poultry rations during 1981-2000 (Figure 4.1).

Figure 4.1 Yearly wheat (feed) use and egg production



A one per cent increase in poultry meat production was found to have affected a corresponding 0.01 per cent increase in wheat demand for feed. Poultry meat production in Pakistan increased at an average annual growth rate of 10.92 per cent, while wheat used as feed increased by 8.64 per cent.

4.4.3 Wheat demand for other uses

Ln WheatOTHERt = E0 +E1 Ln (WheatFOODt + WheatFEEDt) + E2 Ln Productiont + E3AR(1)
Estimation method: OLS
Number of observations: 20 (1981-2000)

Table 4.9 Wheat demand for other uses

Coefficients	Estimates	t-statistics
E0	-0.618799	-0.328166
E1	0.209575	1.133747
E2	0.592656	2.073205
E3	0.329485	0.840944

R-squared = 0.88; Adjusted R^2 = 0.85; D-W statistics = 2.03.

A one per cent increase in wheat demand for food and feed would result in a corresponding significant increase of 0.21 per cent in wheat demand for other uses such as seed.

A one per cent increase in wheat production would result in corresponding increase of 0.59 per cent in other uses of feed

4.4.4 Imports of wheat

Pakistan has been net importer of wheat for the last twenty years and to balance the domestic need for wheat, imports of wheat, up to 2000, have been a continuous phenomenon.

Wheat it = Io + I1 Ln Wheat Qcit + I2 Ln (Wheat WPt/Wheat PPt) + I3 Ln INC
Estimation method: OLS
Number of observations: 20 (1981-2000)

Where; WP = world price, WP = procurement price, INC=per capita income and QC=total demand

Table 4.10 Imports of wheat

Coefficients	Estimates	t-statistics
Io	-10.583	-0.967
I1	0.875	0.486
I2	1.503	1.942
I3	0.995	1.318

R^2 =0.71; Adjusted R^2 = 0.66; D-W statistics = 1.92

The results show that when wheat demand (total quantity consumed) increases by one per cent, imports of wheat increase by 0.88 per cent, but the coefficient estimates are not statistically significant. The estimate showed that when the relative world price of wheat to the producer price of wheat increased by one per cent, imports of wheat increased by 1.5 per cent. Results also showed that there was no significant affect of per capita income on the import of wheat.

4.4.5 Ending stock

Ln ESt= F0 + F1 Ln CONSUMPTIONt /WheatPCt

Table 4.11 Ending stock of wheat

Coefficients	Estimates	t-statistics
F0	3.486793	0.904547
F1	1.523602	0.590922

The results indicate that when relative consumption of wheat to consumer price increases, the ending stock in the country would increase. The government maintains ending stock to cater for wheat demand to feed the people in the country and to avoid any food crisis.

4.4.6 Maize demand for food

Ln MaizeFOODt = C0 + C1 Ln MaizePCt + C2 Ln WheatPCt + C3 Ln POPt + C4 Ln INCt + C5 AR(1)

Estimation method: OLS

Number of observations: 20 (1980-1999)

PC = consumer price, POP = human population and

INC = per capita income

Table 4.12 Maize demand for food

Coefficients	Estimates	t-statistics
C0	5.76	2.55
C1	-0.06	-0.62
C2	0.19	2.04
C3	1.08	2.06
C4	-0.63	-1.49
C5	0.20	0.69

R^2 = 0.97; Adjusted R^2 = 0.95; D-W statistics = 1.93.

The results of the model show that if the consumer price of maize increases by one per cent the corresponding demand of maize for food use would decrease by 0.06 per cent, which is statistically non-significant. However, maize consumer price is not the major force determining its consumption in the country. The prices of substitutes present in the market, also affect the demand of the commodity. Wheat predominantly substitutes maize for food use. When the consumer price of wheat increases, maize demand for food use significantly increases. The results indicate that a one per cent increase in the wheat consumer price increased the demand of maize for food use by 0.19 per cent. It is the producer itself that mainly consumes maize as

food. Therefore, when the wheat consumer price increases, maize growers shift from wheat to maize.

Population elasticity of maize demand for food is elastic, indicating a one per cent increase in population would result in a 1.08 per cent increase in maize demand for food. The data shows that the population of the country grew at an average annual growth rate of 2.56 per cent from 1981 to 2000, the corresponding demand of maize for food use increased by 2.97 per cent. When the population of Pakistan was 84.3 million in 1981, the maize demand for food use was 530 thousand tons. In 1991, the population of the country had increased to 110.8 million and the corresponding maize demand for food had increased to 701 thousand tons. When the population of the country further increased to 137.5 million, maize food increased to 958 thousand tons in 2000. Maize demand for food use was negatively responsive to per capita income of the country. The demand of maize for food is income inelastic. A one per cent increase in per capita income of the country would result in a corresponding decrease of 0.63 per cent in maize demand for food and the people might shift to a substitute food grain i.e., wheat.

4.4.7 Maize demand for feed

Ln MaizeFEEDt = D0 + D1 Ln (MaizePCt /WheatPCt) + D2 Ln Poultry meat productiont + D3 Ln egg productiont + D4 AR(1)

Estimation method: OLS

Number of observations: 20 (1981-2000)

PC = consumer price of commodity for feed use

Table 4.13 Maize demand for feed

Coefficients	Estimates	t-statistics
D0	-0.633012	-0.231352
D1	-0.092924	-0.610293
D2	0.107478	0.937796
D3	0.366454	1.822847
D4	0.618789	2.612486

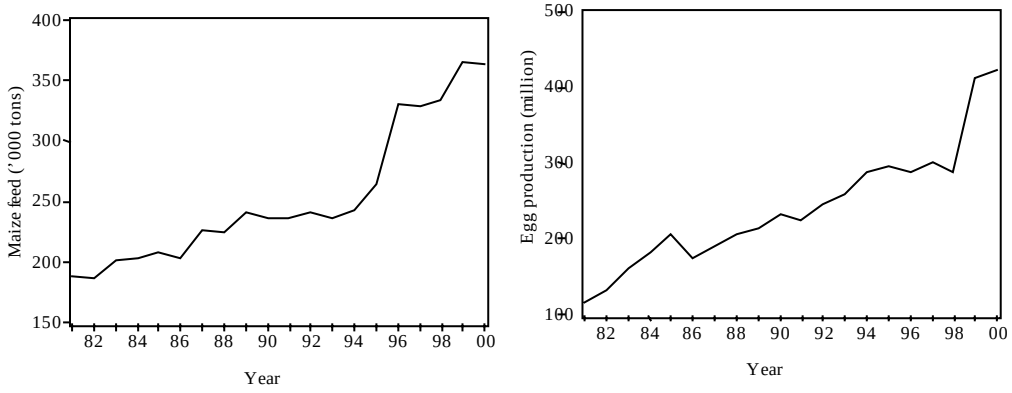
R-squared = 0.91; Adjusted R^2 = 0.88; D-W statistics = 1.54.

The results show that maize demand for feed declines with an increase in prices but coefficients estimated were not statistically significant. The estimates show that when relative prices of maize to wheat increase by one per cent, the demand of maize for feed use declines by 0.09 per cent.

The results show that the main factor influencing demand of maize for feed is poultry production in the country. The estimates of coefficients very well provided a quantitative explanation to the pattern of maize consumption for feed in the country. The results of the model indicate that an increase in poultry meat production results in an increase of maize demand for feed. The estimates of poultry meat production were positive but not significant. The estimates of coefficients show that a one per cent increase in poultry meat production would lead to a 0.11 per cent increase in maize demand for feed. Production of poultry meat has been increasing at an average annual growth rate of 10.92 per cent and in response, feed use of maize has increased.

A one per cent increase in egg production would result in a 0.36 per cent increase in maize demand for feed. Egg production in Pakistan has increased at an average annual growth rate of 7.38 per cent while maize feed use increased at 3.45 per cent in poultry rations during 1981-2000. (Figure 4.2)

Figure 4.2 Yearly maize (feed) use and egg production



4.4.8 Maize demand for other uses

Ln MaizeOTHERt = E0 + E1 Ln (MaizeFOODt + MaizeFEED) + E2 Ln Maize productiont + E3 AR(1)

Estimation method: OLS

Number of observations: 20 (1981-2000)

Table 4.14 Maize demand for other uses

Coefficients	Estimates	t-statistics
E0	-0.084290	-0.671823
E1	-0.283210	-23.45416
E2	1.064339	41.51765

R-squared = 0.99; Adjusted R^2 = 0.97; D-W statistics = 2.44.

A one per cent increase in maize demand for food and feed would result in a corresponding significant decrease of 0.28 per cent in maize demand for other uses. Maize demand for other uses was positively responsive to maize production. As production of maize increased, maize demand for other uses also increased due to the increase in seed requirements. When production of maize increased by one per cent, other uses of maize significantly increased by 1.31 per cent.

4.4.9 Sorghum demand for food

Ln SorghumFOODt = C0 + C1 Ln SorghumPCt/ MilletPCt + C2 Ln INCt + C3 Ln POP + C4 LnT + C5 AR(1)

Estimation method: OLS

Number of observations: 20 (1981-2000)

PC = consumer price, POP = human population and INC = per capita income

Table 4.15 Sorghum demand for food

Coefficients	Estimates	t-statistics
C0	1.109717	0.112905
C1	0.334674	1.930366
C2	0.299954	-1.309158
C3	0.109587	0.049202
C4	-0.000262	-0.004936
C5	-0.547151	-2.288983

R-squared = 0.44; Adjusted R^2= 0.22; D-W statistics = 2.37

As the relative price of sorghum to millet increases, sorghum demand for food use increases. A one per cent increase in the consumer price of sorghum relative to millet would result in a 0.33 per cent increase in sorghum demand for food in the country but the estimate is statistically significant at 10 per cent.

The coefficient of per capita income of the country is negative, indicating that if per capita income increases, the use of sorghum as food would decrease. A one per cent increase in per capita income results in a 0.29 per cent decrease in sorghum demand for food in the country but it is statistically non-significant.

The results indicate that a one per cent increase in population would result in a 0.1 per cent increase in sorghum demand as food.

4.4.10 Sorghum demand for feed

Ln SorghumFEEDt = D0 + D1 Ln (SorghumwsPCt/Wheat PCt) + D2 Ln Milk Productiont + D3 Ln Poultry meat Productiont + D4 LnT + D5 Ln AR(1)

Estimation method: TSLS

Number of observations: 20 (1980-1999)

Table 4.16 Sorghum demand for feed

Coefficients	Estimates	t-statistics
D0	-1.987251	0.446276
D1	-0.104487	-1.020000
D2	0.418957	0.865975
D3	0.142390	2.165265
D4	-0.034958	-1.141170
D5	-0.358413	-1.942742

R-squared = 0.27; D-W statistics = 2.14.

The results show that sorghum demand for feed decreases with an increase in the relative price of sorghum to wheat. The estimates show that when the relative price of sorghum to wheat increases by one per cent, demand of sorghum for feed use decreases by 0.10 per cent. The results show that when milk production in the country increases, sorghum use as feed also increases. The estimates of milk production are positive but non-significant. Results show that a one per cent increase in milk production would lead to a 0.41 per cent increase in sorghum demand for feed.

Sorghum is positively responsive to poultry meat production. As poultry meat production increases, sorghum use as feed increases significantly. A one per cent increase in poultry meat production would lead to a 0.14 per cent increase in sorghum use as feed. The trend variable shows that the trend in feed use of sorghum decreased from 1981 to 2000 but the value was non-significant.

4.4.11 Sorghum demand for other uses

Ln SorghumOTHRt = E0 + E1 Ln (Sorghum Foodt + Sorghum Feedt) + E2 Ln Sorghum productiont

Estimation method: OLS

Number of observations: 20 (1981-2000)

Table 4.17 Sorghum demand for other uses

Coefficients	Estimates	t-statistics
E0	0.342626	0.498090
E1	-0.932105	-2.154500
E2	1.396058	2.934360

R-squared = 0.48; Adjusted R^2= 0.42; D-W statistics = 2.10.

The response of other uses of sorghum to food and feed use was negative. A one per cent increase in sorghum demand for food and would feed result in a corresponding decrease of 0.93 per cent in sorghum demand for other uses and it is statistically significant.

Sorghum demand for other uses is predominantly responsive to sorghum production. The estimate of the coefficient is highly significant. A one per cent increase in sorghum production would result in a corresponding increase of 1.39 per cent in sorghum demand for other uses.

4.4.12 Millet demand for food

Ln MilletFOODt = C0 + C1 Ln MilletPCt + C2 Ln WheatfoodPCt + C3 Ln INCt + C4 Ln POPt + C5 Ln T + C6 AR(1)

Estimation method: OLS
Number of observations: 20 (1981-2000)
PC = consumer price, POP = human population and
INC = per capita income

Table 4.18 Millet demand for food

Coefficients	Estimates	t-statistics
C0	-30.29440	-1.532438
C1	-0.652030	-3.678263
C2	1.893441	4.223438
C3	2.041702	1.471692
C4	2.093254	0.759723
C5	-0.219004	-2.181587
C6	-0.578486	-2.431763

R-squared = 0.76; DW stat=2.13

As millet prices increase, demand for millet for food consumption decreases. A one per cent increase in consumer prices of millet would lead to a 0.65 per cent decrease in millet use as food. The estimate is highly significant.

The major competing crop to millet as food is wheat. As prices of wheat increase, the use of millet as food also increases. A one per cent increase in the consumer price of wheat would lead to a 1.89 per cent increase in the use of millet as food.

The coefficient of per capita income is positive, indicating that if the per capita income of the country increased, millet use as food in the community would decrease. A one per cent increase in per capita income would lead to a 2.04 per cent increase in food use of millet. The coefficient of per capita income is non-significant. A one per cent increase in the population would result in a 2.09 per cent increase in the use of millet as food but the results are non-significant. The trend results show that the trend in food use of millet significantly decreased from 1981 to 2000. The quantitative data of food use of millet shows a similar trend.

4.4.13 Millet demand for feed

Ln MilletFEEDt = D0 + D1 Ln (MilletPCt) + D2 Ln Sorghum productionCt + D3 Ln poultry meat productiont + D4 Ln Egg productiont

Estimation method: OLS
Number of observations: 20 (1980-1999)
PC = consumer price

Table 4.19 Millet demand for feed

Coefficients	Estimates	t-statistics
D0	4.085223	0.832166
D1	-0.345860	-1.951074
D2	0.205641	0.923947
D3	-0.203564	-1.216224
D4	0.184229	0.437612

R-squared = 0.41; D-W statistics = 2.13

As the consumer price of millet increases, demand of millet for feed decreases. A one per cent increase in consumer prices of millet results in a 0.49 per cent decrease in its use as feed.

The major competing crop for feed is sorghum. As prices of sorghum increase, the use of millet as feed increases. A one per cent increase in the consumer price of sorghum leads to a 0.20 per cent increase in feed use of millet.

As poultry meat production increases, the use of millet in feed decreases. A one per cent increase in poultry meat production would result in a 0.20 per cent decrease in millet use as feed. Millet is not commonly used in commercial poultry production, therefore, its inclusion in broiler rations is practiced. Most of the millet is used for lactating animals.

The use of millet as feed is positively but statistically non-significantly responsive to egg production in the country. As egg production increased by one per cent, the use of millet in feed increased by 0.18 per cent. Millet is used mainly in feeding rural poultry and rural poultry contributes a reasonable level to egg production in the country.

4.4.14 Millet demand for other uses

Ln Milletothert = E0 +E1 Ln (MilletFOODt+MilletFEEDt) +E2 Ln Millet Productiont
Estimation method: OLS
Number of observations: 20 (1981-2000)

Table 4.20 Millet demand for other uses

Coefficients	Estimates	t-statistics
E0	-1.480937	-3.013701
E1	10.72367	1.605559
E2	-9.926353	-1.494669

R-squared = 0.82; Adjusted R^2 = 0.80; D-W statistics = 1.82.

Other uses of millet are determined by its food and feed use. A one per cent increase in millet demand for food and feed would result in a corresponding increase of 10.72 per cent in millet demand for other uses.

Millet demand for other uses is negatively responsive to the production of millet. As millet production increases, millet demand for other uses decreases. A one per cent increase in millet production would result in a corresponding decrease of 9.9 per cent in millet demand for other uses.

4.5 Development of products

Wheat, maize, sorghum and millet are used as food and feed, therefore, they are processed for utilization as food and feed. As stated earlier, wheat is milled in the flour mills to obtain flour for human use and wheat bran is produced as a by-product, which is mostly used in livestock but also poultry feeding. Sorghum and millet are used at the village level and no by-products are produced.

Maize is processed in wet milling industries to produce starch to meet the needs of the textile industry in the country. Other products of wet milling industries are liquid glucose and

cooking oil. There are several by-products of the wet milling industries such as maize oil cake, gluten feed 20 per cent and gluten meal 30 and 60 per cent. These products are used in commercial poultry rations and in livestock feeding. There are three wet maize milling industries in the country, namely Rafhan Maize Products Ltd., Fuji Corn Complex and Sethi Corn Processing Industry, however, Rafhan Maize Products is dominant in the wet milling industry by utilizing almost two-thirds of the maize used in wet milling. During the 1980's, about 154 thousand tons of maize grain were used in all three wet milling industries combined. Rafhan Maize Products has established linkages in the market and also with the farmers to purchase the maize grain. The company also provides incentives to the producers and thus plays a very import role in increasing maize production in the country (Amir, 1986). The wet milling industries purchased 225 thousand tons of maize grain in 1999 for processing (Sarwar, 2002). The by-products, such as maize oil cake and gluten feeds, are utilized in commercial poultry feed production and also in livestock production.

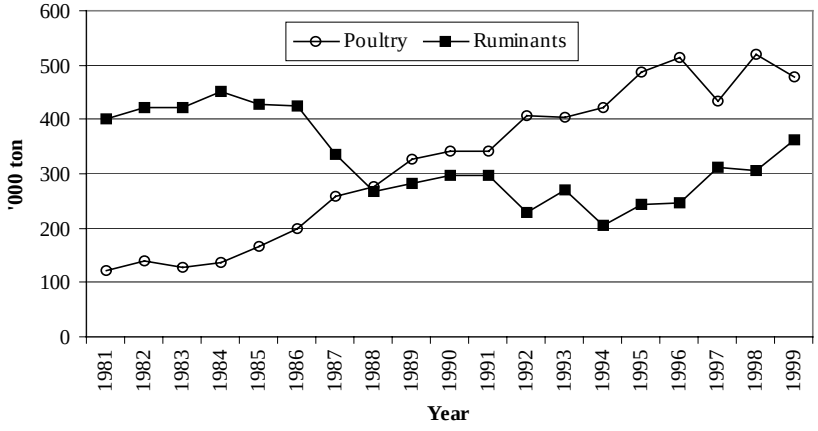
The cereal grains, except millet, are used in poultry feed production and also in livestock feed. The consumption of cereal grains used in commercial poultry rations and in ruminant feeding is presented in Table 4.21.

Table 4.21 Feed consumption in commercial poultry and livestock feeding ('000 tons)

Year	Poultry Feed			Ruminant Feed			Total feed
	Cereal	Other Ingredients	Total	Cereal	Other Ingredients	Total	
1981-85	139	273	412	425	3,566	3,991	4,403
1986-90	280	587	867	321	4,550	4,871	5,738
1991-95	412	901	1,313	249	5,045	5,294	6,607
1996-2000	488	1,046	1,534	342	5,798	6,140	7,674

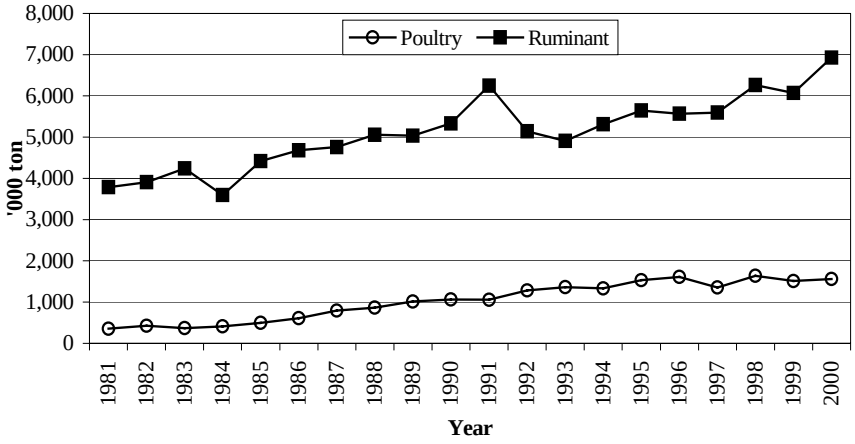
The pattern of total poultry feed consumption during the last twenty years has been shown in the Figures 4.3 and 4.4.

Figure 4.3 Cereal utilization in poultry and ruminant feeding



The contribution of cereals in the total feed consumed ranged between 31-33 per cent, whereas the contribution of all other ingredients was 66-69 per cent. It is worth mentioning here that rice tips are used in commercial poultry feeds, usually up to 25-30 per cent and if it's contribution is included, then the total cereal share rises to 50-55 per cent.

Figure 4.4 Total poultry and ruminant feed use in Pakistan



The total quantity of ingredients used in ruminant feeding largely for dairy animals ranged between 3,991 and 6,140 thousand tons during the last twenty years. The contribution of cereal grains in livestock feeding ranged between 5-11 per cent, whereas the contribution of other feed ingredients was between 89-95 per cent.

A comparison of poultry and livestock feed utilization indicates that out of the total feed consumption during the previous twenty years, 9-20 per cent was consumed as poultry feed, and livestock feed consumed 80-91 per cent. It is summarized that most of the cereal grains were consumed in poultry feed production, whereas all the other ingredients were mainly consumed in livestock feeding. Total livestock output unit and feeding ratio in Pakistan are presented in Table 4.22.

Table 4.22 Livestock output units (LOU) and feeding ration in Pakistan

Year	LOU	Total feed (000t)	Feeding ratio
1981-85	2,106	4,402.7	2.097
1986-90	2,895	5,739	1.986
1991-95	3,830	6,606.9	1.741
1996-2000	4,657	7,668.5	1.646

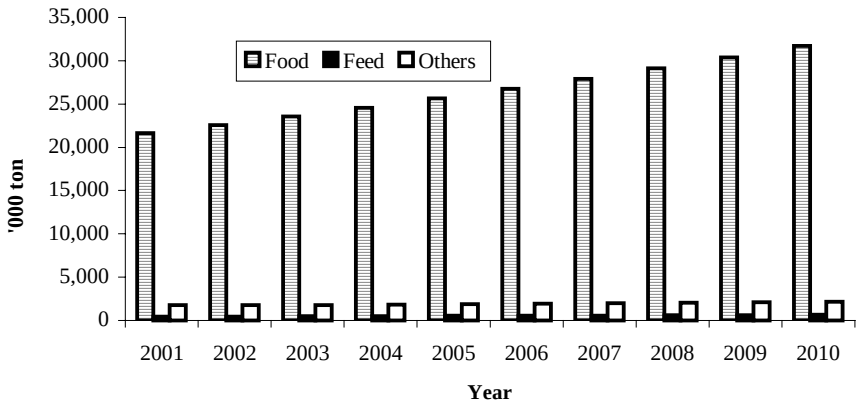
There was a gradual increase in livestock output units (LOU) during the last twenty years. It should be noted here that the total feed consumed does not include green fodder, dry roughages or grazing feed contributions. Feed consumed to LOU ratio was calculated as total feed consumed divided by total LOU. A decreasing trend of feeding ratio was observed during the last twenty years. As per the strict definition of feeding ratio, the less the value of the feeding ratio the better the productivity of livestock is. However, in this case it is not exactly true. Ruminant per unit productivity has not contributed towards increases in total LOU production, this is mainly due to increased numbers of livestock. This is because in Pakistan the ruminants are not only fed on concentrates but they derive their maximum nutrients from grazing green and dry fodder. Contributions of these feed resources have not been taken into account, therefore, the lower feeding ratios cannot be attributed to increased livestock productivity.

4.6 Consumption projections

Projections for wheat, maize, sorghum and millet consumption as food, feed and other uses were made by applying the suggested model. Projected quantities for consumption of wheat, maize, sorghum and millet are presented in the proceeding paragraphs.

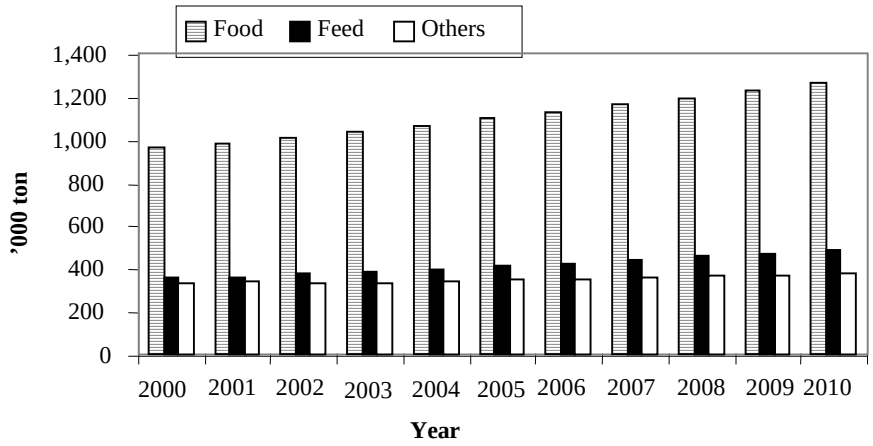
Total consumption of wheat is projected at 28,031 and 34,508 thousand tons for 2005 and 2010 respectively. Consumption of wheat for food, feed and other uses is projected at 25,631, 523 and 1,877 thousand tons in 2005 and 31,699, 654 and 2,155 thousand tons in 2010. The projections for food, feed and other uses were made at a growth rate of 4.23, 4.47 and 2.55 per cent respectively (Figure 4.5).

Figure 4.5 Consumption projections of wheat



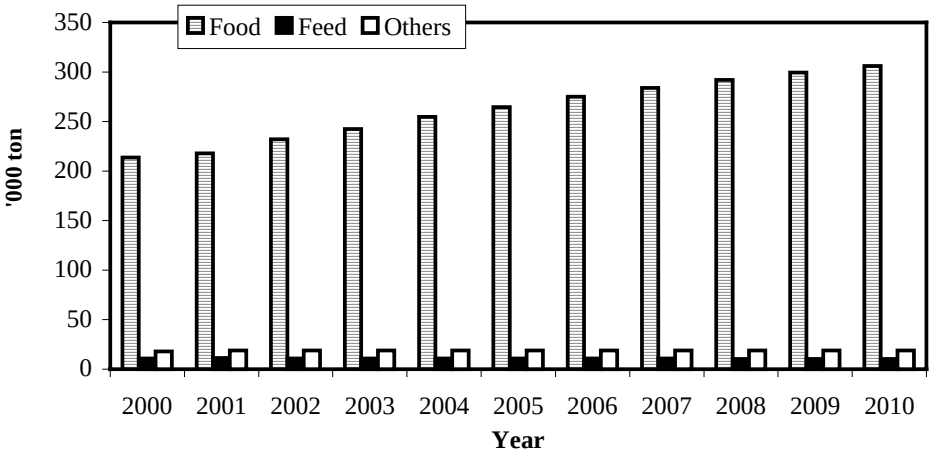
Total consumption of maize is projected at 1,845 and 2,124 thousand tons for 2005 and 2010 respectively. Consumption of maize for food, feed and other uses is projected at 1,096, 405 and 344 thousand tons in 2005 and 1,262, 489 and 373 thousand tons in 2010. The projections for food, feed and other uses were made at a growth rate of 2.78 per cent, 3.34 and 2.4 per cent respectively (Figure 4.6).

Figure 4.6 Consumption projections of maize in Pakistan



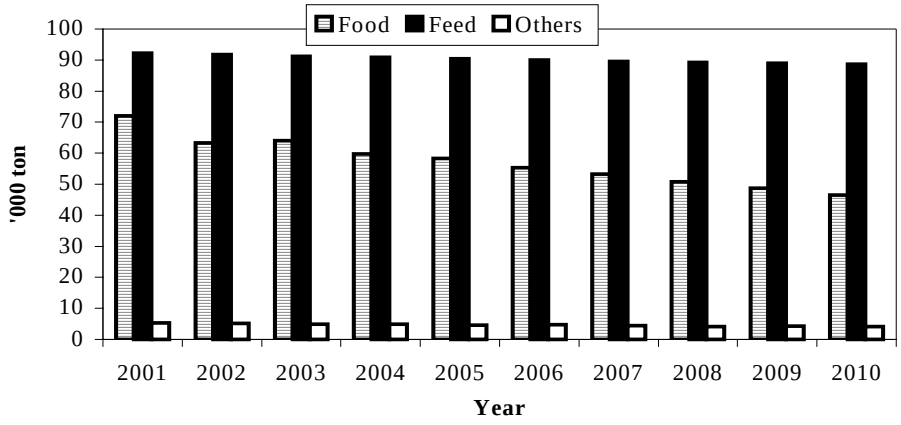
Total consumption of sorghum is projected at 294.7 and 335 thousand tons for 2005 and 2010 respectively. Consumption of sorghum for food, feed and other uses is projected at 265, 10.8 and 18.9 thousand tons in 2005 and 306, 10.5 and 18.9 thousand tons in 2010. The projections for food, feed and other uses were made at a growth rate of 3.77, -0.51 and 0 per cent respectively (Figure 4.7).

Figure 4.7 Consumption projections of sorghum in Pakistan



Total consumption of millet is projected at 153.23 and 139.27 thousand tons for 2005 and 2010 respectively. Consumption of millet for food, feed and other uses is projected at 58.2, 90.4 and 4.6 thousand tons in 2005 and 46.5, 88.7 and 4.0 thousand tons in 2010 respectively (Figure 4.8). The projections for food, feed and other uses were made at growth rates of –3.96, -0.59 and –2.99 per cent respectively.

Figure 4.8 Consumption projections of millet in Pakistan



4.6.1 Projected demand for feed

Projected cereal consumption as feed is derived from the model. The use of cereals and other feed ingredients to produce commercial poultry feed is calculated on the basis of the trend of the previous twenty years (1981-2000). Projected cereal requirements to produce 2,307 and 3,492 thousand tons of poultry feed are 736 and 1,095 thousand tons for 2005 and 2010 (Table 4.23).

Table 4.23 Projected feed consumption for poultry and livestock in 2005 and 2010

Year	Poultry Feed			Ruminant Feed			Total feed
	Cereal	Other Ingredients	Total	Cereal	Other Ingredients	Total	
2000*	495	1,066	1,561	484	6,438	6,922	8,483
2005	736	1,571	2,307	280	7,491	7,771	10,078
2010	1,095	2,397	3,492	147	8,646	8,793	12,285

*Actual

5. Supply of Feedstuffs and Feed Crops

5.1 Production behaviour

5.1.1 Wheat

Wheat is the major crop in Pakistan, it occupies a central position in the agricultural farming system. Its share of total cropped area is about 37 per cent, the largest area under a single crop. It is grown in both irrigated and rainfed areas of Pakistan. About 80 per cent of the total wheat acreage is planted on irrigated land, whereas 20 per cent is grown in rainfed areas (Kisana *et al.*, 2001). The overall production behaviour of wheat is presented in Table 5.1.

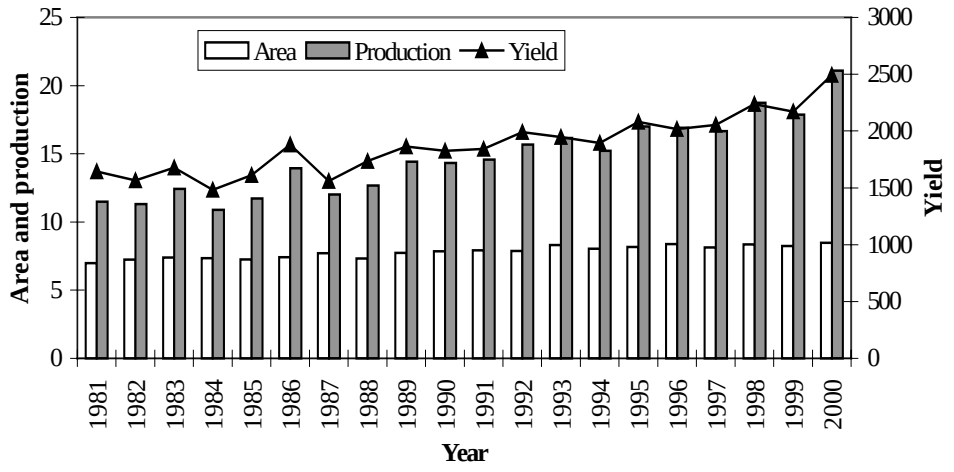
Table 5.1 Production behaviour of wheat (1981-2000)

Parameter	Period				Growth rate (%)
	1981-85	1986-90	1991-95	1996-2000	1981-2000
Area ('000 ha)	7,241	7,598	8,095	8,707	1.15
Yield kg/ha	1,596	1,773	1,950	2,194	2.07
Production ('000 t)	11,556	13,470	15,724	18,238	3.00

Source: Agricultural Statistics of Pakistan, 1999-2000.

The trends of wheat area, yield and production are explained graphically in Figure 5.1.

Figure 5.1 Area, production and yield of wheat in Pakistan



5.1.2 Maize

After wheat and rice, maize is the third most important cereal crop in Pakistan. Maize occupies about 4.8 per cent of total cropped area in the country. Table 5.2 shows the production behaviour of maize in Pakistan from 1981 to 2000.

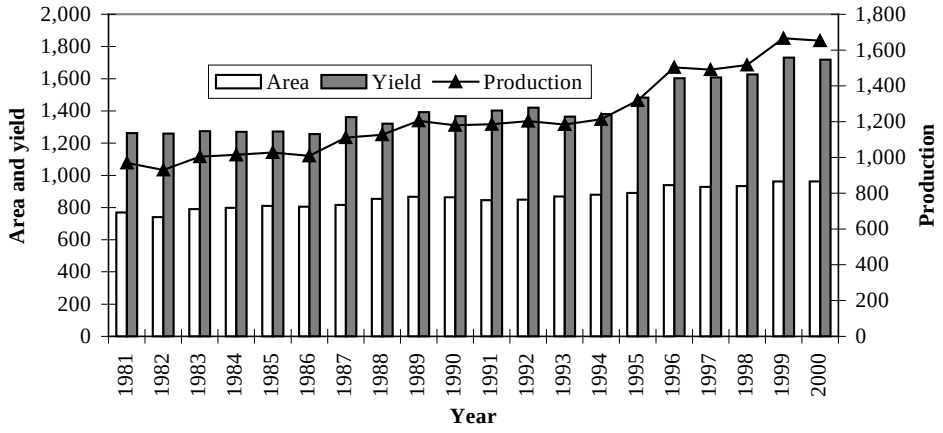
Table 5.2 Production behaviour of maize (1981-2000)

Parameter	Period				Growth rate (%)
	1981-85	1986-90	1991-95	1996-2000	1981-2000
Area ('000 ha)	781	841	866	945	1.22
Yield kg/ha	1,267	1,339	1,410	1,657	1.68
Production ('000 t)	989	1,126	1,221	1,566	2.91

Source: Agricultural Statistics of Pakistan, 1999-2000.

The trends of maize area, production and yield are shown in Figure 5.2.

Figure 5.2 Area, production and yield of maize in Pakistan



Maize production was 970 thousand tons in 1981, increasing to 1,652 thousand tons in 2000. The overall growth rate was 2.91 per cent during the last twenty years.

5.1.3 Sorghum

Sorghum is an important coarse grain crop in Pakistan, especially in rainfed areas where droughts have been commonplace for the last 3-4 years. Despite their economic importance, these crops have received little attention from the government compared to wheat, rice and maize. The production behaviour of sorghum is given in Table 5.3

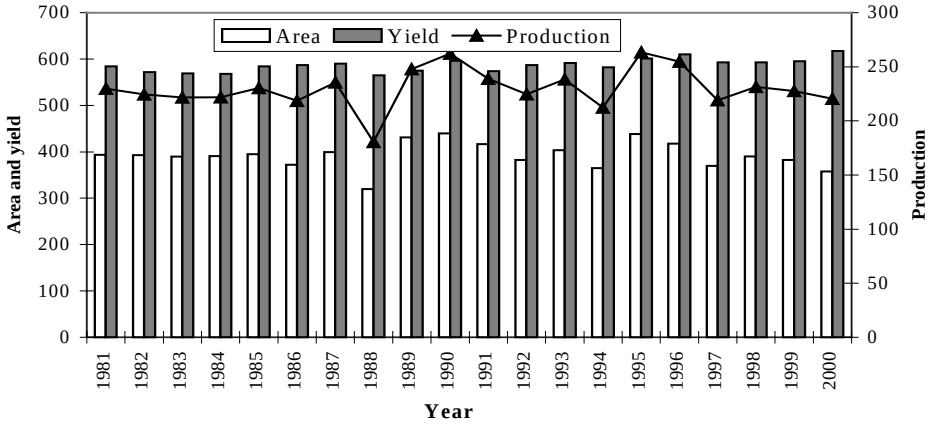
Table 5.3 Production behaviour of sorghum (1981-2000)

Parameter	Period				Growth rate (%)
	1981-85	1986-90	1991-95	1996-2000	1981-2000
Area ('000 ha)	392	393	401	375	-0.05
Yield kg/ha	575	583	587	602	0.28
Production ('000 t)	226	229	235	231	0.22

Source: Agricultural Statistics of Pakistan, 1999-2000.

The trends of sorghum area, yield and production are shown in Figure 5.3.

Figure 5.3 Area, production and yield of sorghum in Pakistan



The negative growth rates in area and production during 1996-2000 can be attributed to the prevailing drought conditions.

5.1.4 Millet

Table 5.4 shows the production behavour of millet in Pakistan from 1981-2000.

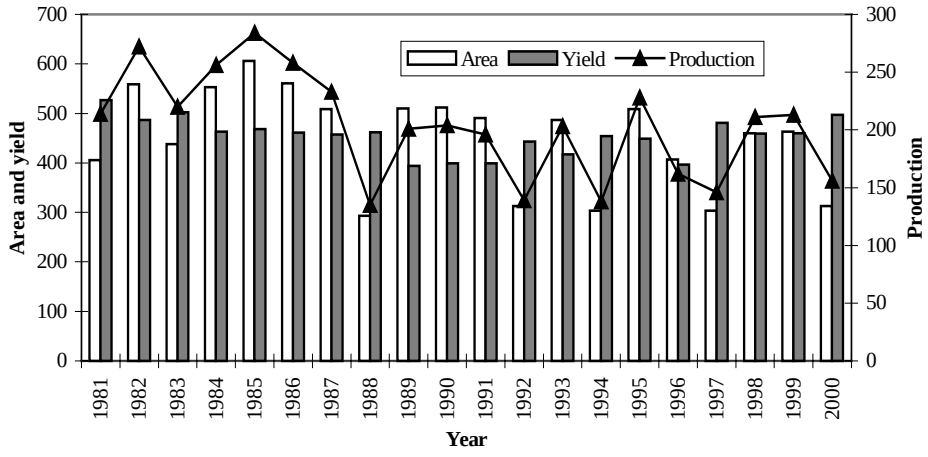
Table 5.4 Production behaviour of millet (1981-2000)

Parameter	Period				Growth rate (%)
	1981-85	1986-90	1991-95	1996-2000	1981-2000
Area ('000 ha)	512	477	421	408	1.73
Yield kg/ha	489	435	432	459	-0.39
Production ('000 t)	249	206	181	178	-2.12

Source: Agricultural Statistics of Pakistan, 1999-2000.

The trends of millet area, yield and production are shown in Figure 5.4.

Figure 5.4 Area, production and yield of millet in Pakistan



5.2 Production structure

The production structure of feed crops such as wheat, maize, sorghum and millet is explained in the proceeding paragraphs in terms of three types of farms i.e. small farms (0.5 to under 2 ha), medium farms (2 ha to under 10 ha) and large farms (10 ha to 60 ha and above).

5.2.1 Production structure of wheat

In 1980, the total number of agricultural farms in Pakistan was 4,069 thousand, increasing to 5,071 thousand in 1990 (Table 5.5). Of these farms, 84 per cent and 82.5 per cent were involved in wheat production in 1980 and 1990 respectively.

Table 5.5 Production structure of wheat (1980 and 1990)

Size of farm	Total farms		Farms under wheat		Production '000 t	
	1980	1990	1980	1990	1988	1990
Small farm (0.5 to 2 ha)	1,386,394	2,404,057	1,098,521	1,927,334	1,050	2,297
Medium farm (2 to 10 ha)	2,308,460	2,321,792	2,008,879	1,978,544	6,247	8,008
Large farm (10 to 60 ha and above)	374,565	345,114	310,309	276,858	3,208	4,171

Source: Pakistan Census of Agriculture 1980 and 1990.

Total production of wheat was 10,505 thousand tons in 1980, increasing to 14,476 thousand in 1990. The contribution to total wheat production was 10, 59 and 31 per cent by small, medium and large farms respectively. However, in 1990, the contribution of small, medium and large farms was 16, 55 and 29 per cent respectively. This showed that the contribution to wheat production by small farms increased from 10 to 16 per cent but the contribution of medium and large farms decreased from 59 to 55 and 31 to 29 per cent respectively from 1980 to 1990.

5.2.2 Production structure of maize

The total number of farms involved in maize production was 828 thousand in 1980, increasing to 1,067 thousand by 1990 (Table 5.6). These farms represent 20 and 21 per cent of the total agricultural farms in Pakistan.

Table 5.6 Production structure of maize (1980 and 1990)

Size of farm	Total farms		Farms under maize		Production '000 t	
	1980	1990	1980	1990	1980	1990
Small farm (0.5 to 2 ha)	1,386,394	2,404,057	381,841	679,542	209	450
Medium farm (2 to 10 ha)	2,308,460	2,321,792	399,580	350,852	372	519
Large farm (10 to 60 ha and above)	374,565	345,114	46,518	36,680	98	135

Source: Pakistan Census of Agriculture 1980 and 1990.

The total production of maize was 679 thousand tons in 1980, increasing to 1,104 thousand tons in 1990. The contribution to total maize production by small, medium and large farms was 31, 55 and 14 per cent respectively. From 1980 to 1990, the share of maize production by small farms increased from 31 to 41 per cent whereas the contribution of medium and large farms decreased from 55 to 47 per cent and 14 to 12 per cent respectively.

5.2.3 Production structure of sorghum

The cultivated area under sorghum was 384 thousand hectares in 1980, increasing to 450 thousand hectares in 1990 (Table 5.7). Total sorghum production was 223 thousand tons in 1980, increasing to 268 thousand tons in 1990.

Table 5.7 Production structure of sorghum (1980 and 1990)

Size of farm	Area under sorghum		Production ('000 tons)	
	1980	1990	1980	1990
Small farms (0.5 to under 2 ha)	26,379	46,124	15	27
Medium farms (2.0 to under 10 ha)	183,627	238,929	108	142
Large farms (10 to 60 ha and above)	173,867	165,328	101	99

Source: Pakistan Census of Agriculture 1980 and 1990.

The contribution of small and medium farms to sorghum production increased from 7 to 10 per cent and from 48 to 53 per cent, whereas the contribution of large farms decreased from 45 to 36 per cent.

5.2.4 Production structure of millet

The total area under millet cultivation was 399 thousand hectares in 1980, increasing to 469 thousand hectares in 1990 (Table 5.8).

Table 5.8 Production structure of millet (1980 and 1990)

Size of farm	Area under millet		Production ('000 tons)	
	1980	1990	1980	1990
Small farms (0.5 to under 2 ha)	27,456	48,006	14	21
Medium farms (2.0 to under 10 ha)	191,121	248,682	101	108
Large farms (10 to 60 ha and above)	180,964	172,077	95	75

Source: Pakistan Census of Agriculture 1980 and 1990.

Millet production was 210 thousand tons in 1980 and 204 thousand in 1990. In 1980, the contribution to total millet production by small, medium and large farms was 10, 48 and 45 per cent respectively, whereas in 1990 this contribution was 10, 52 and 37 per cent. This indicates that the medium farms produced more millet in 1990 compared to 1980.

5.3 Producer price behaviour

A continuous increasing trend was observed for producer prices of wheat, maize, sorghum and millet during the last twenty years. The producer prices of feed crops are given in Table 5.9.

Table 5.9 Producer prices of different feed crops (RS/ton)

Period	Wheat	Maize	Sorghum	Millet
1981-85	1,570	2,110	1,480	1,571
1986-90	2,118	2,720	2,316	1,876
1991-95	3,495	4,761	3,300	2,300
1996-00	6,600	7,930	4,706	2,814
Overall annual growth rate (%)	9.40	8.92	7.72	3.95

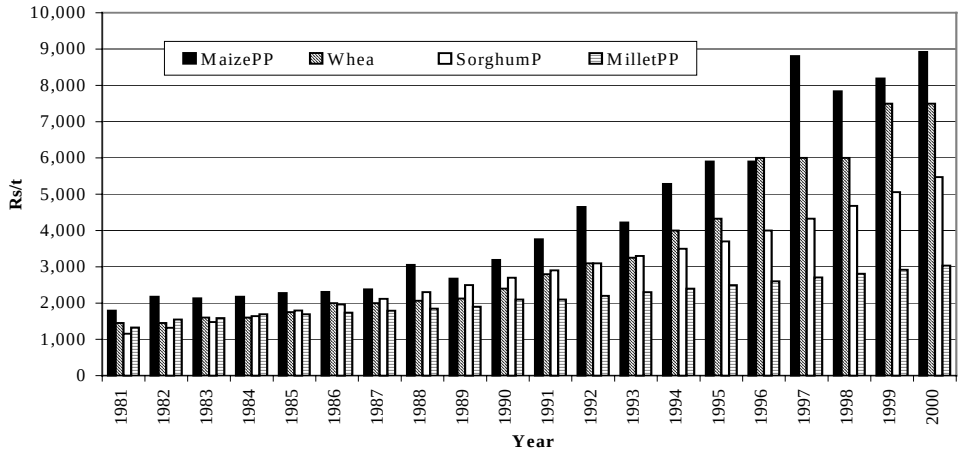
Wheat PP = Procurement or support price announced by government. (Agricultural Statistics of Pakistan, various issues)

Maize PP = Wholesale price 2 months after harvest (Agricultural Statistics of Pakistan, various issues)

Sorghum PP and Millet PP = FAO agro-statistic database

The producer prices of wheat were taken as the procurement/support price announced by the government before sowing the wheat crop. The trends in producer price behaviour of wheat, maize, sorghum and millet during the last twenty years are shown in the Figure 5.5.

Figure 5.5 Producer price behaviour of cereal crops in Pakistan



The overall growth rate of the producer price of wheat was 9.40 per cent during the last twenty years.

Maize producer prices were taken wholesale two months after harvesting. The producer price of maize linearly increased with an overall growth rate of 8.92 per cent during the last twenty years.

The producer prices of sorghum were taken from the FAO database. The producer price of sorghum was Rs 1,160/ton in 1981, increasing to Rs 5,469/ton in 2000. The overall growth rate of the producer price of sorghum was 7.72 per cent during the last twenty years.

Producer prices of millet were also taken from the FAO database. The overall growth rate of the millet producer price was 3.95 per cent during the last twenty years. The producer prices of maize were highest followed by wheat, sorghum and millet.

5.4 Production response to market forces

Supply/production of any commodity is determined by the commodity's own prices, the prices of competing commodities, prices of the inputs and technological developments.

5.4.1 Wheat acreage function

Ln WheatAHt = A0 +A1 Ln (WheatPPt-1) +A2 Ln (SugarCanePPt-1) +A3 Ln WheatAHt-1
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; AH = area harvested and PP = producer price of the commodity

Table 5.10 Wheat acreage function

Coefficients	Estimates	t-statistics
A0	13.11	8.35
A1	0.31	5.00
A2	-0.15	-2.08
A3	-0.63	-3.24

R-squared = 0.86; Adjusted R^2 = 0.83; D-W statistics = 1.98.

Results of the acreage function of wheat show that as the producer price of wheat increases by one per cent, the area increases by 0.31 per cent. The producer price of wheat increased during the last twenty years with an annual growth rate of 9.4 per cent. The wheat price in 1981 was Rs 1,450/ton, which increased to Rs 7,500/ton in 2000. In response to the wheat producer price, the area under wheat increased at a growth rate of 1.15 per cent per annum during the last twenty years. For example in 1999, the producer price of wheat increased from Rs 6,500/ton to Rs 7,500/ton. Simultaneously, the area under crop production also increased from 8,230 thousand hectares to 8,463 thousand hectares and a bumper production of wheat was obtained (21,081 thousand tons). This shows that an increase in the producer price of wheat was the main incentive to wheat farmers for enhanced area allocation for wheat and ultimately wheat production.

Another market force that determines the supply of a product is the price of related commodities (substitutes). The cropped area under wheat is observed to be negatively responsive to the price of the competing crop i.e., sugarcane. The response to the price of sugarcane is negative but statistically significant. As the producer price of sugarcane increases by one per cent, the area under wheat decreases by 0.15 per cent. Results of the area function indicate that when the sugarcane producer price increases, it encourages farmers to shift some land from wheat to sugarcane.

The results of the acreage function show that the area under wheat has a negative response to that of the previous year's area of wheat. A one per cent increase in the previous year's area of wheat would reduce the following year's area by 0.63 per cent. This shows that wheat's cultivated area does not increase due to previous trends (not a continuous increase in area) but increases in the area are due to increases in the producer price of wheat in Pakistan. Thus, the increase in wheat harvested area was more responsive to the price mechanism.

It may be summarized that the producer price of wheat plays a significant role when making the decision to allocate the amount of land for wheat cultivation.

5.4.2 Wheat yield function

Ln WheatYieldt = B0 +B1 Ln (WheatPPt) +B2 Ln (UreaPCt-1) + B3 WheatYeildt-1 + B4 Ln T
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; PP =producer price and PC = consumer price

Table 5.11 Wheat yield function

Coefficients	Estimates	t-statistics
B0	10.01	4.77
B1	0.04	0.38
B2	-0.009	-0.068
B3	-0.39	-1.43
B4	0.026	1.94

R-squared = 0.86; Adjusted R^2 = 0.82; D-W statistics = 2.22.

The results show that the yield of wheat is not significantly responsive to the wheat producer price. As the price of wheat increases by one per cent, the yield of wheat increases by only 0.04 per cent.

The yield of wheat responds negatively to the price of urea. The results indicate that when the price of urea increases, the farmers limit the use of urea in the field, however, they also show that the price of urea did not significantly decrease. When the price of urea increases by one per cent, wheat yield decreases by only 0.009 per cent.

The yield of wheat is negatively responsive to the yield of its previous year. With a one per cent increase in yield of the previous year, the yield of wheat decreases by 0.39 per cent the following year. The decrease in yield is non-significant. This decrease in yield is due to year-to-year variations. Perhaps technological factors are not strong enough for continuous yield increases but there are other factors such as soil moisture at the time of sowing, vacation of area by the previous crop, price of substituting crop and previous year's price of wheat. However, trend of wheat yield was positive and significant during the last 20 years. In 2000, the yield of wheat was at a maximum i.e., 2,491 kg/ha and the wheat crop was a bumper crop bringing the total production to 21,081 thousand tons. This may be due to improved wheat production technologies, including high yielding varieties (Shakhar-95, Vandanak-95 SR-95, Kohsar, 95, Drawar-96, Bakhtawar-95 and Kiran-96, Wkaak-98, Iqbal, 99 Mangla-97, Takbeer-99 and Bahawalpur, 97), greater use of inputs i.e. fertilizer, improved seed and irrigation, water supply and the government policy factors (Economic Survey, 2000-2001).

5.4.3 Maize acreage function

Ln MaizeAHt = A0 +A1 Ln (MaizePPt-1) +A2 Ln (SugarCanePPt) +A3 Ln MaizeAHt-1
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; AH = area harvested, PP = producer price

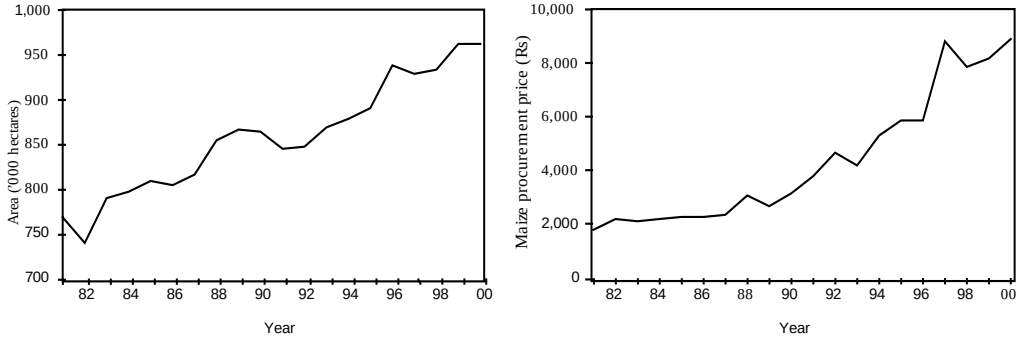
Table 5.12 Maize acreage function

Coefficients	Estimates	t-statistics
A0	2.201367	1.875999
A1	0.108685	1.940970
A2	-0.060637	-0.890541
A3	0.597203	3.002416

R-squared = 0.92; Adjusted R^2 = 0.90; D-W statistics = 2.02.

Increases in the producer price of maize by one per cent result in a corresponding increase of 0.11 per cent in maize cultivated area. The average producer price of maize was Rs 1,790/ton in 1981 and Rs 8,920/ton in 2000. In response to price, the area under maize increased from 769 thousand hectares in 1981 to 962 thousand hectares in 2000 at an annual growth rate of 1.22 per cent per annum during the last twenty years (Figure 5.6).

Figure 5.6 Area under maize cultivation and maize procurement price



In Pakistan, maize is cultivated in two seasons. In rainfed areas, it is sown during June-July and in irrigated areas it is sown as Zaid Rabi during February and March. Sugarcane is also sown during the same period i.e. February and September. Therefore, sugarcane can compete with maize in terms of cultivated area. However, the results show that sugarcane would not significantly compete with maize mainly due to the price factor, as the co-efficient for the variable of sugarcane producer price is negative and statistically non-significant. The growth in area under maize is positive and highly significant, indicating that area under maize cultivation is positively responsive to better technological factors. A one per cent increase in the previous year's area under maize results in a corresponding increase of 0.59 per cent in the next year's area under maize.

5.4.4 Maize yield function

Ln MaizeYieldt = B0 +B1 Ln MaizePPt-1 + B2 UreaPCt-1 +B3 Ln MaizeYieldt-1
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; PP = producer price, PC = consumer price

Table 5.13 Maize yield function

Coefficients	Estimates	t-statistics
B0	3.189208	2.920748
B1	0.122185	2.160395
B2	-0.009806	-0.161501
B3	0.432759	2.270878

R-squared = 0.93; Adjusted R^2 = 0.92; D-W statistics = 1.95.

Yield was found to be responsive to the producer price of maize. When the producer price of maize increased by one per cent, yield increased by 0.12 per cent. The producer price of maize increased during the last twenty years (1981-2000) at a rate of 8.92 per cent. Maize yield was 1,262 kg/ha when the producer price was Rs 1,790/ton in 1981. In 1998, when the producer price of maize increased to Rs 3,758/ton, the yield increased to 1,400 kg/ha. Similarly, when the price of maize increased to Rs 8,920/ton, the yield of maize increased to 1,718 kg/ha in 2000. Therefore, it can be said that when the yield of maize increased, ultimately, production of maize also increased.

The results of the model also indicate that when the price of urea increases the producers reduce their use of fertilizer (urea) in maize production. However, urea price does not significantly affect maize yield. A one per cent increase in urea price decreases the yield of maize by only 0.009 per cent.

Results of the model show that a one per cent increases in the previous year's yield would result in a significant 0.43 per cent increase in yield of the following year. It might also be due to the inclusion of new high yielding varieties of maize. The yield of maize in previous years has significantly increased due to technological improvements. The previous 20 years' trend of maize yield also shows continuous increases in yield. Very little variation exists in year-to-year yield.

5.4.5 Sorghum acreage function

Ln SorghumAHt = A0 +A1 Ln (SorghumPPt-1) +A2 Ln (MilletPPt-1) +A3 Ln SorghumAHt-1
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; AH = area harvested, PP = producer price

Table 5.14 Sorghum acreage function

Coefficients	Estimates	t-statistics
A0	7.537991	2.758406
A1	0.109834	0.334489
A2	-0.225181	-0.350624
A3	-1.119709	-4.182830

R-squared = 0.55; Adjusted R^2 = 0.46; D-W statistics = 1.99.

The results reveal that the area under sorghum is not significantly responsive to the producer prices of sorghum. Increases in the sorghum producer price by one per cent result in an increase of 0.1 per cent in sorghum cultivated area.

Millet was the only competing crop in area allocation for sorghum. The cropped area of sorghum was not found to be significantly responsive to the price of the competing crop i.e. millet. An increase in the producer price of millet by one per cent would result in a corresponding reduction of 0.22 per cent in sorghum cultivated area.

The sorghum cropped area was mainly determined by the previous year's area. Under this crop, a one per cent increase in the previous year's area would result in a highly significant decrease of 1.11 per cent in the next year's sorghum cultivated area. Data from the last twenty years (1981-2000) shows a declining trend in sorghum cultivated area. Sorghum area in 1981 was 393 thousand hectares and in 2000 the area had decreased to 357 thousand hectares. The area decreased at a rate of 0.24 per cent per annum.

5.4.6 Sorghum yield function

Ln SorghumYieldt = B0 +B1 Ln (UreaPCt-1/SorghumPPt-1) +B2 Ln SorghumYieldt-1 + B3 Ln T
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; PP = producer price, PC = consumer price

Table 5.15 Sorghum yield function

Coefficients	Estimates	t-statistics
B0	6.654771	3.741912
B1	-0.009591	-0.345084
B2	-0.053107	-0.192380
B3	0.003261	3.114642

R-squared = 0.57; Adjusted R^2: 0.48; D-W statistics = 1.98.

Results show that the relative consumer price of urea to the producer price of sorghum does not produce any significant effects on the yield of sorghum. When the relative consumer price of urea increases by one per cent compared to the producer price of sorghum, yield decreases by 0.009 per cent.

The yield of sorghum was also not responsive to the previous year's yield of the crop. A one per cent increase in the yield of the previous year's sorghum would result in a 0.053 per cent decrease in the following year's yield.

The yield of sorghum significantly increased over the last twenty years. In 1981, sorghum yield was 584 kg/ha and in 2000 it had increased to 617 kg/ha.

5.4.7 Millet acreage function

Ln MilletAHt = A0 +A1 Ln (MilletPPt-1) +A2 Ln (SorghumPPt-1) +A3 Ln MilletAHt-1 + A4 Ln T
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; AH = area harvested, PP = producer price

Table 5.16 Millet acreage function

Coefficients	Estimates	t-statistics
A0	-3.003827	-0.186036
A1	1.715006	0.830225
A2	-0.093580	-0.069816
A3	-1.388225	-5.432415
A4	-0.087787	-0.702614

R-squared = 0.69; D-W statistics = 2.22.

The results reveal that the area under millet is positive and significantly responsive to producer prices of millet. A one per cent increase in the producer price would result in an increase of 1.71 per cent in millet cultivated area. However, this increase is non-significant. The cropped area for millet is also not responsive to the price of the competing or substitute crop (sorghum). The coefficient for this variable is negative and statistically non-significant. An increase in the producer price of sorghum by one per cent would result in a corresponding decrease of 0.09 per cent in millet growing area. Millet area is mainly determined by the previous year's area. A one per cent increase in the previous year's area under millet would result in a corresponding decrease of 1.38 per cent in the following year's area of millet cultivation. This decrease is significant. The results were also confirmed by the previous 20 years' (1981-2000) quantitative data. This shows high unsustainability in the area of millet. The trend indicates that the area under millet linearly decreased. The overall area of millet decreased at a rate of 1.43 per cent per annum.

5.4.8 Millet yield function

Ln MilletYieldt = B0 +B1 Ln(MilletPPt-1) + B2 Ln (UreaPCt) + B3 MilletYieldt-1 + B4 Trend + B5AR(1)
Estimation method: OLS
Number of observations: 20 (1981-2000)
Where; PP = producer price, PC = consumer price

Table 5.17 Millet yield function

Coefficients	Estimates	t-statistics
B0	-8.697084	-1.600614
B1	1.679387	1.960075
B2	-0.118273	-0.654434
B3	-0.427445	-1.942213
B4	-0.053444	-1.739288
B5	-0.609193	-2.241430

R-squared = 0.56; D-W statistics = 2.33

The results show that there can be a significant increase in millet yield by increasing the producer price of millet. As the producer price of millet increases, the yield of millet increases significantly. A one per cent increase in the producer price of millet would increase the yield of millet by 1.68 per cent.

When the urea price increases by one per cent, millet yield decreases by 0.11 per cent but is non-significant. Urea price had little affect on the yield of millet. The yield of millet is significantly but negatively responsive to the previous year's yield. A one per cent increase in the previous year's yield would result in a 0.42 per cent decrease the following year. The trend data also shows that there is year-to-year variation in the yield of the millet crop. The relative data indicates that during the past twenty years the trend in yield decreased from 489 kg/ha in 1981 to 459 kg/ha 2000. This decrease was at a rate of 0.39 per cent per annum.

5.5 Development of production technology

The efficient use of key inputs, a proper economic environment and research and development play an important role in raising the productivity of crops and improving farm incomes. If all the factors are organized properly and weather also remains favorable, rapid agricultural development can take place in the country. Production technologies in the development of agriculture are:

1) High yielding varietal development.
2) Efficient use of inputs.
3) Mechanization.
4) Plant protection.

5.5.1 Varieties

Wheat

Seven new varieties were introduced in 1996, namely Shahkan-95, Vandanak-95, SR-95, Kohsar 1995, Drawar-96, Bakhtawar-95 and Kiran-96. Due to these varieties, the yield of wheat increased from 2,018 kg/ha in 1995/1996 to 2,053 kg/ha in 1996/1997 (Economic Survey, 1996/1997, Kisana, 2002). Research efforts are being made for development through hybridization and breeding for desirable characteristics. In National Uniform Yield Trials (NUYT) 73, individual sets of the varieties were distributed by NARC to coordinated units located in different agro-ecological zones. This resulted in the development of 5 new wheat varieties for commercial cultivation namely, Ukaab-98, Iqbal-99, Mangla-97, Takbeer-99 and Bahawalpur-97.

Maize

High yielding maize varieties released during 1984-96 were Sarhad White, Kissan, Azam, Pahari, Sultan, Golden Agaiti-85, Gauher and Kashmir Gold. Commercial maize hybrids have also been made available in the market by private companies. The main suppliers of the hybrids are Cargill, ICI, Pioneer and Lasani/Sandoz. The National Agricultural Research Centre is also involved in the development of maize hybrids with the potential to produce 12 tons of grain/ha (Malik, 1998 and Aslam, 2001).

Some high yielding varieties of sorghum and millet have been identified. These include Sorghum: Pak SS-11, NES-1747, IC-1039, Mr-839, BR-123, Jowar-96, Giza-3, Red Janpur, Bagdar, PARC SS-1, PARC SS-2. Millet: 18-BY, Y-84, Cholistani Bajra, Barani Bajra, DBR-3, DB-5, C-47 PARC MC-1 and PARC-MS-2 (Aslam, 2001).

Fertilizer

Fertilizer is one of the key inputs to agricultural production. Fertilizer is estimated to contribute half of the targeted increase in production. In 1980-81 the off take of fertilizers was 1,079 thousand N/ton, increasing to 2,833 thousand N/ton in 2002 (Economic Survey, 2000-2001). The amount of fertilizer used for wheat in 1980-1981 was 518.62 thousand tons (74 kg/ha) and this increased to 908.59 thousand tons in 1990-1991 (114.79 kg/ha). The official fertilizer use figures for maize are not specifically recorded by the agricultural statistics services. However, a survey conducted in 1995 by PARC/CIMMYT in various districts of NWFP and in central Punjab revealed that approximately 66 per cent of all the maize growers now use chemical fertilizers (70 kgN/ha and 18 kgP/ha).

According to the Census of Agriculture of Pakistan 1980, 31 per cent of farms utilized both chemical fertilizer and manure, 40 per cent of farms used only chemical fertilizer and only 9 per cent used just manure. According to the 1990 Census of Agriculture, 28 per cent of all farms used chemical fertilizers and manure, 49 per cent of the farms used chemical fertilizers

only and 6 per cent used manure only. The number of farms using chemical fertilizers increased during this period (Census of Agriculture, 1980 and 1990).

Table 5.18 Percentage of farms that utilize fertilizer

Fertilizer utilization	1980	1990
Chemical fertilizer and manure	31	28
Chemical fertilizer only	40	49
Manure only	9	6
Not utilized	20	17

Improved seeds

Seeds play a pivotal role in boosting agricultural production, especially in market oriented and subsistence farming systems. Hence, authentic purity during the flow of seeds from plant breeders to the farming community is essential for assured productivity per unit area.

In Pakistan, the Federal Seed Certificate and Registration Department regulates the quality of seeds from breeders to be declared as certified seeds. In accomplishing this task, the department registers crop varieties for certified seed production and inspects the standing crop in order to assess the genetic purity, off-type plants, weeds and diseases in the field. There are about 328 private sector companies, including 5 multinational companies, engaged in seed production of wheat, cotton and maize and marketing in the country. However, their contribution in the total seed production is not significant. With the active participation of the private sector, a total of 143 seed processing units have been working with a total investment of Rs 818.7 million. In 2000, total improved seed production was 74,000 tons, of which 67,000 tons of wheat seed was distributed to the farming community.

Mechanization

Mechanization of agriculture has played an important role in increasing agricultural production. Mechanization of agriculture is crucial for achieving self-sufficiency and surpluses in food production through increasing productivity and reducing pre and post harvest losses. For the introduction of the latest technology in the agricultural production system, the government allowed the import of agricultural machinery (not manufactured locally) at 10 per cent custom duty ad-valorem. It has been used on a large-scale for the introduction of agricultural modernization in the country. According to an estimate in 1981, the total production of tractors was 16,137, increasing to 35,038 by 2000 (Agricultural Statistics of Pakistan, 1988-1989 and 1999-2000). Mechanization has been widely adopted in Pakistan for wheat in the form of tractors, roatavators, combined harvesters, etc. Now more than 80 per cent of maize farmers in both irrigated and rainfed areas are using mechanical shellers.

Plant protection

The adoption of plant protection measures helps to increase per hectare yield by protecting the crop from damage through disease. It is estimated that pests and pathogens reduce agricultural production by about 25 per cent. The excessive use of pesticides may also be a health hazard by killing useful insects and predators. Therefore, efforts were made to popularize Integrated Pest Management (IPM) techniques among the farmers in order to prevent the indiscriminate use of insecticides. The government is trying to popularize the use of pheromones to control harmful insects. The pheromones are environmentally friendly and safe for other useful insects and predators.

In 1980, insecticides were used on only 4 per cent of farms in Pakistan, while in 1990 the use of insecticides increased to 25 per cent of farms (Census of Agriculture, 1980 and 1990).

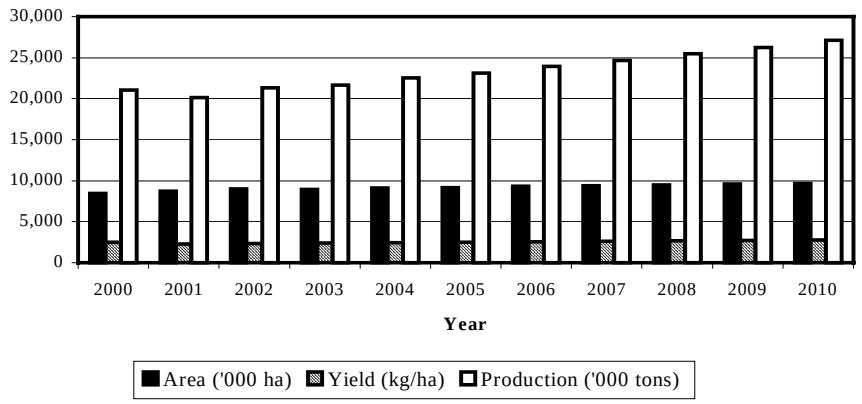
5.6 Production projections

The projections of area, yield, production and domestic consumption of wheat, maize, sorghum and millet were made using the suggested model.

5.6.1 Projections of wheat

Projections of area of cultivation, yield and production of wheat are presented in Figure 5.7.

Figure 5.7 Projections of wheat



Source: Author's calculation.

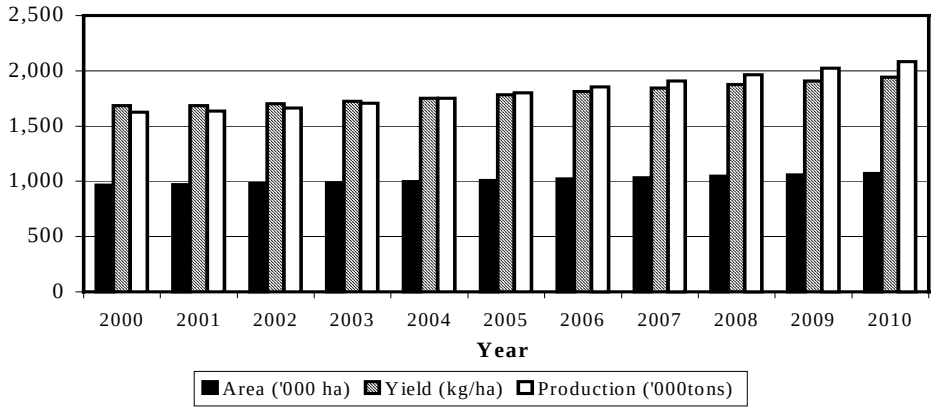
The area under wheat cultivation was 8,463 thousand hectares in 2000. It is projected to be 9,177 and 9,680 thousand hectares for 2005 and 2010 respectively. A 0.96 per cent growth rate was used to project wheat area for cultivation. The yield of wheat is projected to be 2,520 kg/ha and 2,790 kg/ha for 2005 and 2010 respectively. The projection was made from a growth rate of 2.06 per cent. The projections of wheat production for 2005 and 2010 are 23,123 and 27,097 thousand tons respectively, using a growth rate of 3.03 per cent. Wheat production is projected to increase by 35 per cent between 2001 and 2010. This projected value of wheat production is almost in agreement with FAO (2000) projections of wheat production for the year 2010 i.e., 26,400 thousand tons with growth rate of 2.93 per cent for Pakistan.

5.6.2 Projections of maize

Projections of area, yield and production of maize are presented in Figure 5.8.

The area under maize was 967 thousand hectares in 2000. It is projected to be 1,010 and 1,072 thousand hectares for 2005 and 2010 respectively, using a 1.08 per cent growth rate to predict the maize area under cultivation. The yield of maize is projected to be 1,783 and 1,942 kg/ha for 2005 and 2010 respectively. The projection was made assuming a growth rate of 1.51 per cent. The projections of maize production for 2005 and 2010 are 1,801 and 2,083 thousand tons respectively (growth rate 2.60 per cent). Maize production is projected to increase by 27 per cent between 2001 and 2010.

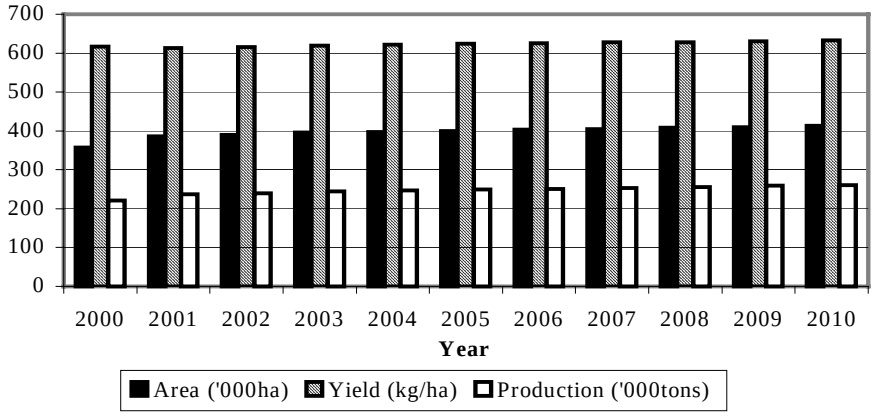
Figure 5.8 Projections of maize



5.6.3 Projections of sorghum

Projections of area, yield and production of sorghum are presented in Figure 5.9.

Figure 5.9 Projections of sorghum

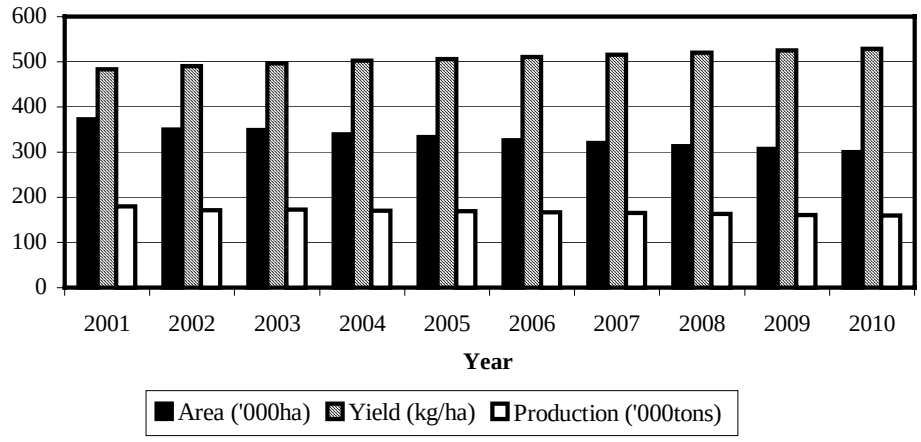


The area under sorghum is projected to be 400 and 413 thousand hectares for 2005 and 2010 respectively (0.163 per cent growth rate). The yield of sorghum is projected at 624 kg/ha 633 kg/ha for 2005 and 2010 (growth rate of 0.36 per cent). The projections of sorghum production for 2005 and 2010 are 249 and 261 thousand tons (growth rate of 0.34 per cent).

5.6.4 Projections of millet

Projections of area, yield and production of millet are presented in Figure 5.10.

Figure 5.10 Projections of millet



The cultivated area of millet is projected at 333 and 300 thousand hectares in 2005 and 2010 respectively (–1.79 per cent growth). The yield of millet is projected to be 506 and 529 kg/ha for 2005 and 2010 (growth rate of 1.04 per cent). The projections of millet production for 2005 and 2010 are 169 and 159 thousand tons respectively (–0.75 per cent growth).

6. Measures for Closing the Supply and Demand Gap

6.1 Government and private company initiatives

6.1.1 Domestic production, reduction and expansion

The analysis and predictions made according to the formula given by the CGPRT Centre for Pakistan's case study on feed crops indicate that there is going to be a shortfall in the availability of wheat, maize and sorghum to meet the country's requirement for food and feed. However, very recent trends in production have given an indication that, in future, there may not be such a shortfall in wheat production because the country is now producing a surplus. For maize, there is hope that with the introduction of hybrid maize in the country, the shortfall may be taken care of. However, in the very near future, the country might have to resort to imports to bridge the gap to meet the domestic requirement for wheat. The projections of requirement, production and deficits are given in Table 6.1.

Table 6.1 Projected demand and supply of wheat in Pakistan ('000 tons)

Year	Demand	Production	Ending stock	Import**	Total supply
2000*	26,187	21,081	3,526	1,588	26,187
2005	28,031	23,123	140	4,768	28,031
2010	34,508	27,097	102	7,309	34,508

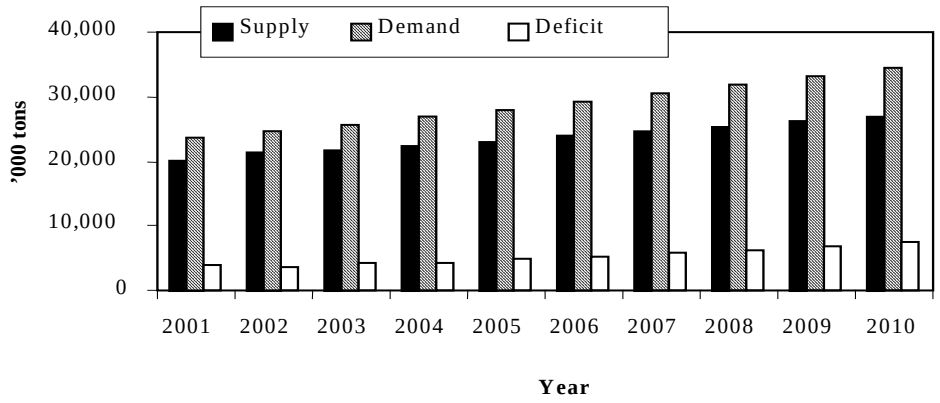
*= Actual, **= These figures indicate the gap between the demand and supply.

This supply demand deficit will be met by imports from other countries. Therefore, imports are equal to the deficit.

To meet total domestic demand of 26,187 thousand tons, the country imported 1,588 thousand tons of wheat in 2000.

The projections for imports of wheat are based on the results of the model, which indicates that wheat will be imported to the tune of 4,768 and 7,309 thousand tons in 2005 and 2010 respectively (Figure 6.1). Projected imports of wheat will be significantly higher than of previous years, for example, in 2000, wheat imports accounted for only 7 per cent of total production of wheat but the projected results show that imports will be 21 and 27 per cent of the total production in 2005 and 2010 respectively.

Figure 6.1 Projections for demand, supply and deficit of wheat in Pakistan



Rosegrant *et al*. (1995) predicted that Pakistan will increase imports from 2.1 million tons in 1990 to 15.5 million tons in 2020. It can be concluded that the results of the present study and the conclusion of Rosegrant *et al*. (1995) are in agreement that Pakistan will continue to import wheat in the future.

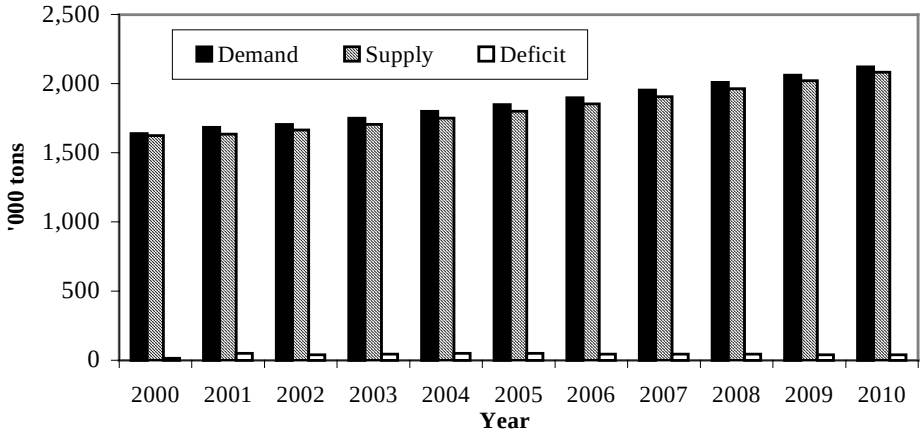
The projected demand and supply of maize and sorghum is presented in Table 6.2.

Table 6.2 Projected demand and supply of maize and sorghum in Pakistan ('000 tons)

Year	Demand	Production	Deficit	Total supply
Maize				
2000	1,626	1,626	-	1,626
2005	1,845	1,801	44	1,845
2010	2,124	2,083	41	2,124
Sorghum				
2000	220	221	-	221
2005	295	249	46	295
2010	335	261	74	335

The amount of maize produced was 1,626 thousand tons in 2000. The projected results show that domestic demand for maize will be 1,845 and 2,124 thousand tons in 2005 and 2010 respectively, whereas projected maize production will be 1801 and 2,083 thousand tons in 2005 and 2010 respectively (Figure 6.2).

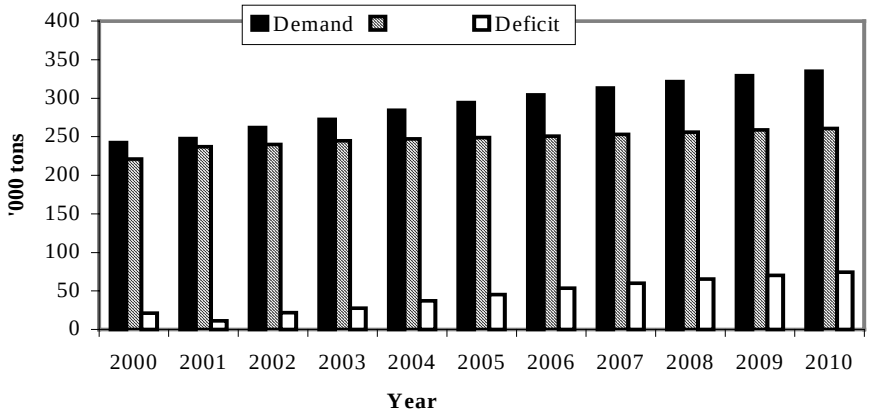
Figure 6.2 Projections for demand, supply and deficit of maize in Pakistan



There will be a shortfall between demand and supply. The discrepancy is only 2.2 per cent of total maize production. The deficit will be met by increased production through improving production technologies, especially by cultivating high yielding varieties of hybrids of maize. Rosegrant *et al*. (1995) predicted that in future, most of the Asian countries, including Pakistan and Bangladesh, will be maize importing countries.

The projected results show that domestic demand of sorghum will be 295 and 335 thousand tons in 2005 and 2010 respectively, whereas projected sorghum production will be 249 and 261 thousand tons for the above mentioned years (Figure 6.3).

Figure 6.3 Projections for demand, supply and deficit of sorghum in Pakistan



There will be a gap between demand and supply. There will be a shortfall of 18 and 28 per cent of total production of sorghum in 2005 and 2010 respectively. This gap can be bridged by enhancing production, by cultivating improved seed varieties and the application of production technologies.

The Government has already put forward a strategy for the development of agriculture up to 2010, where an annual growth rate of about 5 per cent will be achieved, through increasing the area under these crops and by increasing productivity. The increase in area will be limited to around 0.5 per cent per annum due to the shortfall in water supply, thus the major increase in production will come through productivity enhancement. This will require improvements in production technology for these crops and effective and efficient use of inputs i.e. seed, fertilizers, weedicides, etc. The projections of agricultural production for selected crops are given in Table 6.3.

Table 6.3 Projections for cereal crops

Crop	Production, 2010 (million tons)	Growth rate per annum (in per cent)
Wheat	26.4	2.93
Rice	6.3	3.17
Maize	2.5	5.94
Other cereals	0.9	3.61

Source: FAO, 2000.

The government has also encouraged the private sector in the provision of input supply to the farmers like seeds, balanced and compound fertilizers, weedicides, etc. The recent directive of the President of Pakistan on corporate farming provides an incentive to the private sector for industrial farming, which can provide grains to meet the shortfalls as the yield levels of these farms would be at least twice the country's average yield. The government will be responsible to provide land on lease to the national/international companies interested in corporate farming. International companies have shown keen interest in entering into joint ventures with local business concerns for initiating agricultural companies for corporate farming. Vast areas of land are available in the country, which can be farmed if water development is forthcoming. The only limitation is the lack of availability and development of water for farming. However, land is available under rainfed and runoff farming systems, which require much less investment for water management. The culturable wasteland available in the country is around 10 million hectares. Culturable wasteland can be farmed if water is available or made available.

6.1.2 Research and development

Research and development is essential to meet the shortfall in the supply of food and feed grains in the country. The National Agricultural Research and Development System (NARDS) needs to be reoriented and strengthened to meet the future shortfalls. System improvements are required both at the upstream and downstream levels.

Upstream

The government has put forward an agricultural strategy for 2010, where the emphasis is placed on self-reliance in food and feed grains and on competitiveness to produce surplus for export purposes. The policy incentives in relation to the support price given for wheat have produced positive results. Emphasis on marketing research would further help the government to provide further support price incentives. The Agricultural Prices Commission and the Agricultural and Livestock Marketing Authority are jointly implementing a research and development project on the imperfections of the marketing system and to develop strategies for improvement.

Higher priority on grain crop research in the country would strengthen the Commodity Research Programmes in the provinces. Furthermore, there is a move for restructuring the national agricultural research system in the country. The Ministry of Food, Agriculture and Livestock in collaboration with FAO and the Asian Development Bank are going to implement a project for the restructuring of the National Agricultural Research System. For this purpose,

institutional reforms, in research and development institutions, will be implemented in line with the Reforms Agenda already in place for the water sector institutions. The Reforms Agenda of the institutional reforms in the irrigation sector resulted in the promulgation of enabling laws for the establishment of Irrigation and Drainage Authorities at the provincial level, Area Water Boards at the canal command level and Farmers' Organizations at the canal distributaries level. Farmers' Organizations will be the vehicle for the development of irrigated agriculture in the country. Similar reforms will take place in the agricultural and livestock sectors in the future.

Downstream

At the downstream level, efforts have been made to systemize research and development activities for variety improvement, provision of quality seeds of improved varieties to farmers and restructuring the technology transfer programmes. PARC is actively engaged in revitalizing its Technology Transfer Programme in collaboration with the provinces, where emphasis will be placed on the provision of information regarding the improved technology packages for the production of grain crops. The devolution model of the district government would also provide effective backward and forward linkages between research and extension institutions in the provinces. Staff of the line departments, like agriculture and livestock, are placed under the district executive officer of agriculture.

The national and provincial Rural Support Programmes in the country have also started motivating the farmers, farmless families and women and started organizing them into village and womens organizations. These organizations are now in place in large parts of the country. The entry point is the saving and credit programme. The credit programme is oriented especially towards resource-poor farmers, because instead of financial collateral, they have accepted and initiated social and community based collateral. This is one of the most successful programmes among the resource-poor farmers even though the interest rates are high, to the order of 18 per cent but access to the credit is easy. These programmes are successful in linking community organizers with research and training institutions in the agricultural and livestock sectors. These linkages will be further strengthened and expanded in the near future. Some of the organizations have already entered into adaptive research for the multiplication and distribution of certified seeds to fellow members. These linkages and community-based organizations, in future will provide a parallel system of extension in the country, which is more effective than the public sector extension system.

6.1.3 International trade

The introduction of tariff and non-tariff measures under the WTO will provide opportunities to the country to produce not only to meet the domestic requirement but also export if there is competitiveness in prices. However, as the country is not yet ready to meet the implications of the WTO, there is a chance that the shortfalls will have to be met from the import of grains.

6.2 Farmer participation in feed crop development

6.2.1 Feed crop farming

SWOT analysis was applied to determine the strengths, weaknesses, opportunities and threats of feed crop production. Feed crops grown in Pakistan include wheat, maize, sorghum, millets, oats, etc. The potentials, constraints, advantages and problems associated with the farming of feed crops are given as follows:

Strengths

- Climate, fertile lands and the availability of freshwater indicate a high potential for growing feed crops in the country. The ecological diversity further adds to the flexibility in adjusting the cropping pattern for feed crops based on the preferences of farmers and the market requirements.
- The average national yield of wheat is around 2.5 tons/ha compared to the potential of 6 tons/ha of the genotypes cultivated throughout the country. This wide gap in productivity potential is yet to be realized. The gap between the potential and actual yield of other crops like sorghum, maize and millets is even higher than wheat.
- The large population of livestock and poultry and their higher growth rate of production add to the demand to grow feed crops. In areas outside of the Indus Basin irrigated agriculture, canal water is not available and thus, cultivation of cash crops is not possible. Therefore, these areas are potentially suitable for the cultivation of feed crops with much lower production costs compared to irrigated agriculture. These areas are spread under Barani (rainfed), Rod-Kohi (spate-irrigation) from hill-torrents and Sailaba (riverine) areas. The non-irrigated area available for cultivation in an average year is around 5.5 million ha.
- Within the Indus Basin, feed crops are grown on 18 million ha of current irrigated land. Wheat is grown on over 8 million ha in an average year. Thus, there is a potential to increase the production of feed crops by increasing the cropped area, cropping intensity and above all, by increasing productivity.
- Export potential for maize exists to neighboring countries, especially Afghanistan.

Weaknesses

- Fragmentation of landholdings and increasing numbers of small farmers.
- Lack of incentives for a support price for feed crops, excluding wheat.
- Lack of storage facilities and public/private sector institutions storing the output of feed crops to fetch higher prices in the market.
- Lack of an effective marketing system for feed crops.
- Weak research, extension and farmer linkages.
- Fluctuation in prices due to variable demand and supply.
- An insufficient supply of freshwater in the canal command areas and poor quality of groundwater in over 60 per cent of the Indus Basin irrigated agriculture.
- Lack of drought resistant varieties, particularly sorghum and millet.

Opportunities

- The country's agriculture provides an ecological advantage of growing feed crops in both the winter and summer cropping seasons due to a favourable climate and the availability of water.
- Grain and coarse grain crops require much less water compared to other crops and thus, water productivity of feed crops is higher. In fact, in arid environments, more marketable products are possible, per drop of water, compared to other crops.
- Easier to cultivate and manage feed crops compared to other cash crops and they require much less input in terms of fertilizer, weedicides, pesticides, etc.
- Demand is higher than supply, therefore, there is an advantage to growing feed crops to meet food and feed demand.

Threats

- The inadequate and untimely availability of improved seeds of feed crops, except wheat and hybrid maize. The seeds of hybrid maize are costly and beyond the reach of the small holders and deprived segments of the feed crop farming community.
- Non-availability of improved production technology, which forces farmers to maintain low-risk, low-input feed crop farming.
- Low productivity of feed crops due to the subsistence level of farming and lack of access to credit and other input facilities.

6.2.2 Response to market development

The response to market development was very encouraging in the case of wheat, where farmers harvested a surplus in wheat production in one year (2000) by having a support price of Rs 7.50 per kg of wheat grain. The government further ensured the procurement of wheat for export and local consumption through public sector institutions. However, there were problems encountered by the smallholders and deprived segments of the farming community in obtaining access to sell wheat to public sector institutions in areas where notables are dominant. Government intervention in the wheat market further ensured the availability of wheat flour to consumers at a subsidized price by rationing the supply to the flourmills. Maize production and marketing is independent and market forces determine its supply and demand in the market. Sorghum and millet's role in market development is less responsive as these crops do not have proper marketing channels.

6.2.3 Response to manufacturing development

A good example of manufacturing development is the intervention by the private sector in maize, where Rafhan Maize Products Pvt. Limited provided a buyback arrangement to farmers through ensuring the availability of quality inputs. This has resulted in the production of hybrid maize, where some of the farmers are now reaping grain yields of 9 to 12 tons/ha. This intervention has developed a special ecology in the central Punjab province of Pakistan, especially in the Division of Lahore and Multan, where spring maize is now a major crop. Corn oil, starch, glucose and liquid sugar are the main products of the maize industry.

Poultry and livestock feed industry development in the country has also provided an environment conducive for the cultivation of feed crops. The poultry industry will develop further to meet the poultry requirement, which in turn, increases the use of grains, which are essential in their rations. The production of coarse grains and maize received a major boost due to the development of the feed industry. Recently, fish feed industry development has also contributed to the utilization of low grade feed grains. Further development of industries related to feed crops would boost the farming of feed crops in the country. Processing of wheat in flourmills produces wheat bran as a by-product, which is utilized in poultry and livestock feeding. In fact, there is a need to support small-scale manufacturing development by the Farmers' Federations so that they can affect the market. A good example is the Halla Kissan Organization, where public sector investment in a milk processing plant as a nucleus resulted in the sustainability of the milk cooperative in the country. Similar interventions are required for the feed crop processing industry.

6.2.4 Measures for mobilization

Equity consideration

Mobilization of farmers and other stakeholders is essential, especially when considering equity concerns. Feed crops, except wheat, are normally grown in fragile environments like Barani, spate-irrigation and riverine areas where the poorest-of-the-poor live. Therefore, social mobilization activities must be concentrated on the deprived segments of the population.

Furthermore, within the more favoured environments like irrigated agriculture, the mobilization of smallholders is also essential for joint learning and joint actions. CGPRT crops especially maize and sorghum have the necessary potential for increased productivity both under the irrigation and rainfed farming systems.

Poverty alleviation

The objective of mobilization must be to alleviate the poverty of deprived segments of the population through productivity and skill enhancement, linking the organized groups with the sources of inputs and markets, organized actions for production and marketing and training and awareness regarding environmental control. Small holders have the key role in increasing the per unit production of cereal crops-feed crops and they must be provided with necessary inputs and the awareness to do so. By optimizing cereal crop production, food security can be addressed and this will also help alleviate poverty.

7. Conclusions and Recommendations

7.1 Conclusions

In Pakistan, feed crops, which are being used in livestock and poultry feeding as grains, are mainly wheat, maize, sorghum and millet. These cereal crops are predominantly grown to meet the human dietary requirements with a primary focus on wheat and rice. Wheat and rice are predominantly used in the human diet, however, their milling by-products i.e. brans, rice polish and rice tips are used in animal feeding.

The livestock sector is very important in the agricultural economy of Pakistan. With the changing scenario in the dietary consumption style in Pakistan, the demand for livestock products i.e. milk, meat and poultry is increasing significantly. It can be concluded that most of the feed crop grains as feed are consumed in poultry feeding, whereas all the other feed ingredients are mainly consumed in livestock feeding.

Potentials

- Climate, fertile land, availability of fresh water and ecological diversity.
- Deficit between potential and actual yield.
- Demand for feed for the large population of livestock.
- Export potential, especially for maize.

Constraints

- Lack of incentives for the support price for feed crops, excluding wheat.
- Lack of marketing systems and storage facilities.
- Weak research, extension and farmer linkages.
- Lack of drought resistant varieties.

Advantages

- Ecological advantages of growing all feed crops in winter and summer.
- Less water requirement of feed crops compared to other crops and simpler to cultivate and manage.
- High demand in the market.

Problems

- Inadequate improved seeds of feed crops.
- Limited access to improve production technologies, credits and other inputs.

7.2 Recommendations

- Efforts should be made for the development of high yielding, disease resistant and drought resistant varieties for feed crops. There are national coordinated programs, which are making efforts towards variety development, however, more continuous and coordinated efforts are required to increase the production of feed crops.

- There is a large gap between supply and demand of improved seeds available to farmers. In spite of the development of potential varieties on-station, most of the farmers do not have access to the improved seeds. This results in comparatively lows yield in the field. Therefore, the public and private sector should undertake steps to produce more improved seeds and make them available to the farming community.
- Efforts should be made to provide the required quantity of fertilizer to the farming community in time.
- Institutional linkages should be established among research and development institutes, private companies and the farming community. Forward and backward linkages should be enhanced among all the stakeholders to promote feed crop production.
- Extension departments have the primary role in making the farmers aware of the latest production technologies. However, extensionists are usually not well equipped and informed about the development of production technologies and hence, timely awareness of the farmers is less effective. There is a dire need to develop strong linkages among the researchers and extentionists on a regular and sustainable basis.
- In Pakistan in general, the farming community does not have cash, especially to purchase the inputs required for desirable production and this is very specific to small-scale farmers. The government is already providing production loans through banks, especially through the Agricultural Development Bank of Pakistan. However, access to these production loans is limited and thus, there is a need to expand them further.
- Recently, progressive farmers have started production of improved seeds of various crops, particularly wheat. The improved seeds produced are supplied to their fellow farmers. There is a need for this system to be strengthened by patronization of the government agencies.
- Provision of credit to the farmers for storing their agricultural produce to sell at a time for fetching reasonable prices.
- The establishment of proper storage facilities by the private sector is required to ensure maximum procurement of grains and the subsequent supply to the consumers. Government of Pakistan is encouraging to establish storage facilities both in public and private sector.
- Attempts should be made to educate the farming community about post harvest losses.
- The livestock sector is, so far, conventional, excluding poultry, therefore, there is an immediate need to give attention to breed improvement and the availability of balanced feed and feeding systems. Development of efficient marketing systems for livestock products is very much required.
- The poultry sector, which includes the commercial feed mills and hatcheries, is already playing a significant role in the development of poultry production at an annual growth rate of almost 9 per cent. They have all the necessary linkages with the poultry farmers. However, the ruminant sector is still operating on a conventional system and needs to be commercialized. The dairy sector is developing steadily by collecting milk from producers which facilitates ensured buying arrangements and the supply of some inputs. To increase livestock productivity, there is need to establish financially strong feed mills to provide balanced feed and technical know-how to the farming communities.

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