EFFECTS OF CROP PRODUCTION SYSTEMS ON THE WELFARE OF RURAL HOUSEHOLDS IN BALOCHISTAN, PAKISTAN

By

KHALID MAHMOOD

Bachelor of Science (Hons)
University of Agriculture
Faisalabad, Pakistan
1982

Master of Science (Hons)
University of Agriculture
Faisalabad, Pakistan
1985

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 1995

EFFECTS OF CROP PRODUCTION SYSTEMS ON

THE WELFARE OF RURAL HOUSEHOLDS

IN BALOCHISTAN, PAKISTAN

Thesis Approved:

Dean F. Schreiner

Thesis Adviser

James N. Trapp

Raymond Joe Schatzer

Michael J. Applegate

Thomas C. Collins

Dean of the Graduate College

ACKNOWLEDGMENTS

I wish to express my deep gratitude and sincere appreciation to a number of people without whom this dissertation could not have been completed. A special word of appreciation is due to my major advisor, Dr. Dean F. Schreiner, for his patience, encouragement and gentle guidance throughout the course of my doctoral program, especially during preparation of this manuscript. Appreciation is also expressed to the committee members, Dr. James N. Trapp, Dr. Joe Schatzer and Dr. Michael Applegate for their assistance, encouragement and counseling during my graduate program. I am also thankful to Dr. Wade Brorson for his kind assistance in developing the regional demand and supply models.

A lot of thanks are extended to the Department of Agricultural Economics for the opportunity to pursue the graduate study. Also, I wish to express my appreciation to the Pakistan Agricultural Research Council, for providing this opportunity and financial support through the USAID/MART project to complete this doctoral program.

A substantial magnitude of debt is extended to my elder brother, Chaudhry Tahir Mahmood Aujla and colleagues in Pakistan Agricultural Research Council for their sincere efforts in supplying a considerable amount of data related to this research. Thanks are also due to the staff of the Pakistan Institute of Development Economics (PIDE) and

Federal Bureau of Statistics, for supplying a valuable amount of information and data about the Household Income and Expenditure Survey (HIES).

I am very grateful to Ms. Gloria for her typing of many preliminary drafts and the final copy of this dissertation.

Finally, I am particularly grateful for the sacrifice and prayers of my dear parents, brothers and sisters/cousin, who have been a constant source of encouragement and support throughout my graduate program.

I dedicate this dissertation to my grandfather, Chaudhry Nabi Bukhsh Aujla.

TABLE OF CONTENTS

Chapter | Page

LIST OF TABLES

Table | Page

Table Page

CHAPTER I

INTRODUCTION AND PROBLEM STATEMENT

Introduction

The role of agriculture in Pakistan's economic development continues to be of great importance, as a producer of food, as an employer of about one-half of the labor force, as a source of foreign exchange earnings, and as a source of purchasing power for much of the nonagricultural consumer goods and services in the economy. Pakistan's agriculture has undergone transformation over the last four decades. It is generally believed that much of this success resulted from use of modern technology (mechanization and bio-chemical technology), price supports, public investment in irrigation, and subsidized inputs including agricultural credit. As a result of structural changes in the economy, the share of agriculture in the Gross Domestic Product has declined from 53 percent in 1949-50 to 24 percent in 1992-93.

Agriculture has advanced rapidly over the last three decades showing more than a four percent real annual growth rate of agricultural production. Agriculture is the single largest source of employment accounting for 52 percent of the labor force. The healthy expansion in agriculture has stimulated exports in other sectors both through raising domestic demand for industrial goods and other services, and by supply of raw-materials to agro-based industries. Growth in the agricultural sector has multiple impacts on overall growth of the economy. Thus, rapid growth in agriculture is essential for sustainable growth and development of the total economy.

Physical resources of land and water have played a major role in the process of agricultural development in Pakistan. At present, the main strategy for agricultural development is focused on increased agricultural productivity in irrigated areas and by increasing the water use efficiency to bring more area under irrigation. The strategy for rainfed agriculture has been limited to increased access to improved inputs and agricultural credit.

In Pakistan about 80 percent of the total land area of 79.61 million hectare (m ha) or about 25 percent of the cultivated hectarage of 20.43 m ha is rainfed. The bulk of these rainfed areas consists of arid and semi-arid lands. Precipitation varies widely from less than 125 mm to 1500 mm per annum. Sixty to 70 percent of the monsoon rain is received during the summer months of July to September, while the rest is received during the winter months of December to February. Outside the rainfed areas, cultivation is made possible by the largest irrigation system in the world. The climate of the rainfed regions is, however, suited to the production of many kinds of cereals, legumes, grasses, range forage and forests.

About 70 percent of Pakistan's total geographical area is comprised of mountainous or arid regions with limited cultivation (GOP 1988). In the past, these regions have not received adequate attention and significant disparities in regional agricultural incomes have occurred. The development of the past, if continued in the future, may further widen the gap between those inhabiting the irrigated areas and those living in mountainous and arid regions.

The Problem Statement

The pressure brought upon the economy to feed more people and to confirm self sufficiency has increased the significance of food production in the rainfed regions of the country. The rainfed areas in Pakistan, the bulk of which constitute arid and semi-arid lands, were left out of the green revolution as they were considered high risk for agriculture. However, their contribution to the national supply suggests that these areas are too large a resource to be ignored.

Despite the fact that the province of Balochistan occupies 43.6 percent of the total geographical area of the country but has only 5 percent of the total population, it depends on other regions of the country to meet a significant part of basic food and feed requirements. At the same time, it has a comparative advantage for livestock production and the production of fresh and dry fruits which are marketed throughout the country by so-called progressive producers who are economically in better positions compared to subsistence farmers.

Climate variation and uncertainty of rainfall pose serious problems for crop and range-livestock production in the rainfed areas of the country, including the province of Balochistan. Low and erratic rainfall more than any other factor is responsible for low productivity of these rainfed lands. Solutions to low agricultural productivity in rainfed areas are elusive and there exists no clear government policies on how to overcome the problems of variability in production to stabilize incomes of rural households in these regions.

The Balochistan rural economy is evaluated by how it effects welfare of rural households. Because producers are assumed rationale, they will adjust their production systems based upon how they receive inputs from factor markets and how they are able to market output through commodity markets. Thus those markets need to be described and quantified for the province of Balochistan. In addition, rationality of producers needs to be interpreted in terms of producers' behavior. Rural welfare thus needs to be interpreted in terms of rural household behavior but also in terms of constraints facing those households. For example, households have limited resources that are used in factor markets and receive compensation for their use by means of factor payments. Factor payments contribute to household income which, in part, is used to purchase commodities for consumption. Thus rural welfare depends upon household behavior, availability of resources, and functioning of factor and commodity markets. It is these rural regional economies that need further elaboration and quantification for purposes of measuring rural welfare. In particular, rural welfare needs to be measured as it relates to the variability of rainfed livestock-crop production systems of Balochistan.

Agricultural producers operate in an environment where yields and input and output prices are uncertain. They typically make most of their production decisions at the beginning of the season, knowing neither the market price for their products at harvest time nor the weather conditions during the season that will determine their yields. Although we generally believe that agricultural resources are scarce in the rainfed areas of in relation to the cropping patterns in the area. The most common resources cited as scarce are cultivated area, capital, and water.

There has been recent interest in yield variability in rainfed farming in Pakistan. It is an important area of research because changes in yield variability could have significant effects on rural household incomes and on policy decisions regarding government farm policy and the direction of future research. Major aims of government farm policy might be to stabilize prices and reduce farmer risk, both of which would be more difficult to achieve with higher yield variability. Instability in gross income is due to fluctuations in acreage and yields caused by weather variability and other natural or physical hazards, and to changes in the prices of agricultural products. The result is that area and farm household income is variable and uncertain, whereas cost commitments and living requirements are relatively fixed. The income variability problem is further aggravated by the tendency of favorable and unfavorable years to bunch. A policy or plan might be derived to stabilize returns for resources under anticipated conditions. Therefore, there is a need to understand and quantify the complex production systems of rainfed agriculture and the interactions of those systems with commodity and factor markets, rural household income and consumption, and overall rural welfare in the Balochistan province for purposes of policy recommendations.

Objectives of This Study

The central focus of this study is on the problem of regional agricultural development. In general, the study seeks to determine the economic constraints which affect the survival and income-earning ability of rural households, in particular those living in ecological zones where climate and agricultural production is highly variable. The main objective of this study is to develop regional agricultural production and food demand models to analyze regional agricultural systems and their interactions with the rural economy of Balochistan. Sub-objectives in completing the main objective include:

1. To develop and empirically estimate a commodity demand system for purposes of analyzing price and income effects of households in Balochistan.
2. To develop and empirically estimate an agricultural commodity supply system for Balochistan for purposes of analyzing effects of price, factor supplies, and climatic variability.
3. To analyze the agricultural commodity demand and supply systems of Balochistan for means of policy control in reducing variability in production and incomes, increasing regional food supplies, and increasing welfare of rural regional households.

Procedure

The area of study is Balochistan, a province which is representative of rainfed agriculture in Pakistan. Rainfall varies from 50 mm to 400 mm. Agriculture is the main economic activity and livestock the predominant sub-sector in the province. Wheat and livestock are the predominate activities although numerous other crops are produced under rainfed and irrigated conditions.

Economic theory concerning the operation of product and factor markets is used to establish appropriate models for empirically estimating commodity demand and supply systems for Balochistan. A non-linear expenditure system using household survey data is estimated for rural and urban households for purposes of analyzing commodity demand. Supply systems are estimated using econometric methods and time series data.

Classical welfare analysis is used to measure the effects of variability of agricultural production systems and to identify the impacts on commodity and factor markets, household consumption, and rural regional welfare. Gains and losses in welfare are highly dependent upon the magnitude of the demand and supply elasticities estimated in the empirical models.

Data for the study were obtained from various published and unpublished sources. The regional demand system was estimated using data from the Household Integrated and Economic Survey (HIES) 1984-85, conducted by the Federal Bureau of Statistics, Pakistan. Crop production data were collected from the Balochistan Department of Agriculture, Statistics Division including various issues of the Agricultural Statistics of Balochistan (1975 to 1992) and from other federal and provincial departments and statistical reports. Data on commodity prices were obtained from the Government of Pakistan, Food and Agriculture Division (Economic Section), Islamabad. A field survey was also conducted to gather information on enterprise budgets from the rainfed and irrigated areas of Balochistan.

Organization of the Study

Chapter II portrays the relevant features of agriculture in Balochistan province. The rationale for dividing the region into two agro-climatic zones -- irrigated and rainfed -- is explained and the agricultural setting in each is described. The rainfed areas' environment is described in detail so that the problems unique to dryland farming are identified.

Chapter III sets out the basic economic model underlying the empirical analysis of the extended non-linear expenditure system. Literature on demand analysis is reviewed with special reference to problems associated with developing nations. Alternative interpretations of the estimating equations are explained and estimation procedures for cross-section data are discussed. Estimates of budget shares, income, price and savings elasticities are presented and analyzed.

Chapter IV reviews available literature on supply analysis and discusses the theoretical framework and empirical problems in the estimation of supply functions. It also discusses the nature of data available and their limitations for this study. It provides estimates of regional supply response for major food and cash crops derived from alternative models and presents the conclusions and policy implications of the analysis.

Chapter V presents the main conclusions of the study and makes suggestions for future research.

CHAPTER II

PHYSICAL AND ECONOMIC ENVIRONMENT OF THE AGRICULTURAL BASE OF BALOCHISTAN

The agro-economic and institutional environment within which farmers and agro-based industry operate affects the degree of supply and demand responsiveness. This chapter, therefore, traces various environmental features and other relevant information on the arid and semi-arid regions of Pakistan, with particular emphasis on Balochistan Province.

The rainfed areas in Pakistan, the bulk of which constitute arid and semi-arid lands, were by-in-large left out of the green revolution as they were considered high risk for agriculture. However, their contribution to the national food supply suggests that these areas are too large a resource to be ignored. These rainfed areas contribute about 11 percent of the national wheat production and approximately 82, 69, 65, 53, 31, 20, and 17 percent of peanut, sorghum, chickpea, barley, millet, oil seeds, and pulses crops respectively (GOP 1992).

Of the total land area of Balochistan (34.72 million hectare), only 4.7 percent or 1.62 m. ha is under cultivation, while 57 percent of the cultivated area is rainfed (GOP 1992). Moreover, nearly 80 percent of the livestock population in Balochistan is sustained by the arid lands of the province, which constitute nearly one-fourth of the country's sheep and goat population (GOP 1988).

Sources of income for rural farm households are diverse. These sources include crop and livestock farming activities, off-farm wages, small scale businesses, and other employment. More than 70 percent of the labor force in Balochistan is directly or indirectly associated with agriculture which operates under highly unfavorable climatic conditions. In addition to climatic variability, production systems are limited in productivity by low levels of technology.

Climate and Location

Located in the desert belt between 25^0N and 32^0N, Balochistan has an arid or semi-arid climate with annual precipitation varying from 50 mm in the West to over 400 mm in the East. Physically it consists of an extensive plateau of rough terrain divided into basins by mountain ranges of inhospitable terrain. Rainfall generally occurs in two seasons: winter (November to March/April), as a result of western disturbances in the anticyclonic system extending from Siberia to Iran; and summer (July to September/October), as a result of monsoon storms originating in the Bay of Bengal and the Arabian Sea. Most of Balochistan is on the fringes of the monsoon area and hence does not receive large or reliable amounts of summer rainfall. The proportion of annual rainfall received as summer rains varies from less than 10 percent to over 60 percent, increasing in a north-westerly to south-easterly direction (Table 2.1).

The variation in elevation from sea level to over 3000 m results in a wide range of temperature and rainfall regimes. Balochistan has been divided into two major crop ecological zones (Rafiq 1976). Based principally on location of the mountain ranges, most of Balochistan south of 30°N has been classified as hot sub-tropical desert where the rainfall varies from 50 to 150 mm. Principal land use is rangeland grazing with some irrigated agriculture, particularly in the north easterly areas of Kacchi and Sibi districts.

TABLE 2.1

ELEVATION AND MEAN MONTHLY RAINFALL AT SELECTED CENTERS IN BALOCHISTAN FROM 1931-1960

Months	Quetta	Zhob	Panjgoor	Dalbandin
Elevation				
Height above Sea level (m)	1589	1407	968	849
Mean Monthly Rainfall (mm)				
January	36.8	36.6	23.9	25.1
February	43.7	25.9	18.5	18.3
March	42.4	63.2	16.5	12.4
April	12.4	37.3	7.6	5.3
May	6.9	32.5	3.3	1.5
June	1.3	9.1	3.0	0.5
July	18.3	64.5	27.4	7.1
August	4.3	51.1	8.4	0.3
September	0.5	7.4	1.0	0.0
October	1.3	5.1	0.0	0.0
November	5.6	19.6	1.0	0.8
December	22.9	29.5	11.4	12.7
Annual Mean Rainfall (mm)	196.4	381.8	122.0	84.0

mm = millimeter (25.4 mm = 1 inch)
m = meter

Source: Pakistan Statistical Year Book, 1990.

The northern areas with a large "extrusion" of high elevation into the hot subtropical desert zone (Kalat and most of Khuzdar districts) have been classified as continental semi-arid mediterranean where rainfall varies from 200 to 350 mm. The principal land uses are rangeland grazing, irrigated cropping and dryland cropping. The main winter season dryland crop in this higher elevation-lower temperature zone is winter wheat with some barley and lentil production. Some sorghum is grown during the summer season. Within this zone there is considerable variation in temperature and rainfall, resulting in a wide range of environments for winter wheat production.

Crop Production

Land Use

Land under cultivation generally depends upon current land use pattern, geo-climatic factors, and economic and population pressure. One reason for the low proportion of cultivated area to total area in Balochistan (4.7 percent) is the low population pressure as shown by the density of population per square kilometer (Table 2.2). The land utilization pattern shows that 46 percent of total area was classified as uncultivated land (Table 2.3). The category "culturable waste" under uncultivated land accounted for 14 percent of the total area. In addition, 2.7 percent of the land was kept fallow due to various reasons. Thus, 17 percent of the total area has a possibility of being extended for cultivation (Table 2.3).

TABLE 2.2

DEMOGRAPHIC FEATURES OF THE BALOCHISTAN PROVINCE
RELATIVE TO PAKISTAN FOR CENSUS PERIODS
1972 AND 1981

Particulars	Balochistan		Pakistan	
	1972	1981	1972	1981
Population (m)	2.4	4.3	65.3	84.3
Population (no.) Density/km	7.0	12.0	82.0	106.0
Rural Population (% of Total Pop.)	83.6	84.4	74.6	71.7
Annual Population Growth Rate between Census Periods(%)	- -.	8.7	- -.	3.2
Literacy Rate (%)	10.1	10.3	21.7	26.2
Labor Force in Agriculture (%)	n.a.	70.0	n.a.	70.0

Source: Pakistan Census, 1972 and 1981.

n.a. = not available

TABLE 2.3

LAND UTILIZATION PATTERN, 1990-1991

Category	Pakistan (m ha)	Balochistan (m ha)	Balochistan as a Percent of Pakistan	Distribution within Balochistan
	Million Hectares		Percent	
Total Geographical Area	79.61	34.72	43.6	100.0
Total Area Reported	57.90	18.60	32.1	53.6
Forest Area	3.44	1.09	31.7	3.1
Uncultivated Area	33.35	15.89	47.6	45.8
Not Available for Cultivation	24.59	11.16	45.4	32.1
Culturable Waste	8.76	4.73	54.0	13.6
Cultivated Area	21.11	1.62	7.7	4.7
Current Fallow	4.96	0.92	18.5	2.7
Net Area Sown	16.14	0.70	4.3	2.0
Area Sown More Than Once	5.21	*	*	*
Total Cropped Area	21.35	0.70	3.3	2.0

Source: Agricultural Statistics of Pakistan, 1991-92.

* indicates close to zero.

It is important to note that the net area sown in the province increased from 0.96 percent of the total area in 1974-75 to 2.02 percent in 1990-91, with an average annual increase of 6.5 percent. The addition came mainly from culturable waste and fallow land.

Irrigated Area

Balochistan has 643.4 thousand hectares of irrigated land (GOP, 1992) which constitutes about 40 percent of the cultivated area. The corresponding percentage of irrigated area to cultivated area for the country is 80 percent. Thus, as far as area under irrigation is concerned, the region is not favorably placed mainly due to highlands which constitute 65 percent of the total area. Further, the sources of irrigation in the region are not reliable. Of the irrigated area in the region, 17.5 percent is irrigated by wells as against 27 percent for the country. Irrigated area and over-time variations along with sources of irrigation are presented in Table 2.4. Irrigated area and total cropped area in the region have been increasing since 1975. Overall, the ratio of irrigated area to total cropped area has also trended upward. Variations of irrigated cropped area for selected crops grown under both irrigated and rainfed conditions and over-time variations are summarized in Table 2.5.

Rainfed Areas

Farming in the rainfed areas is a complex activity and must consider agroclimatic conditions, soil structure, and topography. This complexity arises out of the small size of most operational farms combined with management strategies that reflect multiple objectives of the farm families (e.g., generation of food and cash needs, provision of fodder for animals

TABLE 2.4

IRRIGATED AREA BY SOURCE OF IRRIGATION IN BALOCHISTAN, 1975-1991 (HECTARES)

Years	Canals	Tank	Wells	Tubewells	Springs	Total
1975	296,138	...	13,172	27,296	87,120	423,726
1976	292,292	...	13,302	33,072	84,719	423,385
1977	294,502	105	13,023	34,256	85,590	427,476
1978	385,644	105	15,093	36,122	86,335	523,299
1979	385,644	105	15,073	42,309	85,913	529,044
1980	385,644	...	14,610	45,850	85,913	532,017
1981	382,980	...	15,000	51,210	81,740	530,930
1982	383,583	...	16,710	54,350	81,900	536,543
1983	382,070	...	34,080	91,400	90,200	597,750
1984	366,370	...	24,200	95,200	76,700	562,470
1985	340,610	...	18,530	93,080	58,800	511,020
1986	340,610	...	15,830	95,660	58,800	510,900
1987	345,610	...	18,830	99,600	58,800	522,840
1988	345,910	...	17,430	121,140	44,700	529,180
1989	379,520	...	15,060	106,040	53,390	554,010
1990	450,480	...	10,520	130,830	55,130	646,960
1991	442,830	...	11,165	141,570	47,830	643,395
Mean	364,732	105	16,566	76,411	71,975	529,703
S.D.	43,887	0	5,362	36,589	15,713	62,685
CV (%)	12.0	0	32.4	47.9	21.8	11.8

Source: Agricultural Statistics of Pakistan.

TABLE 2.5

PERCENTAGE OF IRRIGATED AREA TO TOTAL AREA FOR SELECTED CROPS IN BALOCHISTAN, 1975-1991

Crops	Average Irrigated Area (ha)	Std Dev	CV (%)	Percent[a]
Wheat	145,029	53,368	36.8	64.8
Barley	6,665	3,531	53.0	61.5
Oilseeds	14,815	6,990	47.2	60.4
Maize	1,846	468	25.3	47.2
Sorghum	28,198	7,792	27.6	49.6
Moong Pulse	753	503	66.8	18.2
Cumin	2,193	1,220	55.6	64.0

[a] Percentage of irrigated area to total area.

throughout the year, and risk aversion) which must be met in an uncertain climatic environment. Moisture shortage is the most important factor which limits the cropland development in the province. Rainfall is low and erratic and, therefore, cannot be relied upon as a source of moisture to stabilize crop production. The hectarage under crops varies from year to year due to variation in the amount and intensity of rainfall.

Cropping Intensity

There are two main cropping seasons in most of Balochistan: summer/kharif (April-November) and winter/rabi (November-April). Wheat, barley (rabi) and sorghum (kharif) are the major crops grown under rainfed farming conditions for subsistence purposes. The winter crops rely on the summer rainfall for establishment and winter rains for yield. Summer crops, except melon, are planted mostly for fodder. Minor crops grown in different parts of Balochistan include oilseeds, vegetables, pulses, fodders, and orchards. Of the total cropped area, about 60 percent is planted in winter season.

Cropping intensity in the province varies from year to year and is far less than the cropping intensity at the country level. This is mainly because of erratic behavior of rainfall and variation in irrigated area over years. It is estimated that cropping intensity in the region is 44 percent as compared to 101 percent at the country level.

Cropping Pattern

Balochistan covers a wide range of latitudes and produces a vast array of crops including cereals, pulses, forages, fruits and vegetables, and cash crops such as tobacco, cumin and melons. Virtually all of these crops compete for resources directly or indirectly. Wheat is the single most important crop in the region. In the cropping pattern, foodgrains occupied 70 per cent of the total cropped area. This is more than the percentage area devoted to these crops in the country as a whole (55 percent). Among foodgrains, the important crops are wheat, rice, maize, barley, sorghum, and millet. These crops occupied 44, 15.5, 3.5, 0.6, 6 and 0.1 percent of the total cropped area respectively. Wheat and barley are grown in winter, and under both irrigated and rainfed conditions. As barley requires less water, it is grown in those fields where the water availability is not adequate for wheat. Expansion in area under wheat and rice has come about through increases in total cropped area or at the expense of oilseeds and pulses. It is clear that competition becomes more acute as resources are strained and growth falters. Chickpea and other pulses, which occupied 4.3 per cent of the cropped area, are mainly irrigated crops.

Non-food grain crops occupied 10.3 percent of the total cropped area. The important crops in this group are oilseeds, potatoes, onions, melons, and tobacco. These crops occupied 4.7, 1.0, 1.5, 2.0, 0.3, and 0.8 percent of cropped area, respectively. These are mainly irrigated crops except cumin and melons which are grown under irrigated and rainfed conditions. Cropping pattern and variations in the region for the period 1975 to 1991 are presented in Table 2.6.

During the study period a decline in the share of area under sorghum, maize, and millet to total cropped area and an increase in the share of wheat, oilseeds, and cash crops was observed. This result is mainly because the additional area brought under cultivation is irrigated.

Farm Mechanization

The basic farm implements in the region are of the traditional type. The most popular forms of mechanization in agriculture have been the use of tractors, threshers, and tubewells (Table 2.7). The total number of tubewells increased from 4,335 in 1974-75 to 15,151 in 1990-91. During the same period, the number of tractors operating in agriculture increased at an average annual rate of 35 percent. The use of tractors and threshers has spread to small- and medium-scale farmers, despite controversies surrounding appropriate mechanization. Threshers are widely used for the wheat crop. There is roughly one thresher for every two tractors currently in use for the country while this ratio is very small at the region level. There

TABLE 2.6

CROPPING PATTERN FOR SELECTED CROPS
IN BALOCHISTAN FROM 1975-1991

Crops	Average Area (ha)	Std Dev	CV (%)
Food Crops			
Wheat	223,604	62,996	28.2
Rice	76,271	35,440	46.5
Barley	10,843	6,073	56.0
Maize	3,904	795	20.4
Chickpea	12,867	9,310	72.4
Sorghum	56,888	11,942	21.0
Moong (Pulse)	4,422	1,114	25.2
Cash Crops			
Oil Seeds	24,518	6,639	27.1
Cumins	3,428	1,852	54.0
Potatoes	4,554	1,609	35.3
Onions	5,864	3,074	52.4
Melons	8,395	4,518	53.8
Tobacco	1,591	286	18.0
All Selected Crops	437,149	117,033	26.8

Source: Agricultural Statistics of Pakistan.

TABLE 2.7

AVAILABILITY OF IMPORTANT FARM IMPLEMENTS
AND MACHINERY IN BALOCHISTAN
AND PAKISTAN, 1984, NUMBER

Implements	Balochistan	Pakistan
Tractors	3,074	157,310
Water Pumps	8,068	248,878
Threshers	71	78,377
Cultivator	2,162	146,863
Mould Board Plough	1,245	7,319
Harrows (Bar & Disc)	210	8,140
Disk Plough	185	6,355
Grain Drills	65	11,251
Ridger	53	4,711
Trailer	2,293	98,787

Source: Census of Agriculture Machinery, 1984.

has been considerable differences of opinion in the country regarding the most appropriate extent of mechanization in agriculture. The choice of appropriate technology to maintain a balance between modernization, employment, and income distribution remains an important issue.

Livestock Production

Livestock is an integrated part of farming in all regions of Balochistan. Bullocks and camels are the main source of draft power for farm work from preparatory ploughing to sowing and threshing. The principal dryland agricultural activity in Balochistan is the production of sheep and goats from natural rangelands which constitute 93 percent of the total area of Balochistan. According to the 1986 livestock census, numbers of small ruminants are estimated to exceed 18 million head which represents just less than 40 percent of the total number of this class of livestock in Pakistan (Table 2.8). Since 1955, numbers of both sheep and goats have increased very rapidly, more than 7 percent per year, and as a result available feed resources from the extensive natural rangelands (21 million hectares of potential grazing) are seriously depleted (FAO 1983). Current estimates of small ruminant reproduction rates are low (60-70%) (Mahmood et al 1991) and mortality rates are high. It can be inferred from these statistics that poor nutrition of range-fed livestock is a major constraint to current offtake from these lands.

Livestock production in dryland areas of Balochistan is generally not market oriented. Livestock is marketed to meet cash requirements during critical periods (Mahmood et al. 1993). The crop and livestock sectors are closely integrated. The crop sector provides fodder and feed to the livestock sector, while a significant portion of the crop area requiring draft power is provided by livestock. It is noted that with the increased use of tractors, the number of work animals has significantly declined over time from 3.2 million pairs in 1976 to 2.3 million pairs in 1984 (Mahmood and Walters). The shift from animal power to tractor power has positively

TABLE 2.8

CENSUS YEARS LIVESTOCK POPULATION, PAKISTAN AND BALOCHISTAN

Year	Sheep			Goats			Cattle		
	Pakistan	Balochistan	%	Pakistan	Balochistan	%	Pakistan	Balochistan	%
1955	8.1	1.2	14.8	7.6	0.7	9.2	10.3	0.3	2.9
1960	12.4	2.6	21.0	10.0	1.6	16.0	16.6	0.6	3.9
1972	13.7	3.9	28.5	15.6	3.2	20.5	14.7	0.5	3.3
1976	18.9	5.1	27.0	21.7	4.4	20.3	14.9	0.7	4.6
1986	23.3	11.1	47.6	29.9	7.3	24.4	17.5	1.2	6.6
Growth Rate* (%)									
1955-1986	3.4	7.2	n.a.	4.4	7.6	n.a.	1.7	4.4	n.a.

* Geometric growth rate.

na = not applicable

affected cropping intensity, especially in rainfed areas. The capacity for the major deficit in animal feed, currently experienced in Balochistan, to be overcome from dryland production of crops and crop residues is at present limited.

The livestock population of the Balochistan province in 1986 census relative to the country level total population is shown in Table 2.9 on a per thousand hectare basis. The province has a higher proportion of sheep than the country. There are 320 sheep and 210 goats per thousand hectares in the region as compared to 292 and 376 in the country.

Production Variability

The farmer makes decisions about production in an uncertain environment caused by weather and price variations. The average annual growth for selected crops in total cropped area, yield and production for Balochistan are shown in Table 2.10. The coefficient of variation for subsistence crops is generally less than for cash crops. Area variability is more than yield variability which together leads to production variability. Despite large variations and uncertain climatic conditions, farmers devoted a significant proportion of rainfed area to crops. The share of all food crops has remained more or less constant over the period under study. Major crops such as wheat, rice, chickpeas and oilseeds showed general increases, along with some gains for onions, melons and potatoes while the share of other crops either remained constant or declined. This result suggests that major crops remained the focus of government policy and the application of new technologies.

The amount and efficiency of fertilizer use and adoption of improved varieties and practices and average response ratios have been well below potential. Other than extension

TABLE 2.9

NUMBER OF MAJOR LIVESTOCK SPECIES
PER THOUSAND HECTARE OF
TOTAL AREA, 1986

Species	Balochistan	Pakistan
Cattle	33.3	220.4
Buffaloes	1.8	197.3
Sheep	320.0	292.6
Goats	210.2	376.2
Camels & Donkeys	20.7	49.7
Poultry	94.9	722.4

Note: Calculations based on Livestock Census, 1986.

services, there is no established scientific procedure for developing optimum fertilizer recommendations for farmers in different ecological zones. Although the improved inputs and fertilizer distribution infrastructure is well established, there have been reports of localized shortages at critical times.

Data showed less variability if crops are considered in aggregate as compared to individual crops (compare Tables 2.11 and 2.6).

TABLE 2.10

AVERAGE ANNUAL GROWTH IN AREA, YIELD AND PRODUCTION OF MAJOR CROPS IN BALOCHISTAN, 1975-1991

Crops	Area	Yield	Production
Wheat	4.98 (15.5)	5.21 (6.1)	10.19 (13.2)
Rice	9.69 (24.9)	6.23 (23.3)	15.93 (38.6)
Barley	10.70 (24.8)	4.18 (9.2)	14.88 (37.8)
Maize	1.81 (18.6)	2.88 (9.6)	4.68 (12.4)
Sorghum	-2.45 (17.5)	2.00 (14.6)	-1.75 (23.2)
Chickpeas	29.88 (37.6)	1.15 (6.5)	31.04 (37.3)
Green Beans	-0.07 (26.0)	3.72 (7.5)	3.65 (21.3)
Potatoes	6.90 (15.2)	4.26 (10.8)	11.16 (15.8)
Onions	10.99 (16.9)	2.22 (11.0)	13.21 (25.2)
Tobacco	1.24 (17.7)	0.001 (8.7)	1.24 (12.3)
Melons	11.60 (19.7)	3.86 (12.7)	15.46 (20.7)
Cumins	10.54 (26.1)	2.18 (7.8)	14.47 (30.2)
Oilseeds	2.13 (26.3)	5.89 (6.7)	7.98 (23.5)

Figures in parenthesis are Coefficients of Variation (%).

TABLE 2.11

DISTRIBUTION OF TOTAL CROPPED AREA UNDER SELECTED CROPS IN BALOCHISTAN, 1975-1991

Years	Area under Selected Crops	Area Under All Crops	Percent to Total Cropped Area
1975	300,865	332,300	90.5
1976	274,557	315,700	87.0
1977	285,260	332,600	85.8
1978	295,480	453,800	65.1
1979	357,736	448,200	79.8
1980	341,648	414,700	82.4
1981	349,301	415,500	84.1
1982	428,543	508,441	84.3
1983	544,471	675,430	80.6
1984	555,505	675,084	82.3
1985	536,579	636,083	84.4
1986	488,914	583,792	83.7
1987	529,902	617,099	85.9
1988	408,569	499,637	81.8
1989	557,446	656,555	84.9
1990	593,545	698,818	84.9
1991	583,218	700,479	83.3
Mean	437,149	527,307	83.0
STD	113,539	133,208	5.1
C.V. (%)	26.0	25.3	6.1

Source: Agricultural Statistics of Pakistan.

The average nominal and real prices and the coefficients of variation are summarized in Table 2.12. Nominal prices had a dominant upward trend from inflationary pressures during the study period. Data showed that there is more price variation in cash crops as compared to food crops or crops for which government announces support prices for purposes of stabilizing prices in the market. Price variation is even more pronounced in the case of export commodities such as rice.

The area sown to dryland crops does not exceed 125,000 ha and in highland Balochistan this is almost entirely restricted to wheat production (approximately 70,000 ha) with an average yield not exceeding 800 kg/ha (GOB 1991; Rees et al 1987). In addition, due to the considerable variability in annual precipitation (Kidd et al 1988), the probability of complete crop failure (<200mm precipitation per annum) is, for example at Quetta, approximately 33 percent for any given season. Farmers are therefore naturally reluctant to invest cash resources in "improved" agricultural technologies under such high risk climatic conditions leading to production variability which adversely affects their income earning abilities and overall welfare in the region.

In summary, climatic conditions, demographic features, infrastructural facilities and possibilities of changing the use of land and labor inputs are conducive to high supply response. On the other hand, low commercialization, dominance of small farms, and high yield variability should lower supply response.

TABLE 2.12

PRICE VARIABILITY OF MAJOR CROPS
IN BALOCHISTAN, 1975-1991

Crops	Nominal Prices*		Real Prices*	
	Average	CV(%)	Average	CV(%)
Wheat	1,881	9.7	1,602	8.1
Rice	4,076	42.4	3,231	43.8
Barley	2,087	20.3	1,753	8.8
Maize	2,670	10.2	2,156	12.1
Sorghum	2,073	20.3	1,736	20.3
Chickpea	4,317	30.5	3,572	33.6
Beans (Moong & Mash)	5,900	15.2	4,899	14.5
Potatoes	2,012	21.6	1,759	20.1
Onions	1,581	27.5	1,366	31.7
Tobacco	7,856	27.6	7,262	24.3
Melons	1,689	28.1	1,428	27.6
Cumin	17,042	35.4	14,370	35.5
Oilseeds	3,205	26.3	2,542	27.2

* Rupees per metric ton.

Source: Agricultural Statistics of Pakistan.

CHAPTER III

REGIONAL DEMAND FOR FOOD IN BALOCHISTAN, PAKISTAN

Introduction

Consumer demand for food is an important component, along with the supply of food, in forming agricultural policy and making related decisions. Providing food sufficient to maintain minimum nutritional levels is an important goal in most developing countries. According to the analysis of Household Income and Expenditure Survey (HIES), 1984-85, one-fourth of the population in Pakistan is below the poverty line i.e. income less than Rs 1000 (GOP, 1988). In the presence of uncertain and unfavorable climatic and socio-economic conditions, agricultural production might be unable to maintain the trend growth rate of 3.4 percent per annum during the last four decades which is slightly higher than the population growth rate of 3.2 percent per annum (GOP,1993). To bridge the gap between supply and demand for food, particularly in years with bad weather which leads to more dependence on imports, the importance of analyzing and predicting future demands increases. Augmenting domestic production, particularly in dryland regions vastly ignored in past development efforts, contributes to the main objectives of agricultural policy in

Pakistan of assuring sufficiency of basic food commodities and increasing export-earning capacity.

Balochistan, a province of Pakistan, has mainly an agricultural economy. Over half of the provincial gross domestic product (GDP) comes from agriculture and 80 percent of the total population is, directly or indirectly, engaged in agriculture. Balochistan has a very harsh and uncertain climate. The province constitutes 44 percent of Pakistan's geographical area and only 5 percent of Pakistan's population, yet its production frequently does not meet its food requirements.

Aggregate demand for food increases with population growth, income growth, and a less skewed income distribution. This result increases the importance of developing the agricultural sector to meet domestic needs and conserve (generate) foreign exchange. Empirical estimates of demand parameters are essential for providing commodity forecasts and analyzing the effects of changes in commodity prices and incomes among domestic population groups. Moreover, priorities and investment decisions are based on demand forecasts. Therefore, reliable estimates of elasticities of different commodities are essential to predict future demand and to evaluate the effects of changes in prices and incomes for policy purposes.

Numerous quantitative studies on the application of demand theory to food commodities have been conducted and used to analyze household consumption patterns in Pakistan. Most of these studies were partial demand analyses in which direct price and per capita income were considered as major determinants without considering the complete interdependent nature of demand.

Much of the earlier work, reviewed in Ali (1985), consists of linear Engel curves based on grouped data published by the Bureau of Statistics. Bussink (1970) estimated demand parameters for households in different income groups by commodity sector. Ahmad, Leung and Stern (1984), and Ahmad, Ludlow and Stern (1987) used household observations from the 1976 Micro-Nutrient Survey (MNS) to estimate commodity parameters and elasticities based on a modified Linear Expenditure System (LES) using maximum likelihood methods. Ahmad and Ludlow (1987) made an analysis using the modified linear expenditure system method and household level observations based on the 1979 Household Income and Expenditure Survey (HIES). Disaggregate estimates of consumption shows differences between rural and urban areas and across provinces for the 17 commodities studied. However, analyses have not presented rigorous testing of these differences. Alderman (1988) used the 1979 HIES data and independent price information to estimate the Almost Ideal Demand System (AIDS) as formulated by Deaton and Muellbauer (1980).

Eastwood and Craven (1981) analyzed the allocation of income among various aggregate consumption categories and savings using extended linear expenditure system (ELES) on the data from the U.S. Department of Commerce's annual series on personal consumption expenditures. Burney and Akmal (1991) used ELES to estimate uncompensated own price and income elasticities using national HIES, 1985 data without considering regional differences in consumption patterns which were found significant by Ahmad and Ludlow (1987). Most previous studies conducted to analyze demand systems in Pakistan have not corrected for heteroskedasticity and have ignored standard errors for elasticities which are essential to observe the significance of elasticities. Another deficiency is that they have assumed linear relationships between consumption and income. Data plotting and analysis clearly support the non-linear relationship between income and consumption. Coefficients observed using non-linear expenditure systems are significant at the 1 percent level. While considering the importance of the regional demand estimates for specific commodities in formulating policy, this study specifically estimates food expenditure shares and a disaggregated and complete set of price and income elasticities for the province of Balochistan to evaluate the potential effects of changes in prices and incomes on consumption and saving behavior.

Model and Estimation Method

Lluch (1973) and Lluch, et al (1977) developed the extended linear expenditure system (ELES) from the maximization of an intertemporal Klein-Rubin utility function subject to a budget constraint in which disposable income is the limiting exogenous variable. Eastwood and Craven (1981) used the ELES to examine the allocation of income among various aggregate consumption categories and saving. Capps (1994) used this approach to link demand systems to macroeconomic models. The extension to the LES is the addition of savings as an endogenous component of the demand system. Assuming that household decisions are made on a per-capita basis, the extended linear expenditure system equations are written as:

(1) $$v_i = p_i x_i = p_i \gamma_i + \beta_i (y - \sum_{i=1}^{n} p_i \gamma_i)$$

where v_i is household's per capita expenditure on commodity i, y is the households' per capita disposable income and x_i is a set of n commodities with prices (p_i). The ELES expresses households' per capita consumption expenditure $p_i x_i$ as a function of exogenous prices (p) and income (y) and (γ_i, β_i) are the parameters to be estimated under the restrictions:

(2) $$0 \prec \beta_i \prec 1; \; p_i x_i - p_i \gamma_i \succ 0$$

The γ_i parameter can be interpreted as representing basic need or the subsistence quantity of good i if it is positive. $\Sigma p_i \gamma_i$ is the total subsistence expenditure. The expression ($y - \Sigma p_i \gamma_i$) represents supernumerary income. Besides the assumptions of intertemporal additivity and static price expectations held with certainty, the ELES as given above incorporates the further assumption that the present value of expected changes in income are zero, so that permanent income and measured income are the same.

The aggregate consumption function ($V = \Sigma v_i$) associated with ELES is obtained as:

(3) $$V = \sum_{i=1}^{n} p_i x_i = (1 - \mu^*) \sum_{i=1}^{n} p_i \gamma_i + \mu^* y$$

where $\mu^* = \Sigma \beta_i^*$, the aggregate marginal propensity to consume, and where β_i^* is the marginal propensity to consume commodity i, calculated from the first derivative of equation 3. Equation (3) enables the identification of $\Sigma p_i \gamma_i$ in the absence of price data and helps to obtain direct price elasticities from the cross-sectional samples. The above relationship is a Keynesian consumption function with the intercept defined as a linear function of prices. Given the aggregate consumption function, we may also derive the aggregate savings function, $S = y - V$:

$$(4) \qquad S = y(1-\mu^*) - (1-\mu^*)\sum_{i=1}^{n} p_i q_i = (1-\mu^*)\ (y - \sum_{i=1}^{n} p_i \gamma_i\ )$$

Thus, $1-\mu^*$ is the marginal propensity to save. The subsistence parameter associated with savings is zero.

System (1) involves cross-equation restrictions on the parameters, as γ_i occurs in all equations. The demand systems must be estimated as a whole following direct maximization of the likelihood functions which impose cross-equation constraints. In case of cross-section estimation, ELES enables all price elasticities to be estimated in the absence of price data. The assumption that all consumers face identical prices is required, however, and for this reason estimations are restricted to groups of households where this assumption is not likely to be grossly violated. In particular, we do not pool data across regions nor for urban and rural households. Under the assumption that $p_{ih} = p_i$ $(i = 1,...,n)$, where p_{ih} denotes the price of i commodities for h households, the $p_i\gamma_i$ terms become independent of the unit of observation and may be replaced by γ_i^* $(i = 1,...,n)$, where γ_i^* measures subsistence expenditure in prices prevailing at the time of the household survey. It should be noted that in comparing γ^* values across different groups of consumers, for example rural and urban, at a given time, the estimates will reflect any differences in prices paid by the various groups.

An extended non-linear expenditure system can be developed along the same line as that taken for the alternative development of the ELES. Indirect utility functions constitute the framework for the development of the non-linear expenditure system. The non-linear expenditure system accomodates curvature and satisfies the budget constraint, homogeneity and symetry conditions. Non-linear will affect the size of the marginal propensities derived. The stochastic specification of the extended non- linear expenditure system may be written as:

(5) $$v_{ih} = \alpha_i + \beta_{i1} y_h + \beta_{i2} y_h^2 + \varepsilon_{ih}$$

where i = 1,..., n goods, h = 1,...,H households, $\alpha_i = \gamma_i^* - \beta_i^* \Sigma_j \gamma_j^*$ and e_{ih} is the error term with the usual classical properties. Expressing y as a function of V in equation (5) and substituting this function into equation (1), we obtain the general form of the LES. Thus, the ELES can be decomposed into the LES and the aggregate consumption function. The associated ELES aggregate consumption function is

(6) $$V_h = \alpha + \mu_1 y_h + \mu_2 y_h^2 + \varepsilon_h$$

where $\alpha = \Sigma \alpha_i = (1 - \mu^*) \Sigma \gamma_i^*$ and $\varepsilon_h = \Sigma \varepsilon_{ih}$

The system of equations (5) is one of identical regressors in which every left-hand-side variable is regressed on the same set of exogenous variables. It follows that estimation of each equation by ordinary least square (OLS), commodity by commodity, is equivalent to systems maximum likelihood estimation (Goldberger 1964; Dhrymes 1970). Separate equations were run for urban and rural consumers. For the correction of heteroskedasticity, Weighted Least Square (WLS) method was used. Maximum likelihood estimates of μ, γ_i^*, and $\Sigma \gamma_i^*$ are obtained from the OLS estimates α_i and β_i^* using the following relationships:

(7) $$\mu^* = \sum_{i=1}^{n} \beta_i^*$$

(8) $$\sum_{i=1}^{n} \gamma_i^* = \sum_{i=1}^{n} \alpha_i / (1-\mu^*)$$

(9) $$\gamma_i^* = \alpha_i + \beta_i^* \sum_{j=1}^{n} \gamma_j^*$$

Income elasticities and uncompensated own-price and cross-price elasticities from the ELES are calculated as:

(i) marginal budget share of good i:

$\omega_i = \beta_i^* / \mu^*$

(ii) marginal propensity to consume commodity i:

$\beta_i^* = \beta_{i1} + 2\ \beta_{i2}y$

where β_i^* is the derivative of equation (5).

(iii) income elasticity of good i:

$\eta_{iy} = \beta_i^*(y/e_i)$

(iv) own-price elasticity of good i:

$\eta_{ii} = (1 - \beta_i^*)(\gamma_i^*/e_i)\text{-}1$

The extended non-linear expenditure system (ENLES) is important because of the inclusion of savings into the demand system. In essence, the ENLES creates a residual category of savings, and consumers allocate a measure of income or wealth to expenditures of goods and services and savings. Savings is not treated as an expenditure category. As such, with the ELES, while it is possible to estimate the MPC and MPS, it is not possible to estimate the own-price elasticity of savings. It is possible, however, to estimate the effects of changes in prices and income on savings. These effects can be derived by taking the derivatives of S with respect to y and p_i in equation (4). Following the pioneering work of Prais and Houthakker on family budget studies, where they found that the residual variance around the regression of consumption on income increased with income, it is now generally assumed that in similar surveys one can expect unequal variances among the disturbances. Because the model in this study is estimated using cross-section data, there might be the problem of heteroskedasticity. The null hypothesis of no heteroskedasticity will be tested using the Glejser test.

A frequent method of testing for differences between two (or more) regressions is the multi-step Chow test procedure which can be substantially abridged by the use of dummy variables. Although the overall conclusions derived from the Chow and dummy variable tests in any given application are the same, there are some advantages to the dummy variable method. Therefore, to differentiate households' consumption pattern, the dummy variable approach will be followed.

Data Source and Descriptive Statistics

Cross sectional data from the comprehensive Household Income and Expenditure Survey (HIES) 1984-85, comprised of 891 households surveyed from Balochistan province (404 urban and 487 rural households), were used to estimate regional demand parameters. A demand systems approach is used to analyze household expenditure on food consumption and to present a pattern of regional differences or similarities in consumption behavior. To distinguish the impact of urbanization and income change on food consumption, separate estimates are presented for urban and rural households categorized by six income classes. This provides a set of price and income elasticities for a disaggregated and complete set of food commodities. To estimate saving elasticities, published retail price data for the year 1984-85 was used.

Consumption patterns of both the rural and urban regions are presented in Table 3.1 along with average family size and saving rate among different income groups. For the purpose of this study, two broad commodity groups, expenditures on food and non-food are distinguished. Moreover, 85 food items reported in the survey were aggregated into 21 food commodity groups which are broadly classified into cereals, livestock products, fruits and vegetable and miscellaneous foods. The distribution of surveyed households among different income classes is also reported in Table 3.1. About two-thirds (65 percent) of the households reported have a monthly income less than Rs 1500 which suggests that in analyzing households' consumption pattern particular attention should be given to the low-income classes, especially those in the rural sector.

In general, household expenditure on food is influenced by a host of factors including culture, tradition, demographic, climate, season, availability and price of food, household income and household size. Because of these factors, large differences in households' expenditure on food are observed. This can partly be seen from the differences in expenditure shares of food for households in different income classes within each region (Table 3.1). On average, urban households spend about 55 percent of their income on food whereas rural households spend approximately 60 percent. In both regions the expenditure share of food declines as income rises.

TABLE 3.1

DISTRIBUTION OF URBAN AND RURAL SURVEY HOUSEHOLDS AMONG DIFFERENT INCOME GROUPS AND SAVING AND EXPENDITURE SHARES IN BALOCHISTAN, 1984-85

Income Groups (Rs/month)	Regions	Households No.	Households %	Households size	Saving share (%)	Food Expenditure Share (%)
1. <= 1000	Urban	111	12.5	4.7	10.4	65.95
	Rural	230	25.8	4.2	10.4	62.88
2. 1001 - 1500	Urban	106	11.9	5.9	14.8	61.29
	Rural	133	14.9	5.5	14.9	64.54
3. 1501 - 2000	Urban	50	5.6	7.0	13.9	59.14
	Rural	56	6.3	6.2	17.4	60.64
4. 2001 - 3000	Urban	76	8.5	7.2	21.1	55.84
	Rural	38	4.3	6.2	21.8	59.55
5. 3001 - 5000	Urban	38	4.3	7.6	21.9	49.00
	Rural	19	2.1	7.7	23.9	53.97
6. > 5000	Urban	23	2.6	7.4	31.0	43.49
	Rural	11	1.2	9.3	42.3	37.74
Overall	Urban	404	45.4	6.2	20.2	55.16
	Rural	487	54.6	5.2	19.6	59.31
	Total	891	100.0	5.6	19.8	57.11

Tables 3.2 and 3.3 show average expenditure shares of different food items for both urban and rural regions as well as for households in different income classes within each region. It is clear that consumption patterns for urban and rural areas differ significantly. Higher shares are devoted to food expenditure in rural areas compared to urban areas. These differences may arise due to different income levels and preferences. In general, expenditure shares for the food items follow three distinct patterns across income groups; (i) continuous decline with higher income, (ii) first rise and then decline, and (iii) continuous rise. The products for which expenditure shares decline continuously are those which are considered to be basic items, e.g., wheat, pulses, vegetable oil and tea, and are usually consumed in a minimum desired amount. Commodities for which expenditure shares first rise and then decline include high protein items but are relatively less preferred when substitutes are affordable, e.g., beef vs. mutton (mutton is preferred over beef in Pakistan). Finally, items for which expenditure shares rise continuously include those which low-income households consume in relatively small amounts, e.g., mutton, poultry, soft drinks and fruits.

Results and Discussion

For both urban and rural regions, as well as for households in different income groups within each region, equation (5) was estimated for each of the 21 food items. Heteroskedasticity in the data was corrected using the Glejser test procedure. On average, the overall goodness-of-fit of the regressions, i.e., R^2, was found to be around 20 percent.

TABLE 3.2

AVERAGE EXPENDITURE SHARES OF FOOD COMMODITIES IN BALOCHISTAN FOR URBAN HOUSEHOLDS BY INCOME GROUPS, 1984-85

	Income Groups (Rs)						
Commodities	Overall	IG1	IG2	IG3	IG4	IG5	IG6
	Percent						
Cereal	**11.62**	**18.03**	**16.02**	**12.87**	**10.75**	**8.69**	**5.73**
Wheat	9.43	15.11	13.47	11.18	8.20	6.73	4.32
Rice	1.97	2.34	2.30	1.60	2.38	1.73	1.32
Other Cereals	0.22	0.57	0.24	0.09	0.17	0.23	0.09
L/Stock Products	**15.70**	**14.43**	**15.31**	**16.73**	**16.74**	**15.75**	**14.85**
Milk & Products	5.97	5.35	5.78	7.41	6.75	5.94	4.57
Mutton	3.83	2.44	2.67	3.43	4.48	4.42	4.82
Beef	2.45	3.22	3.07	3.45	2.17	1.69	1.72
Fish	2.42	3.26	3.19	1.71	2.54	1.74	2.01
Poultry	1.04	0.16	0.61	0.73	0.79	1.96	1.72
Fruits & Veg.	**6.95**	**7.79**	**7.53**	**8.16**	**6.84**	**5.80**	**6.19**
Fruits	2.18	1.68	1.86	2.37	2.11	2.12	2.93
Potatoes	0.83	1.28	1.05	1.07	0.81	0.52	0.44
Onions	1.15	1.73	1.61	1.31	1.03	0.93	0.54
Fresh Vegetables	2.78	3.11	3.01	3.42	2.88	2.23	2.28
Bakery Products	1.29	0.57	0.82	1.15	1.52	2.16	1.16
Pulses	2.33	3.79	3.78	2.39	1.83	1.52	1.26
Veg. Oil & Fat	5.18	8.42	6.47	5.72	5.13	3.55	2.84
Spices	1.40	2.01	1.82	1.45	1.46	1.09	0.75
Sugar & Sweets	3.88	4.52	4.42	4.60	4.04	3.61	2.42
Tea & Coffee	2.20	2.99	2.44	2.30	2.17	1.95	1.58
Soft Drink	0.19	0.07	0.02	0.04	0.39	0.22	0.23
Cigaret & Tobaco	2.71	1.76	1.80	1.89	3.34	3.16	3.61
Miscellaneous Food	1.67	1.56	0.86	1.57	1.64	1.50	2.88
All Food Items	**55.16**	**65.95**	**61.29**	**59.14**	**55.84**	**49.00**	**43.49**
Non-Food	**44.84**	**34.05**	**38.71**	**40.86**	**44.16**	**51.00**	**56.51**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.3

AVERAGE EXPENDITURE SHARES OF FOOD COMMODITIES IN BALOCHISTAN FOR RURAL HOUSEHOLDS BY INCOME GROUPS, 1984-85

	Income Groups (Rs)						
Commodities	Overall	IG1	IG2	IG3	IG4	IG5	IG6
	.... Percent						
Cereal	**14.50**	**17.35**	**16.94**	**14.37**	**13.57**	**9.72**	**6.15**
Wheat	11.35	13.95	13.13	10.33	10.59	7.85	5.28
Rice	2.65	2.68	3.14	3.61	2.70	1.62	0.73
Other Cereals	0.50	0.72	0.67	0.42	0.27	0.24	0.14
L/Stock Products	**15.92**	**14.54**	**17.22**	**17.17**	**18.86**	**15.31**	**10.79**
Milk & Products	8.00	7.98	9.35	9.07	7.84	6.84	4.11
Mutton	3.48	2.20	3.32	2.97	6.04	4.12	4.05
Beef	1.73	2.01	1.90	2.37	1.44	0.73	0.94
Fish	1.30	1.97	1.31	0.89	1.18	1.07	0.42
Poultry	1.40	0.37	1.33	1.87	2.36	2.54	1.26
Fruits & Veg.	**6.83**	**7.12**	**7.24**	**6.54**	**7.27**	**6.33**	**5.19**
Fruits	2.03	1.54	2.05	2.01	2.60	2.66	1.94
Potatoes	1.27	1.51	1.52	1.41	1.05	0.78	0.56
Onions	1.26	1.72	1.35	1.23	1.17	0.64	0.52
Fresh Vegetables	2.26	2.36	2.32	1.90	2.45	2.25	2.17
Bakery Products	0.60	0.38	0.79	0.69	0.68	0.39	0.68
Pulses	2.78	3.16	3.16	2.77	2.73	2.50	1.04
Veg. Oil & Fat	5.35	7.09	6.01	5.29	4.31	3.43	2.16
Spices	1.72	2.16	1.89	1.65	1.47	1.37	0.79
Sugar & Sweets	4.59	5.34	4.80	4.76	4.73	3.98	2.06
Tea & Coffee	2.18	2.77	2.34	1.79	1.76	2.06	1.35
Soft Drink	0.19	0.00	0.01	0.03	0.37	0.56	0.84
Cigaret & Tobaco	3.06	2.14	2.62	3.99	2.72	5.57	3.32
Miscellaneous Food	1.58	0.83	1.52	1.58	1.07	2.74	3.37
All Food Items	**59.31**	**62.88**	**64.54**	**60.64**	**59.55**	**53.97**	**37.74**
Non-Food	**40.69**	**37.12**	**35.46**	**39.36**	**40.45**	**46.03**	**62.26**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

The F-ratios, however, were reasonably high and in almost all cases were significant at the one percent probability level. For a few of the commodities, the estimated slope coefficients were insignificant, for instance, pulses, other cereals, soft drinks, tobacco and miscellaneous foods for urban households, and other cereals for high income rural households.

The consumption behavior of an urban household is expected to be considerably different from that of a rural household because of differences in income, relative product prices, needs and tastes and the structural and cultural differences between the two areas. To test if the consumption behavior of rural and urban areas are similar, the Dummy Variable Model was used to differentiate households' consumption pattern using pooled urban and rural data. A statistically significant difference in consumption pattern between urban and rural households was found except for rice, other cereals, spices, and soft drinks. However, the relationship for individual commodities did not appear stable across income groups within each region.

For a majority of food items, the α_i were positive for both urban and rural households irrespective of income, implying that these items are essential for the households. The estimated β_i^*, i.e., the marginal propensity to consume of different food items, are low for both urban and rural households. However, the β_i^* for the two regions are considerably different. Except for bakery products, mutton, fruit, and other cereals, the marginal propensity to consume is higher in urban areas than in rural areas. Within each commodity sector, the marginal propensity to consume varies considerably across the different income groups, particularly in the rural region, but, for most commodities, the marginal propensity to consume has a tendency to decline across successively high income groups.

The estimates of marginal budget shares (Tables 3.4 and 3.5) indicate that if per capita income of the household increases by one rupee then urban households allocate between 23 percent and 52 percent of the additional income to food consumption depending upon income, and rural households allocate between 30 percent and 42 percent. Furthermore, among various food commodities, a relatively larger proportion of the increased expenditure is allocated to fresh milk, followed by mutton, fruit, fresh vegetables, poultry, vegetable oil and tobacco. This indicates that demand for these items is likely to grow at a relatively faster rate compared to other items and suggests that particular attention needs to be paid towards increasing domestic production of these items to meet expected demand.

The estimated income elasticities obtained for different commodities are reported in Tables 3.6 and 3.7. For the broad commodity group 'Food', the income elasticity varies considerably across income groups. For urban households the range is from 0.46 to 0.77 and for rural households from 0.43 to 0.64, with a tendency to decline with an increase in the level of income. The income elasticities of specific food products indicate that for wheat, rice, other cereals, pulses, fish, potatoes, and onions the response is relatively low with respect to changes in income. Income elasticities are relatively high for commodities such as bakery products, mutton, poultry and fruits. In the case of rural households, the income elasticity is less than unity for all food commodities except for poultry, fruit,

TABLE 3.4

MARGINAL BUDGET SHARES OF FOOD COMMODITIES IN BALOCHISTAN FOR URBAN HOUSEHOLDS BY INCOME GROUPS, 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
	.... Percent					
Cereal	**7.83**	**7.31**	**6.68**	**5.74**	**3.82**	**-1.54**
Wheat	5.46	5.08	4.62	3.93	2.53	-1.40
Rice	2.07	1.96	1.82	1.63	1.22	0.09
Other Cereals	0.07	0.06	0.06	0.06	0.05	0.03
L/Stock Products	**17.16**	**16.86**	**16.50**	**15.97**	**14.87**	**11.81**
Milk & Products	6.63	6.45	6.24	5.94	5.30	3.53
Mutton	4.90	4.88	4.84	4.79	4.70	4.42
Beef	2.20	2.07	1.91	1.67	1.19	-0.15
Fish	1.72	1.66	1.59	1.48	1.27	0.66
Poultry	1.39	1.47	1.57	1.71	2.01	2.85
Fruits & Veg.	**6.40**	**6.25**	**6.08**	**5.82**	**5.29**	**3.80**
Fruits	2.27	2.34	2.41	2.52	2.74	3.36
Potatoes	0.50	0.46	0.43	0.38	0.29	0.02
Onions	0.76	0.71	0.65	0.56	0.38	0.13
Fresh Vegetables	2.74	2.26	2.48	2.27	1.83	0.62
Bakery Products	1.82	1.81	1.80	1.79	1.76	1.69
Pulses	0.82	0.79	0.75	0.70	0.58	0.24
Veg. Oil & Fat	3.53	3.32	3.09	2.74	2.02	0.10
Spices	1.01	0.96	0.90	0.80	0.61	0.08
Sugar & Sweets	4.02	3.81	3.55	3.17	2.39	0.22
Tea & Coffee	1.96	1.86	1.75	1.58	1.23	0.25
Soft Drink	0.30	0.29	0.29	0.29	0.28	0.26
Cigaret & Tobaco	2.20	2.40	2.65	3.01	3.75	5.82
Other Food	0.70	0.94	1.23	1.66	2.54	4.99
All Food Items	**51.90**	**50.28**	**48.36**	**45.49**	**39.63**	**23.22**
Non-Food	**42.05**	**44.39**	**47.16**	**51.30**	**59.75**	**83.42**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.5

MARGINAL BUDGET SHARES OF FOOD COMMODITIES IN BALOCHISTAN FOR RURAL HOUSEHOLDS BY INCOME GROUPS 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
	.... Percent					
Cereal	**8.52**	**8.42**	**8.31**	**8.14**	**7.77**	**4.88**
Wheat	6.18	6.14	6.09	6.02	5.87	4.66
Rice	2.39	2.26	2.13	1.91	1.44	-2.19
Other Cereals	0.10	0.09	0.09	0.09	0.08	0.02
L/Stock Products	**15.46**	**15.30**	**15.14**	**14.87**	**14.27**	**9.71**
Milk & Products	6.58	6.50	6.41	6.27	5.96	3.60
Mutton	4.10	4.13	4.16	4.21	4.33	5.20
Beef	0.89	0.91	0.94	0.98	1.07	1.78
Fish	0.56	0.54	0.53	0.51	0.45	0.05
Poultry	1.98	2.00	2.02	2.06	2.14	2.76
Fruits & Veg.	**5.77**	**5.71**	**5.66**	**5.57**	**5.38**	**3.92**
Fruits	2.34	2.33	2.32	2.30	2.26	1.95
Potatoes	0.75	0.74	0.73	0.71	0.66	0.32
Onions	0.70	0.68	0.65	0.60	0.50	-0.26
Fresh Vegetables	1.80	1.83	1.86	1.91	2.03	2.88
Bakery Products	0.72	0.71	0.70	0.68	0.65	0.37
Pulses	2.19	2.11	2.02	1.88	1.57	0.81
Veg. Oil & Fat	2.38	2.37	2.35	2.32	2.26	1.81
Spices	1.02	1.00	0.99	0.96	0.90	0.46
Sugar & Sweets	3.26	3.22	3.18	3.10	2.94	1.72
Tea & Coffee	1.31	1.31	1.31	1.31	1.30	1.26
Soft Drink	0.45	0.45	0.45	0.46	0.46	0.51
Cigaret & Tobaco	3.53	3.66	3.79	4.01	4.48	8.10
Other Food	2.41	2.39	2.37	2.33	2.25	1.63
All Food Items	**41.67**	**41.34**	**41.00**	**40.44**	**39.23**	**29.86**
Non-Food	**42.55**	**43.60**	**44.68**	**46.48**	**50.37**	**80.30**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.6

INCOME ELASTICITIES OF FOOD COMMODITIES
IN BALOCHISTAN FOR URBAN HOUSEHOLDS
BY INCOME GROUPS, 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
Cereal	**0.39**	**0.42**	**0.47**	**0.51**	**0.39**	**-0.23**
Wheat	0.33	0.35	0.37	0.45	0.34	-0.28
Rice	0.80	0.79	1.03	0.65	0.63	0.06
Other Cereals	0.10	0.24	0.62	0.33	0.19	0.27
L/Stock Products	**1.08**	**1.03**	**0.89**	**0.90**	**0.85**	**0.68**
Milk & Products	1.12	1.04	0.76	0.83	0.80	0.66
Mutton	1.82	1.70	1.27	1.01	0.95	0.79
Beef	0.62	0.63	0.50	0.73	0.63	-0.07
Fish	0.48	0.49	0.84	0.55	0.65	0.28
Poultry	7.69	2.23	1.95	2.06	0.92	1.42
Fruits & Veg.	**0.74**	**0.77**	**0.67**	**0.81**	**0.82**	**0.53**
Fruits	1.22	1.17	0.92	1.13	1.16	0.99
Potatoes	0.35	0.41	0.36	0.45	0.49	0.03
Onions	0.40	0.41	0.45	0.51	0.37	-0.21
Fresh Vegetables	0.80	0.81	0.65	0.75	0.74	0.23
Bakery Products	2.88	2.06	1.41	1.11	0.73	1.25
Pulses	0.20	0.20	0.28	0.36	0.34	0.17
Veg. Oil & Fat	0.38	0.48	0.49	0.51	0.51	0.00
Spices	0.46	0.49	0.55	0.52	0.50	0.09
Sugar & Sweets	0.80	0.80	0.70	0.74	0.59	0.08
Tea & Coffee	0.59	0.71	0.68	0.69	0.56	0.13
Soft Drink	3.85	15.40	6.20	0.70	1.13	0.95
Cigaret & Tobacco	1.13	1.24	1.26	0.85	1.06	1.38
Miscellaneous Food	0.41	1.02	0.71	0.96	1.51	1.49
All Food Items	**0.71**	**0.76**	**0.74**	**0.77**	**0.72**	**0.46**
Non-Food	**1.12**	**1.07**	**1.04**	**1.10**	**1.05**	**1.27**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.7

INCOME ELASTICITIES OF FOOD COMMODITIES
IN BALOCHISTAN FOR RURAL HOUSEHOLDS
BY INCOME GROUPS, 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
Cereal	**0.47**	**0.48**	**0.55**	**0.56**	**0.66**	**0.44**
Wheat	0.42	0.45	0.56	0.53	0.62	0.48
Rice	0.85	0.69	0.56	0.66	0.74	-1.64
Other Cereals	0.13	0.13	0.20	0.30	0.27	0.09
L/Stock Products	**1.02**	**0.85**	**0.83**	**0.73**	**0.78**	**0.49**
Milk & Products	0.79	0.67	0.67	0.74	0.72	0.48
Mutton	1.79	1.20	1.33	0.65	0.87	0.70
Beef	0.42	0.46	0.38	0.63	1.22	1.04
Fish	0.27	0.40	0.56	0.40	0.35	0.07
Poultry	5.07	1.44	1.02	0.81	0.70	1.20
Fruits & Veg.	**0.77**	**0.76**	**0.82**	**0.71**	**0.71**	**0.41**
Fruits	1.46	1.09	1.09	0.82	0.71	0.55
Potatoes	0.48	0.47	0.49	0.63	0.70	0.31
Onions	0.39	0.48	0.50	0.48	0.66	-0.28
Fresh Vegetables	0.73	0.76	0.93	0.73	0.75	0.73
Bakery Products	1.81	0.86	0.96	0.94	1.37	0.30
Pulses	0.66	0.64	0.69	0.64	0.52	-0.43
Veg. Oil & Fat	0.32	0.38	0.42	0.50	0.55	0.46
Spices	0.45	0.51	0.57	0.60	0.55	0.32
Sugar & Sweets	0.58	0.65	0.63	0.61	0.62	0.46
Tea & Coffee	0.45	0.54	0.69	0.69	0.53	0.51
Soft Drink	104.71	31.77	14.20	1.14	0.69	0.33
Cigaret & Tobacco	1.58	1.34	0.90	1.37	0.67	1.34
Miscellaneous Food	2.79	1.51	1.42	2.02	0.68	0.27
All Food Items	**0.63**	**0.62**	**0.64**	**0.63**	**0.60**	**0.43**
Non-Food	**1.10**	**1.18**	**1.07**	**1.07**	**0.91**	**0.71**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

mutton, bakery products and tobacco. Rural households have relatively higher income elasticities compared to urban households for cereals, fresh vegetables, pulses, vegetable oil, and soft drinks. Urban households have relatively higher income elasticities for livestock products, fruits, bakery products, and sugar and sweets.

The uncompensated own-price elasticities for different food products estimated from the regression results are presented in Tables 3.8 and 3.9. For the broad commodity group 'Food', the own-price elasticity varies from -0.77 to -0.95 and from -0.78 to -0.91 for urban and rural households, respectively. For almost all the specific food items, the sign of the own-price elasticities is negative but numerical values vary from commodity to commodity. For commodities such as bakery products, mutton, poultry, fruits, soft drinks, and cigarettes, which are non-essential food items, the own price elasticity is relatively high. Basic commodities such as cereals, pulses, vegetable oil, spices, and tea have relatively low elasticities. Furthermore, the response of high income households to price changes for all 'Food' is greater compared to that of low income households. In general, the own-price elasticities for rural households for cereals, livestock products, and fruits and vegetables are relatively higher compared with that of urban households. This may be attributed to the tendency of rural households producing those commodities to curtail consumption so as to have larger marketable surpluses in response to price increases.

Elasticities of saving with respect to prices of food commodities and income are presented in Tables 3.10 and 3.11 for the urban and rural regions, respectively, by income classes. These elasticities correspond to the mean values over all households in the

TABLE 3.8

UNCOMPENSATED OWN-PRICE ELASTICITIES OF FOOD ITEMS OF URBAN HOUSEHOLDS BY INCOME GROUPS IN BALOCHISTAN, 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
Cereal	**-0.36**	**-0.52**	**-0.59**	**-0.62**	**-0.70**	**-0.71**
Wheat	-0.26	-0.45	-0.54	-0.52	-0.62	-0.63
Rice	-0.69	-0.81	-0.82	-0.92	-0.94	-0.96
Other Cereals	-0.36	-0.00	0.93	-0.21	-0.63	-0.40
L/Stock Products	**-0.87**	**-0.93**	**-0.97**	**-0.98**	**-0.99**	**-1.00**
Milk & Products	-0.85	-0.92	-0.97	-0.98	-0.99	-1.01
Mutton	-1.42	-1.28	-1.17	-1.11	-1.08	-1.05
Beef	-0.50	-0.66	-0.80	-0.76	-0.81	-0.89
Fish	-0.34	-0.55	-0.43	-0.71	-0.73	-0.86
Poultry	-5.72	-1.85	-1.51	-1.37	-1.10	-1.07
Fruits & Veg.	**-0.59**	**-0.73**	**-0.83**	**-0.85**	**-0.89**	**-0.94**
Fruits	-0.94	-0.97	-0.99	-1.00	-1.00	-1.01
Potatoes	-0.24	-0.39	-0.58	-0.59	-0.58	-0.70
Onions	-0.28	-0.49	-0.57	-0.59	-0.70	-0.69
Fresh Vegetables	-0.61	-0.75	-0.85	-0.88	-0.91	-0.95
Bakery Products	-2.21	-1.59	-1.31	-1.19	-1.09	-1.12
Pulses	-0.04	-0.36	-0.29	-0.29	-0.44	-0.57
Veg. Oil & Fat	-0.39	-0.47	-0.59	-0.65	-0.68	-0.75
Spices	-0.35	-0.53	-0.59	-0.69	-0.74	-0.77
Sugar & Sweets	-0.67	-0.79	-0.87	-0.90	-0.93	-0.95
Tea & Coffee	-0.54	-0.64	-0.74	-0.80	-0.86	-0.90
Soft Drink	-3.48	-7.75	-3.05	-1.18	-1.22	-1.14
Cigaret & Tobacco	-0.52	-0.68	-0.79	-0.91	-0.94	-0.97
Miscellaneous Food	-0.14	-0.07	-0.58	-0.68	-0.77	-0.92
All Food Items	**-0.77**	**-0.84**	**-0.88**	**-0.90**	**-0.93**	**-0.95**
Non-Food	**-0.86**	**-0.93**	**-0.95**	**-0.97**	**-0.99**	**-0.99**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.8

UNCOMPENSATED OWN-PRICE ELASTICITIES OF FOOD ITEMS OF URBAN HOUSEHOLDS BY INCOME GROUPS IN BALOCHISTAN, 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
Cereal	**-0.36**	**-0.52**	**-0.59**	**-0.62**	**-0.70**	**-0.71**
Wheat	-0.26	-0.45	-0.54	-0.52	-0.62	-0.63
Rice	-0.69	-0.81	-0.82	-0.92	-0.94	-0.96
Other Cereals	-0.36	-0.00	0.93	-0.21	-0.63	-0.40
L/Stock Products	**-0.87**	**-0.93**	**-0.97**	**-0.98**	**-0.99**	**-1.00**
Milk & Products	-0.85	-0.92	-0.97	-0.98	-0.99	-1.01
Mutton	-1.42	-1.28	-1.17	-1.11	-1.08	-1.05
Beef	-0.50	-0.66	-0.80	-0.76	-0.81	-0.89
Fish	-0.34	-0.55	-0.43	-0.71	-0.73	-0.86
Poultry	-5.72	-1.85	-1.51	-1.37	-1.10	-1.07
Fruits & Veg.	**-0.59**	**-0.73**	**-0.83**	**-0.85**	**-0.89**	**-0.94**
Fruits	-0.94	-0.97	-0.99	-1.00	-1.00	-1.01
Potatoes	-0.24	-0.39	-0.58	-0.59	-0.58	-0.70
Onions	-0.28	-0.49	-0.57	-0.59	-0.70	-0.69
Fresh Vegetables	-0.61	-0.75	-0.85	-0.88	-0.91	-0.95
Bakery Products	-2.21	-1.59	-1.31	-1.19	-1.09	-1.12
Pulses	-0.04	-0.36	-0.29	-0.29	-0.44	-0.57
Veg. Oil & Fat	-0.39	-0.47	-0.59	-0.65	-0.68	-0.75
Spices	-0.35	-0.53	-0.59	-0.69	-0.74	-0.77
Sugar & Sweets	-0.67	-0.79	-0.87	-0.90	-0.93	-0.95
Tea & Coffee	-0.54	-0.64	-0.74	-0.80	-0.86	-0.90
Soft Drink	-3.48	-7.75	-3.05	-1.18	-1.22	-1.14
Cigaret & Tobacco	-0.52	-0.68	-0.79	-0.91	-0.94	-0.97
Miscellaneous Food	-0.14	-0.07	-0.58	-0.68	-0.77	-0.92
All Food Items	**-0.77**	**-0.84**	**-0.88**	**-0.90**	**-0.93**	**-0.95**
Non-Food	**-0.86**	**-0.93**	**-0.95**	**-0.97**	**-0.99**	**-0.99**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.9

UNCOMPENSATED OWN-PRICE ELASTICITIES OF FOOD ITEMS OF RURAL HOUSEHOLDS BY INCOME GROUPS IN BALOCHISTAN, 1984-85

	Income Groups (Rs)					
Commodities	IG1	IG2	IG3	IG4	IG5	IG6
Cereal	**-0.54**	**-0.70**	**-0.73**	**-0.77**	**-0.78**	**-0.77**
Wheat	-0.48	-0.65	-0.66	-0.75	-0.76	-0.77
Rice	-0.97	-0.95	-0.96	-0.94	-0.93	-0.87
Other Cereals	0.03	-0.37	-0.25	-0.14	-0.35	-0.29
L/Stock Products	**-1.16**	**-1.05**	**-1.03**	**-1.01**	**-1.00**	**-0.99**
Milk & Products	-0.87	-0.91	-0.92	-0.92	-0.93	-0.92
Mutton	-1.95	-1.34	-1.26	-1.09	-1.08	-1.04
Beef	-0.41	-0.60	-0.76	-0.70	-0.60	-0.80
Fish	-0.40	-0.43	-0.37	-0.64	-0.73	-0.56
Poultry	-4.99	-1.63	-1.31	-1.18	-1.11	-1.12
Fruits & Veg.	**-0.93**	**-0.93**	**-0.93**	**-0.94**	**-0.95**	**-0.95**
Fruits	-1.70	-1.28	-1.19	-1.10	-1.06	-1.04
Potatoes	-0.50	-0.68	-0.74	-0.73	-0.75	-0.77
Onions	-0.51	-0.60	-0.67	-0.73	-0.66	-0.73
Fresh Vegetables	-0.86	-0.89	-0.89	-0.93	-0.94	-0.96
Bakery Products	-1.95	-1.24	-1.19	-1.13	-1.15	-1.04
Pulses	-0.80	-0.85	-0.86	-0.88	-0.91	-0.84
Veg. Oil & Fat	-0.36	-0.53	-0.59	-0.62	-0.68	-0.67
Spices	-0.53	-0.66	-0.70	-0.74	-0.81	-0.78
Sugar & Sweets	-0.70	-0.78	-0.82	-0.86	-0.88	-0.84
Tea & Coffee	-0.57	-0.67	-0.67	-0.74	-0.85	-0.85
Soft Drink	-145.38	-26.22	-9.17	-1.48	-1.21	-1.08
Cigaret & Tobacco	-1.87	-1.39	-1.18	-1.18	-1.06	-1.05
Miscellaneous Food	-3.53	-1.78	-1.53	-1.55	-1.14	-1.07
All Food Items	**-0.78**	**-0.85**	**-0.87**	**-0.89**	**-0.91**	**-0.90**
Non-Food	**-1.30**	**-1.17**	**-1.10**	**-1.07**	**-1.04**	**-1.01**

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.10

SAVINGS ELASTICITIES WITH RESPECT TO FOOD PRICES AND INCOME IN URBAN BALOCHISTAN BY INCOME CLASSES, 1984-85

	Income Groups (Rs)						
Commodities	Overall	IG1	IG2	IG3	IG4	IG5	IG6
A. With Respect to Prices:							
Wheat	-0.13	-0.53	-0.25	-0.21	-0.11	-0.08	-0.04
Rice	-0.01	-0.07	-0.03	-0.02	-0.01	-0.01	-0.00
Pulses	-0.13	-0.52	-0.25	-0.21	-0.11	-0.08	-0.04
Veg. Oil & Fat	-0.30	-1.23	-0.59	-0.48	-0.24	-0.18	-0.10
Milk & Products	-0.01	-0.08	-0.03	-0.02	-0.01	-0.00	0.00
Mutton	0.16	0.51	0.27	0.24	0.14	0.11	0.07
Beef	-0.08	-0.34	-0.16	-0.13	-0.06	-0.04	-0.02
Fish	-0.16	-0.67	-0.32	-0.26	-0.13	-0.10	-0.05
Poultry	0.09	0.32	0.16	0.13	0.07	0.05	0.03
Fruits	-0.00	-0.02	-0.01	-0.00	-0.00	0.00	0.00
Potatoes	-0.01	-0.05	-0.03	-0.02	-0.01	-0.01	-0.00
Onions	-0.01	-0.06	-0.03	-0.02	-0.01	-0.01	-0.00
Sugar & Sweets	-0.04	-0.17	-0.08	-0.06	-0.03	-0.02	-0.01
Tea & Coffee	-0.09	-0.37	-0.18	-0.14	-0.07	-0.05	-0.02
B. With Respect to Income:							
	1.16	1.83	1.40	1.62	1.20	1.37	1.32

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

TABLE 3.11

SAVINGS ELASTICITIES WITH RESPECT TO FOOD PRICES AND INCOME IN RURAL BALOCHISTAN BY INCOME CLASSES, 1984-85

	Income Groups (Rs)						
Commodities	Overall	IG1	IG2	IG3	IG4	IG5	IG6
A. With Respect to Prices:							
Wheat	-0.10	-0.26	-0.14	-0.11	-0.08	-0.06	-0.03
Rice	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Pulses	-0.03	-0.07	-0.04	-0.04	-0.03	-0.02	-0.01
Veg. Oil & Fat	-0.31	-0.82	-0.43	-0.32	-0.23	-0.19	-0.10
Milk & Products	-0.04	-0.08	-0.06	-0.05	-0.04	-0.03	-0.02
Mutton	0.25	0.77	0.35	0.24	0.15	0.12	0.05
Beef	-0.07	-0.19	-0.10	-0.08	-0.06	-0.05	-0.02
Fish	-0.11	-0.28	-0.15	-0.11	-0.08	-0.06	-0.03
Poultry	0.16	0.47	0.22	0.16	0.10	0.08	0.04
Fruits	0.05	0.15	0.07	0.04	0.03	0.02	0.01
Potatoes	-0.01	-0.03	-0.02	-0.01	-0.01	-0.01	-0.00
Onions	-0.01	-0.03	-0.02	-0.01	-0.01	-0.01	-0.00
Sugar & Sweets	-0.06	-0.14	-0.08	-0.06	-0.05	-0.04	-0.02
Tea & Coffee	-0.10	-0.24	-0.13	-0.10	-0.07	-0.06	-0.03
B. With Respect to Income:							
	0.99	1.37	1.22	1.25	1.25	1.54	1.62

IG = Income Group;
IG1 ≤ Pak Rs. 1000; IG2 = 1000 - 1500;
IG3 = 1500 - 2000; IG4 = 2000 - 3000;
IG5 = 3000 - 5000; IG6 > 5000;

particular group. The elasticity of saving with respect to overall commodity prices ranges from -0.01 to 0.16 and -0.01 to 0.25 for urban and rural households, respectively. If we compare saving elasticities by commodity across the region, we find that saving is more responsive to changes in prices for households in the low income classes in comparison to households in high income classes in both urban and rural regions. Saving elasticity with respect to mutton, poultry and fruit prices shows positive relation in rural and urban regions with high saving elasticity in case of low income group. It indicates that increase in prices of these commodities reduce their consumption while increase in prices of basic food commodities have negative relation with saving.

Price and income elasticities calculated in this study are very much similar to those in previous studies but the magnitude of the elasticities differ.

Summary and Conclusions

Although population growth has expanded aggregate demand for all foods, important changes in food consumption patterns have occurred over the past two decades due to changes in income and its distribution, urbanization, and public policies which have influenced absolute and relative price levels of various food commodities. Analysis shows a continuing strong demand for food commodities in Balochistan. This result is based upon three factors. (1) Over 65 percent of all households are currently in the lowest two income groups (Table 3.1) where the marginal budget shares for food are the highest (Tables 3.4 and 3.5). As incomes increase for these households, expenditures for food will increase significantly. (2) Urban households have higher marginal budget shares compared to rural households for lower income groups (compare Table 3.4 with Table 3.5). As urbanization of the population continues, expenditures for food will increase at an increasing rate. (3) Food in general is less price elastic at the lower income levels (Tables 3.8 and 3.9) where the majority of families are grouped implying strong demand for basic food commodities irrespective of prices. Food price policy thus will have little impact on total food consumption although price policy may significantly effect nutrition levels.

A major concern of public policy is to stabilize domestic production and the supply of basic food commodities to meet the expected increase in demand due to population and income growth. More comprehensive policies in addition to pricing policies are needed to stimulate agricultural production, particularly in dryland areas such as Balochistan. Timely access to modern inputs such as seeds, fertilizer, improved production technology, and credit must be facilitated. Agricultural intensification is essential to meet future food needs, raise the living standards of the poor, and reduce the degradation of resources. Traditional "green-revolution-type" technology offers great opportunities for sustainable food production expansions. Furthermore, alternative technologies and farming practices already exist for sustainable food production that involve appropriate crop rotations, mixed farming systems with crops and livestock, agroforestry, integrated pest management, disease and pest-resistant varieties, balanced application and correct timing and placement of fertilizer, and minimum or zero tillage . Many of these options can be competitive in terms of their profitability to farmers. However, additional agricultural research and extension services are needed for the more marginal and dryland areas to assure continued increases in food production.

The results presented and discussed in this paper highlight the fact that, among different food items within agriculture, the demand for non-grain commodities such as poultry, mutton, fruits, and milk is likely to grow at a relatively faster rate compared to basic food grains. Thus, when planning for the development of the agricultural sector to increase the overall food supply, particular attention needs to be given to the development of poultry, livestock, and fruit orchards so as to raise the output of these sub-sectors to meet expected future demand. Moreover, price policy for basic food commodities such as wheat and rice should ensure that the interests of the poor households including producers are protected. The results further suggest that the demand responses for different food items vary between urban and rural areas as well as by household income class size. For effective policy-making, it is important to take account of such differences. The availability of demand parameters for different groups of households makes it possible to evaluate the impact of policy reform on specific segments of society. No single policy will assure long-term food security for marginal dryland regions such as Balochistan, Pakistan. However, development policies and programs to prevent food insecurity and malnutrition should benefit from results of this research on estimation of demand parameters for dryland regions.

CHAPTER IV

REGIONAL SUPPLY RESPONSE OF MAJOR FOOD AND CASH CROPS IN BALOCHISTAN, PAKISTAN

Introduction

The pressure to feed a rapidly growing population has increased the significance of agriculture and food production in regions not traditionally considered as major sources of food and fiber and recipients of past development efforts. About 75 percent of Pakistan's total geographical area of 87.98 million hectares (m ha) or about 25 percent of the cultivated area of 20.43 m ha is rainfed with limited production (GOP, 1988). Rainfed areas in Pakistan produce about 11 percent of the national wheat production and about 69, 31, 53, 65, 17, 82, and 20 percent of sorghum, millet, barley, chickpea, pulses, peanut, and oil seeds, respectively (GOP, 1991). These areas represent too large a resource to be ignored in future development efforts.

Balochistan, a significant rainfed region of Pakistan, comprises 44 percent of the total geographical area but approximately five percent of the national population. Population in Balochistan has been growing more than double the growth rate at the national level. Balochistan province has a total land area of 34.7 m ha of which only 4 percent or 1.47 m ha is under cultivation. About 60 percent of the cultivated area is rainfed (GOB, 1991). It has nearly one-third of the country's sheep and goat population and 80 percent of the livestock population, all sustained by the rainfed lands of the province (GOP, 1992).

Overcoming problems of regional production deficits and maintaining sufficient supplies of basic food commodities in the presence of a high national population growth rate (3.2 percent) appears difficult without the development of rainfed agriculture in Pakistan. To date, public policies and plans have mainly focused on development and improvement of agriculture in the irrigated regions. This has resulted in declining soil fertility due to high cropping intensity. To maintain or improve productivity requires intensive input use, specifically agricultural chemicals which may adversely effect underground water quality.

Climatic variation and uncertainty pose serious problems for crop and livestock production in the rainfed areas of the country, including the province of Balochistan. The solutions to low agricultural productivity in dry regions are elusive and there exists no clear public policy on how to overcome these problems. A primary problem resulting from the variability in production is instability of income for rural households. Lack of basic marketing and communication infrastructure further reduces the opportunities of development and employment in the area. This results in low incomes and living standards, and ultimately leads to substantial interregional disparities.

Higher production in agriculture might be achieved by improving efficiency in the use of inputs and by reducing post harvest losses. Primitive methods of farming with out-dated means of harvesting, inefficient use of irrigation water and other inputs adversely affects productivity in the arid and semi-arid regions of Balochistan, which are far below other country's similar regions. Price support policy in certain commodities stabilizes prices but benefits slip away from the producers as most of the farmers sell their produce before harvesting.

The response of farm production to expected commodity prices is a key relationship in developing agricultural policy. Both the level and composition of production are major objectives of economic policies. The agricultural supply relationship is the result of decisions with multiple goals or incentives. Therefore, a sound policy designed to obtain a desired level and composition of production rests on a thorough understanding of regional agricultural production systems.

Rainfed regions have not received adequate attention and significant disparities have occurred between regional rural household income in these regions versus the well developed irrigated regions. There is a need to determine the direction and magnitude of interactions among crops and the factors influencing rainfed regional supply. These estimated parameters of supply response are particularly useful in welfare analysis to estimate the effects of alternative price policy options on producers. This paper focuses on supply response by estimating direct and cross price elasticities and the corresponding short-run and long-run price elasticities for food and cash crops grown in Balochistan region. These elasticities are estimated to assess the impact of development and improvement of mechanization and irrigation resources on production.

Supply Analysis

Several streams of research have been pursued to address the response of crop production and hectarage to changes in output prices and other variables. Judging by the number of related studies since the late 1950's, Nerlove's seminal formulation of agricultural supply response (1956, 1958) is certainly one of the most successful econometric models introduced into the literature. The large body of work on application of the Nerlovian model in developing countries can be found in the studies by Askari and Cummings, Henneberry, and Chaudhry. The econometric procedure used to estimate the adaptive expectation Nerlovian model has been strongly criticized (Baltas; Braulke; Colman; Jennings and Young). Some critics have expressed concern over the statistical problems which arise when using ordinary least squares (OLS). Others have questioned the adaptive expectations assumptions of the model.

Falcon, after examining the supply response of area and yield of important crops in West Pakistan, concludes that aggregate supply elasticity is zero. Due to a change in price structure, the cropping pattern is changed and, therefore, total production may increase. Tweeten (1986) estimated own- and cross-price elasticities of supply for major crops and livestock in Pakistan. He first estimated the own-price elasticity of each crop and then used these estimates to calculate cross-price elasticities applying the factor share approach. Both short- and long-run cross elasticities were mostly, very small. In the area of acreage response analysis, studies using adaptive expectations have included analysis of U.S. (Lidman and Bawden) and Canadian (Schmitz) wheat supply. Houck and Ryan, and Ryan and Abel (1973a, 1973b) analyzed feed grain supply response to effective support prices and application to several crops were made (Gardner).

Second, programming models have formed the basis for development of the "representative farm" approach to supply estimation (Sharples; Tomek and Robinson).

Extensions have included multiple product approaches based on constant elasticity of transformation (CET) production functions (Green; Shumway and Chang) and more recently, mathematical programming models developed by Hazell and Norton. However, there have been few applications in developing countries because of limitations of data (Colman).

A third body of work has, in recent years, begun to address the important role played by risk-related variables in agricultural supply response (Just; Traill; Whittaker). Introduction of risk related variables in supply modeling is a growing field of study (Behrman; Just; Wolgin; Adesina and Brorsen). Risk analysis, however, may be less important in estimating supply response because of price support policy for basic food commodities in Pakistan.

The 'supply relation' means the relation between the quantities of a product which would be produced at different 'expected' prices under given conditions of technology, input prices, etc. during a specified time period. In the context of crop enterprises in the agricultural sector, the supply relation in agriculture shows the production of crops which would be produced in response to expected prices of the output during a specified period, after keeping constant other variables affecting production such as (i) prices of inputs, (ii) prices of other crops, (iii) mechanization, (iv) total irrigated area, (v) weather, etc.

The nature of supply elasticity, i.e., direction and magnitude of supply elasticity, depends upon (a) the nature of the production function during the supply period, (b) the nature of the markets of inputs, including the flexibility of prices and the elasticity of supply of inputs, (c) cost structure as regards fixed and variable cost, (d) the motivating force behind the production response of farmers, and (e) the price expectation of farmers (Tomek and Robinson). The supply process involving these factors is described below.

When the price of a product increases, the marginal value product (MVP) of the resources used also increase and, therefore, it becomes profitable to employ more resources until the equilibrium between MVPs and prices of inputs is restored. In the short-run, additional variable resources applied with fixed resources cause marginal products of the variable resources to decline rapidly. This causes the marginal cost curve, which is the same as the supply curve in perfect competition, to rise steeply. Thus, the elasticity of production in the short-run is low because most resources are fixed. In the long-run, most resources become variable and, therefore, the supply curve becomes less steep when diminishing returns to scale prevail and nearly horizontal when constant returns to scale prevail.

The supply process described above involves two results, i.e. cross-elasticity of input demand with respect to product price and the elasticity of production with respect to input:

$$E_{P_i} = [\partial X_i / \partial P_y * P_y / X_i][\partial Y / \partial X_i * X_i / Y] \qquad (1)$$

where E_{pi} is the partial supply elasticity; P_y is output price, Y is production, X_i is input and i=1.........n inputs. Total supply elasticity may be expressed as:

$$E_p = \Sigma_i \; b_{ip} \; d_i \qquad (2)$$

where b_{ip} are demand elasticities of inputs X_i with respect to commodity price and d_i are elasticities of production with respect to inputs X_i. However, the above relationship assumes infinite elasticity of input supply with respect to its own price, which is not true at the market level. The following formula takes into account supply elasticity of inputs:

$$E_p = bd / 1 + b - bd \qquad (3)$$

where b is input supply elasticity and d is the elasticity of production with respect to inputs. Given b or d, the E_p is determined by the other.

It can be concluded that in addition to production elasticity, the mobility or substitutability of resources from one use to another affects the supply elasticity. Conditions in the factor market determine the transfer of resources to and from other competitive uses. Individual crops have more elastic supply, as shown in various studies, because most resources can be shifted easily from one commodity to another.

Most studies on supply response in developing countries actually model hectarage rather than production responses. Hectarage is used as a proxy for two reasons. First, in an adaptive expectation framework, actual output may differ considerably from the desired output due to environmental factors which are beyond the farmers' control. The second reason for the use of hectarage in lieu of output is based on the relation between production, hectarage and yield:

$$Q = A * Y \quad (4)$$

where Q = production, A = hectarage, and Y = yield.

Given equation (4), the total elasticity of output with respect to price can be expressed as (Tweeten, 1986):

$$E_{QP} = E_{YP} + E_{AP}(1 + E_{YA}) \quad (5)$$

where

E_{QP} = elasticity of production (Q) with respect to price (P);
E_{AP} = elasticity of hectarage (A) with respect to price (P);
E_{YP} = elasticity of yield (Y) with respect to price (P); and
E_{YA} = elasticity of yield (Y) with respect to area (A).

If the elasticity of yield with respect to area E_{YA} is zero, the total supply elasticity E_{QP} is the sum of the yield E_{YP} and area E_{AP} components. The elasticity for the interaction between yield and acreage can be obtained directly from the coefficient of the logarithm of the area variable A in a statistical yield equation (logarithm of Y dependent variable) including independent variables for current area A as well as for prices, irrigation infrastructure, and mechanization. If the expansion of area is on marginal lands, E_{YA} will be negative.

Dynamic models have ignored the elasticity of yield because of the low yields in developing countries as compared to price variabilities experienced. Hence, the output response studies are conducted as hectrage response studies. However, in a period of rapid yield growth (induced by yield-augmenting technical changes such as irrigation, fertilizers, high-yielding varieties, and mechanization), the determinants of output, hectarage and yield, would respond to price changes. It is only logical to conclude that at the early age of development in developing countries where land is abundant (not a limiting factor for the time-being), farmers will respond to output price increases by expanding their planted area since land is easy to access. However, when the availability of marginal land to expand is a limiting factor, output response will be more linked to yield increase through alternative production practices. Input application rates depend on returns and costs. Economic theory suggests that costless (fully subsidized) inputs should be applied at a level per land unit until the marginal product is zero.

Model Specification for Balochistan

The major crops grown in Balochistan are wheat, rice, barley, sorghum, maize for grain, cumin, melons, tobacco, potatoes, onions for cash, oilseeds, and winter and summer pulses. These crops account for about 83 percent of cropland. These crops account for 99 percent of foodgrains, 90 percent of cash crops, 91 percent of oilseeds, and 78 percent of pulses in the region. Fruits, vegetables and fodder crops are not considered in this study and constitute the remaining 17 percent of the cropland.

A completely specified supply model would be a simultaneous system involving determination of production, input demand, and cross-product effects. But such a model requires data on prices and quantities of inputs and outputs and other causal factors for a long period of time. Such data are generally not available and, therefore, less comprehensive systems are proposed.

The supply model should include not only the crop's own but also competing crops' input and output prices. Expected price is defined as a linear function of past prices. Using the higher of lagged price or target price is commonly used, but may underestimate expected price because it fails to account for the time value of the option provided by government programs (Kang and Brorsen). Input prices used as independent variables include prices paid by farmers for fertilizers and other important variable inputs. Fertilizer price provides an opportunity to examine the impact of input taxes or subsidies on cropping pattern.

Theoretically, the production, acreage and yield response model for Balochistan is specified as follows:

(a) Quantity Supply Function:

$$Q_i = f(P_i, P_c, P_f, TIA, M, O) \qquad (6)$$

(b) Acreage Supply Function:

$$A_i = f(P_i, P_c, P_f, TIA, M, O) \qquad (7)$$

(c) Yield Supply Function:

$$Y_i = f(P_i, P_f, TIA, M, O) \qquad (8)$$

where Q_i is production of crop i, A_i is area under crop i and Y_i is yield of crop i. The explanatory variables are P_i commodity own prices, P_c prices of competing crops, P_f prices of inputs (fertilizer), TIA proportion of crop area irrigated, M index of mechanization or other infrastructure (i.e. number of tractors and bulldozers, etc.), and O other variables. Lagged dependent variable is used as an independent variable in production and acreage equations to obtain an adjustment coefficient required for estimating long-run price elasticities.

All input and output prices were taken from the Balochistan Department of Agricultural Extension (1975-1991) and Agricultural Statistics of Pakistan (1975-1991). All the nominal prices were deflated by the GDP deflator. Data on production and harvested acreages in Balochistan province of Pakistan during 1975-1991 were obtained from the Agricultural Statistics of Balochistan and Agricultural Statistics of Pakistan (GOB; GOP).

A variety of statistical models, linear, log-linear, exponential, etc. can be used in supply analysis. Generally, the choice of the model is based upon theoretical considerations of relationships involved, past experience and statistical considerations, such as goodness of fit as measured by R^2, standard errors, etc.

It is assumed that the residuals should be independent and normally distributed around mean zero, i.e., $E(U_i)=0$ for all i and $E(U_iU_j)=0$ and $E(U_iU_j)=\sigma^2$ for i=j where i and j= 1...n. Furthermore, it is assumed there is no extremely high degree of correlation among the independent variables and there are no systematic errors in the observations. If these assumption do not hold, the estimates obtained are generally biased or have low precision. The most frequent problem when using time-series data is autocorrelation (i.e. correlation between error terms for each crop in succeeding years).

Most of the available tests for autocorrelation are based on the principle that if the true disturbances are autocorrelated, this will be revealed through the autocorrelations of the least squares residuals. The most widely used test is the Durbin-Watson test. The test statistic is

$$d = \Sigma_{t=2} (e_t - e_{t-1})^2 \; / \; \Sigma_{t=1} e_t^2 \qquad (9)$$

where e_t indicates the disturbance term for time period t. However, the Durbin-Watson test is not likely to be valid when there is a lagged dependent variable in the equation. The statistic will usually be biased toward a finding of no autocorrelation. In this case Durbin's h statistic or Breusch-Godfrey statistic may be carried out (Judge 1988, pp. 394-401):

$$h = (1 - d/2) \sqrt{(T/1 - Ts^2)} \qquad (10)$$

where s^2 is the estimated variance of the least squares regression coefficient on the dependent variable and T is the number of observations.

Because land allocation imposes joint production decisions and disturbances for different crops reflect common factors (e.g., climate and the general state of the economy), contemporaneous correlation (i.e., correlation between errors for different crops) likely exists.

Contemporaneous correlation is tested using the Lagrange Multiplier test suggested by Breusch and Pagan (Greene 1993, p. 515).

Results and Discussion

This section presents the estimates of the parameters of the structural equations of production, hectarage, and yield models, and discusses the economic implications of the results obtained. Variables in linear and logarithmic terms were considered for each model. The levels of significance accepted in the statistical results were 1 percent, 5 percent, 10 percent, and 20 percent. Three reasons were considered for the selection of these levels of significance. First, all variables included in the models were at the regional aggregate level; therefore, data manipulation could distort the "true" relation among the variables. Second, limited number of data observations provides the basis for acceptance of the level of significance up to 20 percent. Third, consistency with economic theory was considered to be an important reason for leaving a variable in the model.

The average response equations for the nine major crops in Balochistan were estimated using Seemingly Unrelated Regression. The Lagrange-Multiplier statistic is 51.34 for the nine-equation system. The five percent critical value for the Chi-distribution with 36 degrees of freedom is less than the calculated value. Thus, the null hypothesis of no contemporaneous correlation is strongly rejected. The results suggest that the nine equations should be estimated using Seemingly Unrelated Regression method.

Positive coefficients with respect to own-price were obtained for all crops. A high majority of coefficients were statistically significant. Further, it was observed that the magnitude of the coefficients were generally stable except for a few price variables. In view of these considerations and the econometric criteria mentioned above, production, acreage and yield response equations are suggested as the true estimates of food and cash crop supplies in the region.

The estimates of the production model coefficients are presented in Tables 4.1, 4.2 and 4.3. The overall short-run and long-run supply elasticities estimated using the coefficients are presented in Table 4.10. Overall, the models for all crops fit the data well. A large proportion of the variation in cropping patterns is explained by the independent variables.

The own-price and competing crop's variables perform reasonably well. Of the nine coefficients of the expected prices, seven are significant at the 10 percent level or better. The signs of the own-price production elasticities are as expected for all nine crops.

Among the input prices, in this study price of fertilizer, eight of the nine coefficients are significant at 10 percent level or better, and one is significant at the 30 percent level (the coefficient for onion crop). The average elasticities with respect to fertilizer price indicate that production of potatoes, wheat and tobacco are more sensitive to fertilizer price than the production of pulses and barley.

The ranking of the nine crops in terms of the magnitude of the production elasticities is cumin, wheat, potato, tobacco, oil-seed, melons, barley, onion and pulses. Magnitude of the estimated elasticities are high when compared with previous studies for each crop. However, most previous studies are based on country level data. Possible reasons for high elasticities include, first, each crop was estimated independently from other crops. Resources may be easily substituted and transferred from one crop to the other crop. Second, this study was

TABLE 4.1

ESTIMATES OF PRODUCTION RESPONSE FOR FOOD AND CASH CROPS (WHEAT, RICE, OILSEED) IN BALOCHISTAN, 1975-1991

Variable	Wheat	T for H_0: Parame.=0[a]	Rice	T for H_0: Parame.=0[a]	Oil-seed	T for H_0: Parame.=0[a]
Intercept	7.24	4.24	-10.83	-4.57	-13.73	-1.71
RPWF1	0.68	3.19			-0.10	-0.17
RPRF1			1.39	2.30		
RPOF1	-0.31	-3.18			0.72	2.75
RPPUF1			-0.41	-1.72		
TRACT	0.95	4.54				
TIA			1.29	2.09	2.97	2.59
LWHTTP	-0.13	-0.51				
LRICTP			1.01	8.04		
LOSDTP					-0.28	-0.95
R^2	0.99		0.99		0.95	
Adj R^2	0.99		0.99		0.93	
DW	2.60		2.84		1.98	
F	5250.15		368.39		50.95	

Variable definition:

RPWF1 = $(PWHT/PFER)_{t-1}$
RPOF1 = $(POSD/PFER)_{t-1}$
RPRF1 = $(PRIC/PFER)_{t-1}$
RPPUF1 = $(PPUL/PFER)_{t-1}$
PPUL = Price of Pulses (Rs/MT)
TRACT = Mechanization (No. of tractors and bulldozers);
WITR = Ratio of irrigated to total cropped area under wheat;
TIA = Total irrigated area in Balochistan (ha);
PWHT = Price of wheat (Rs./MT);
POSD = Price of Oil seed crops (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
LWHTTP = Lagged wheat production in Balochistan in metric tons (MT);
LRICTP = Lagged rice production in Balochistan (MT);
LOSDTP = Lagged oil seed production in Balochistan (MT);
Note: All equations are in log form.

[a] The 1%, 5%, 10% and 20% critical values of the t-distribution are 2.65, 1.77, 1.35 and 0.87, respectively.

TABLE 4.2

ESTIMATES OF PRODUCTION RESPONSE FOR FOOD AND CASH CROPS (GRAMS, MOONG, CUMIN) IN BALOCHISTAN, 1975-1991

Variable	Grams	T for H_0: Parame.=0[a]	Moong	T for H_0: Parame.=0[a]	Cumin	T for H_0: Parame.=0[b]
Intercept	-15.64	-2.91	7.35	5.49	-8.12	-2.69
RPGF1	2.28	2.37				
RPMGF1			0.21	0.67		
RC					1.03	1.63
RPOF1	-1.89	-1.77				
RPMZF1			-0.20	-0.67		
RO					-1.96	-2.63
TRACT	3.11	3.64	0.30	2.25	2.28	5.70
TIA						
LGRMTP	-0.09	-0.46				
LMNGTP			-0.29	-1.11		
LCUMTP					-0.53	-2.43
R^2	0.64		0.92		0.98	
Adj R^2	0.50		0.89		0.97	
DW	1.73		2.30		1.47	
F	4.82		31.51		98.99	

Variable definition:

RPGF1 = $(PGRM/PFER)_{t-1}$

RPMGF1 = $(PMNG/PFER)_{t-1}$

RPCF1 = $(PCUM/FRER)_{t-1}$

RPMZF1 = $(PMZ/PFER)_{t-1}$

PMZ = Price of Maize (Rs/MT)

PGRM = Price of Grams (Rs/MT)

$RC=.50*(PCUM/PFER)_t + 0.33*(PCUM/PFER)_{t-1} + 0.17*(PCUM/PFER)_{t-2}$

$RO=.50*(POSD/PFER)_t + 0.33*(POSD/PFER)_{t-1} + 0.17*(POSD/PFER)_{t-2}$

TRACT = Mechanization (No. of tractors and bulldozers);

CITR = Ratio of irrigated to total cropped area under cumin;

TIA = Total irrigated area in Balochistan (ha);

PCUM = Price of cumin (Rs./MT);

PMNG = Price of Moong beans (Rs/MT);

PFER = Price of Fertilizer (Rs/MT);

LGRAMTP = Lagged grams production in Balochistan (MT);

LCUNTP = Lagged cumin production in Balochistan (MT);

LMNGTP = Lagged moong beans production in Balochistan (MT);

[a] The 1%, 5%, 10% and 20% critical values of the t-distribution are 2.65, 1.77, 1.35 and 0.87, respectively.

[b] The 1%, 5%, 10% and 20% critical values of the t-distribution are 2.68, 1.78, 1.36 and 0.87, respectively.

TABLE 4.3

ESTIMATES OF PRODUCTION RESPONSE FOR FOOD AND CASH CROPS (ONIONS, MELONS, TOBACCO) IN BALOCHISTAN, 1975-1991

Variable	Onions	T for H_0: Parame.=0[a]	Melons	T for H_0: Parame.=0[a]	Tobacco	T for H_0: Parame.=0[a]
Intercept	4.37	2.88	3.54	3.17	2.93	1.35
RON	0.52	0.98				
RM			0.67	1.57	-0.23	-0.99
RT					0.58	2.28
RPO	-0.50	-0.65				
RMZ			-1.02	-2.13		
TRACT	0.88	2.87	1.66	3.78	0.35	2.85
LONITP	0.03	0.08				
LMELTP			-0.40	-1.17		
LTOBTP					0.20	0.77
R^2	0.99		0.99		0.99	
Adj R^2	0.98		0.99		0.99	
DW	1.56		2.42		3.02	
F	174.65		454.64		394.87	

Variable definition:

$RPO=.50*(PPOT/PFER)_t + 0.33*(PPOT/PFER)_{t-1} + 0.17*(PPOT/PFER)_{t-2}$

$RM=.50*(PMEL/PFER)_t + 0.33*(PMEL/PFER)_{t-1} + 0.17*(PMEL/PFER)_{t-2}$

$RT=.50*(PTOB/PFER)_t + 0.33*(PTOB/PFER)_{t-1} + 0.17*(PTOB/PFER)_{t-2}$

$RON=.50*(PONI/PFER)_t + 0.33*(PONI/PFER)_{t-1} + 0.17*(PONI/PFER)_{t-2}$

$RMZ=.50*(PMAZ/PFER)_t + 0.33*(PMAZ/PFER)_{t-1} + 0.17*(PMAZ/PFER)_{t-2}$

TRACT = Mechanization (No. of tractors and bulldozers);
PPOT = Price of potatoes (Rs./MT);
PMEL = Price of Melons (Rs/MT); PTOB = Price of Tobacco (Rs/MT);PONI
PONI = Price of onions (Rs/MT); PPUL = Price of Pulses (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
LONITP = Lagged potato production in Balochistan (MT);
LMELTP = Lagged melon production in Balochistan (MT);
LTOBTP = Lagged tobacco production in Balochistan (MT);

[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.68, 1.78, 1.36 and 0.87, respectively.

based on data available at the regional level and crop substitutions may occur across regions. Third, special programs from federal and provincial governments including investment in basic infrastructure, emphasis on the development of the agricultural sector in the neglected regions to reduce regional food deficiencies, and upgrading living standards and socio-economic conditions of the peoples living in arid and semi-arid regions such as Balochistan may influence supply elasticities.

High coefficients of the explanatory variables for mechanization and investment in the development and extension of irrigation infrastructure indicate the government's keen interest in the development of marginal regions by providing infrastructure investment and subsidized credit for the purchase of tractors and installation of tubewells.

The estimated coefficients of acreage response models for all nine crops are presented in Tables 4.4, 4.5, and 4.6. The own-price coefficients are positive and statistically significant at less than the 10 percent probability level for almost all nine crops. Coefficients for investment in the expansion and development of irrigation infrastructure and mechanization were highly significant. The lagged dependent variable had negative sign but insignificant in most equations. Acreage response shows that a significant portion of the increase in cropped area was brought under wheat production as compared to other crops.

Tables 4.7, 4.8 and 4.9 present the estimated coefficients for yield response in the region. Own price coefficient in the case of wheat crop was small and comparatively less significant than the acreage response coefficient. This means that the increase in production of wheat in the region was primarily due to expansion in area under wheat crop. This is also true for other crops except potato, melons and tobacco where yield and acreage coefficients

TABLE 4.4

ESTIMATES OF ACREAGE RESPONSE FOR FOOD AND CASH CROPS (WHEAT, RICE, OIL SEED) IN BALOCHISTAN, 1975-1991

Variable	Wheat	T for H_0: Parame.=0[a]	Rice	T for H_0: Parame.=0[a]	Oil-seed	T for H_0: Parame.=0[a]
Intercept	10.86	5.25	-11.70	-1.92	0.32	0.06
RPWF1	0.58	2.78			-0.11	-0.52
RPRF1			0.61	0.82		
RPOF1	-0.33	-2.87			0.28	1.70
RPPUF1			-0.10	-0.33		
TRACT	0.58	4.99				
TIA			1.74	2.29	1.63	2.10
LWHTTA	-0.23	-1.01				
LRICTA			0.71	2.92		
LOSDTA					-0.42	-1.90
R^2	0.99		0.97		0.93	
Adj R^2	0.99		0.96		0.91	
DW	2.60		2.84		1.98	
F	1385.26		100.45		38.06	

Variable definition:
RPWF1 = $(PWHT/PFER)_{t-1}$
RPOF1 = $(POSD/PFER)_{t-1}$
RPRF1 = $(PRIC/PFER)_{t-1}$
RPPUF1 = (PPUL/PFER)
PPUL = Price of Pulses (Rs/MT)
TRACT = Mechanization (No. of tractors and bulldozers);
WITR = Ratio of irrigated to total cropped area under wheat;
TIA = Total irrigated area in Balochistan (ha);
PWHT = Price of wheat (Rs./MT);
POSD = Price of Oil seed crops (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
LWHTTP = Lagged wheat production in Balochistan (MT);
LRICTP = Lagged rice production in Balochistan (MT);
LOSDTP = Lagged oil seed production in Balochistan (MT);
Note: All equations are in log form.
Numbers in parenthesis are estimates of standard errors.
[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.65, 1.77, 1.35 and 0.87, respectively.

TABLE 4.5

ESTIMATES OF ACREAGE RESPONSE FOR FOOD AND CASH CROPS (GRAMS, MOONG, CUMIN) IN BALOCHISTAN, 1975-1991

Variable	Grams	T for H_0: Parame.=0[a]	Moong	T for H_0: Parame.=0[a]	Cumin	T for H_0: Parame.=0[b]
Intercept	-9.15	-1.80	8.74	3.88	-4.39	-2.71
RPGF1	2.62	2.71				
RPMGF1			0.09	0.21		
RC					1.64	4.22
RPOF1	-1.07	-1.03				
RPMZF1			-0.34	-0.81		
RO					-2.41	-4.99
TRACT	2.33	2.89	0.09	0.65	1.72	6.04
TIA						
LGRMTA	-0.16	-0.84				
LMNGTA			-0.13	-0.43		
LCUMTA					-0.44	-2.00
R^2	0.57		0.53		0.98	
Adj R^2	0.42		0.36		0.97	
DW	1.73		2.30		1.47	
F	3.68		3.14		98.99	

Variable definition:

RPGF1 = $(PGRM/PFER)_{t-1}$

RPMGF1 = $(PMNG/PFER)_{t-1}$

RPCF1 = $(PCUM/PFER)_{t-1}$

RPOF1 = $(POSD/PFER)_{t-1}$

RPMZF1 = $(PMZ/PFER)_{t-1}$

PMZ = Price of Maize (Rs/MT)

PGRM = Price of Grams (Rs/MT)

$RC = .50*(PCUM/PFER)_t + 0.33*(PCUM/PFER)_{t-1} + 0.17*(PCUM/PFER)_{t-2}$

$RO = .50*(POSD/PFER)_t + 0.33*(POSD/PFER)_{t-1} + 0.17*(POSD/PFER)_{t-2}$

TRACT = Mechanization (No. of tractors and bulldozers);

CITR = Ratio of irrigated to total cropped area under cumin;

TIA = Total irrigated area in Balochistan (ha);

PCUM = Price of cumin (Rs./MT);

PMNG = Price of Moong beans (Rs/MT);

PFER = Price of Fertilizer (Rs/MT);

LGRMTA = Lagged grams production in Balochistan (MT);

LCUMTP = Lagged cumin production in Balochistan (MT);

LMNGTP = Lagged Moong beans production in Balochistan (MT);

[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.65, 1.77, 1.35 and 0.87, respectively.

[b] The 1%, 5%, 10% and 20% critical values of the t-distribution are 2.68, 1.78, 1.36 and 0.87, respectively

TABLE 4.6

ESTIMATES OF ACREAGE RESPONSE FOR FOOD AND CASH CROPS (ONIONS, MELONS, TOBACCO) IN BALOCHISTAN, 1975-1991

Variable	Onions	T for H_0: Parame.=0[a]	Melons	T for H_0: Parame.=0[a]	Tobacco	T for H_0: Parame.=0[a]
Intercept	3.23	2.78	2.15	2.59	1.81	0.99
RON	0.04	0.08				
RM			0.52	1.52	-0.34	-1.60
RT					0.33	1.48
RPO	-0.54	-0.87				
RMZ			-1.02	-2.60		
TRACT	0.67	2.58	1.33	4.58	0.24	1.93
LONITA	0.02	0.05				
LMELTA			-0.36	-1.31		
LTOBTA					0.44	1.49
R^2	0.99		0.99		0.99	
Adj R^2	0.98		0.99		0.99	
DW	1.56		2.42		3.02	
F	225.67		605.61		1063.18	

Variable definition:

$RPO=.50*(PPOT/PFER)_t + 0.33*(PPOT/PFER)_{t-1} + 0.17*(PPOT/PFER)_{t-2}$

$RM=.50*(PMEL/PFER)_t + 0.33*(PMEL/PFER)_{t-1} + 0.17*(PMEL/PFER)_{t-2}$

$RT=.50*(PTOB/PFER)_t + 0.33*(PTOB/PFER)_{t-1} + 0.17*(PTOB/PFER)_{t-2}$

$RON=.50*(PONI/PFER)_t + 0.33*(PONI/PFER)_{t-1} + 0.17*(PONI/PFER)_{t-2}$

$RMZ=.50*(PMAZ/PFER)_t + 0.33*(PMAZ/PFER)_{t-1} + 0.17*(PMAZ/PFER)_{t-2}$

TRACT = Mechanization (No. of tractors and bulldozers);
PPOT = Price of potatoes (Rs./MT);
PMEL = Price of Melons (Rs/MT); PTOB = Price of Tobacco (Rs/MT);PONI
PONI = Price of onions (Rs/MT); PPUL = Price of Pulses (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
LONITP = Lagged onion production in Balochistan in metric tons (MT);
LMELTP = Lagged melon production in Balochistan (MT);
LTOBTP = Lagged tobacco production in Balochistan (MT);

[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.68, 1.78, 1.36 and 0.87, respectively.

TABLE 4.7

ESTIMATES OF YIELD RESPONSE FOR FOOD AND CASH CROPS (WHEAT, RICE, OIL SEED) IN BALOCHISTAN, 1975-1991

Variable	Wheat	T for H_0: Parame.=0[a]	Rice	T for H_0: Parame.=0[a]	Oil-seed	T for H_0: Parame.=0[a]
Intercept	-1.32	-8.31	2.02	0.94	-6.29	-1.71
RPWF1	0.09	1.55				
RPRF1			0.03	0.06		
RPOF1					0.26	4.05
TRACT	0.25	13.75	-0.33	-0.92		
TCRPA					0.66	5.24
CFER			0.66	1.99		
OITR					0.15	2.90
WITR	0.43	7.11				
R^2	0.99		0.92		0.99	
Adj R^2	0.99		0.91		0.99	
DW	2.60		2.84		1.98	
F	207400.01		52.06		1994.61	

Variable definition:

RPWF1 = $(PWHT/PFER)_{t-1}$
RPOF1 = $(POSD/PFER)_{t-1}$
RPRF1 = $(PRIC/PFER)_{t-1}$
RPPUF1 = $(PPUL/PFER)_{t-1}$
PPUL = Price of Pulses (Rs/MT)
TRACT = Mechanization (No. of tractors and bulldozers);
WITR = Ratio of irrigated to total cropped area under wheat;
TIA = Total irrigated area in Balochistan (ha);
PWHT = Price of wheat (Rs./MT);
POSD = Price of Oil seed crops (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
WHTTP = Wheat production in Balochistan in metric tons (MT);
RICTP = Rice production in Balochistan (MT);
OSDTP = Oil seed production in Balochistan (MT);

Note: All equations are in log form.
Numbers in parenthesis are estimates of standard errors.

[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.65, 1.77, 1.35 and 0.87, respectively.

TABLE 4.8

ESTIMATES OF YIELD RESPONSE FOR FOOD AND CASH CROPS (GRAMS, MOONG, CUMIN) IN BALOCHISTAN, 1975-1991

Variable	Grams	T for H_0: Parame.=0[a]	Moong	T for H_0: Parame.=0[a]	Cumin	T for H_0: Parame.=0[b]
Intercept	-0.16	-0.90	-1.52	-4.28	-2.13	-19.24
RPGF1	-0.02	-1.02				
RPMGF1			0.04	0.64		
RC					0.07	2.66
TRACT	-0.04	-1.23	0.13	3.13	0.18	15.16
CFER	0.08	2.74				
MGITR			0.10	3.93		
CITR					0.18	7.32
R^2	0.99		0.99		0.99	
Adj R^2	0.99		0.99		0.99	
DW	1.73		2.30		1.47	
F	12968.18		8649.60		144371.57	

Variable definition:

RPGF1 = $(PGRM/PFER)_{t-1}$
RPMGF1 = $(PMNG/PFER)_{t-1}$
RPCF1 = $(PCUM/PFER)_{t-1}$
RPOF1 = $(POSD/PFER)_{t-1}$
RPMZF1 = (PMZ/PFER)
RMZ = Price of Maize (Rs/MT)
PGRM = Price of Grams (Rs/MT)
$RC=.50*(PCUM/PFER)_t + 0.33*(PCUM/PFER)_{t-1} + 0.17*(PCUM/PFER)_{t-2}$
$RO=.50*(POSD/PFER)_t + 0.33*(POSD/PFER)_{t-1} + 0.17*(POSD/PFER)_{t-2}$
TRACT = Mechanization (No. of tractors and bulldozers);
CITR = Ratio of irrigated to total cropped area under cumin;
TIA = Total irrigated area in Balochistan (ha);
PCUM = Price of cumin (Rs./MT);
PMNG = Price of Moong beans (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
CUMTP = Wheat production in Balochistan in metric tons (MT);
MNGTP = Moong beans production in Balochistan (MT);

[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.65, 1.77, 1.35 and 0.87, respectively.

[b] The 1%, 5%, 10% and 20% critical values of the t-distribution are 2.68, 1.78, 1.36 and 0.87, respectively.

TABLE 4.9

ESTIMATES OF YIELD RESPONSE FOR FOOD AND CASH CROPS (ONIONS, MELONS, TOBACCO) IN BALOCHISTAN, 1975-1991

Variable	Onions	T for H_0: Parame.=0[a]	Melons	T for H_0: Parame.=0[a]	Tobacco	T for H_0: Parame.=0[a]
Intercept	2.12	2.68	1.21	4.06	-0.53	-0.84
RON	0.45	3.80				
RM			0.08	0.75		
RT					0.27	4.07
CFER	0.16	1.20			-0.03	-0.38
MITR			0.16	1.68		
TRACT	0.05	0.34	0.19	5.05	0.12	1.19
R^2	0.99		0.99		0.99	
Adj R^2	0.99		0.99		0.99	
DW	1.56		2.42		3.02	
F	3083.43		1755.11		1610.30	

Variable definition:

$RPO=.50*(PPOT/PFER)_t + 0.33*(PPOT/PFER)_{t-1} + 0.17*(PPOT/PFER)_{t-2}$

$RM=.50*(PMEL/PFER)_t + 0.33*(PMEL/PFER)_{t-1} + 0.17*(PMEL/PFER)_{t-2}$

$RT=.50*(PTOB/PFER)_t + 0.33*(PTOB/PFER)_{t-1} + 0.17*(PTOB/PFER)_{t-2}$

$RON=.50*(PONI/PFER)_t + 0.33*(PONI/PFER)_{t-1} + 0.17*(PONI/PFER)_{t-2}$

$RMZ=.50*(PMAZ/PFER)_t + 0.33*(PMAZ/PFER)_{t-1} + 0.17*(PMAZ/PFER)_{t-2}$

TRACT = Mechanization (No. of tractors and bulldozers);
PPOT = Price of potatoes (Rs./MT);
PMEL = Price of Melons (Rs/MT); PTOB = Price of Tobacco (Rs/MT);PONI
PONI = Price of onions (Rs/MT); PPUL = Price of Pulses (Rs/MT);
PFER = Price of Fertilizer (Rs/MT);
ONITP = Potato production in Balochistan in metric tons (MT);
MELTP = Melon production in Balochistan (MT);
TOBTP = Tobacco production in Balochistan (MT);

[a] The 1%, 5% 10% and 20% critical values of the t-distribution are 2.68, 1.78, 1.36 and 0.87, respectively.

contributed almost equally to the increase of production in the region. In the case of pulses, results show that both acreage and yield contributed only small shares to production. Increase in pulse production was mainly due to mechanization and increase in ratio of irrigated to rainfed area under pulses.

Supply elasticities for area and yield are positive , but the area elasticities, although inelastic, are larger when compared to yield elasticities. Thus the expected hypothesis that supply is affected more by area than by yields is accepted. It strengthens the argument that prices play a significant role in the allocation of resources and the production of agricultural commodities in Balochistan. It also supports the argument that there is flexibility in the use of resources.

An analysis of variance indicates that the models fitted were highly significant as shown by the F-test. In all equations, whether production, acreage or yield, the F values were highly significant.

Short-run and long-run own price elasticities are presented in Table 4.10. The short-run price elasticities are higher compared to long-run elasticities for most crops. Long-run elasticities are calculated by dividing the short-run elasticities by one minus the coefficient of the lagged dependent variable. The coefficients of lagged dependent variables are not significant and are not consistent with theory (i.e. most have negative sign).

The validity of the models were tested by comparing the predicted and actual values of production and acreage in each crop. The regression results of predicted production on actual production show that in most cases the intercept is not significantly different from zero and the

TABLE 4.10

SHORT-RUN AND LONG-RUN SUPPLY ELASTICITIES
OF FOOD AND CASH CROPS IN BALOCHISTAN,
1975-1991

Crops		Production Elasticity			Acreage Elasticity		
		Short-run	Long-run	R^2	Short-run	Long-run	R^2
a)	Food and Oil-Seed						
	Wheat	0.68	0.60	0.99	0.58	0.47	0.99
	Rice	1.39	....	0.99	0.61	2.10	0.97
	Oil-seed	0.72	0.56	0.95	0.28	0.20	0.93
	Grams	2.28	2.09	0.64	2.62	2.25	0.57
	Moong	0.21	0.16	0.92	0.09	0.08	0.53
a)	Cash Crops						
	Cumin	1.03	0.67	0.98	1.64	1.13	0.98
	Onion	0.52	0.54	0.99	0.04	0.04	0.99
	Melons	0.67	0.72	0.99	0.52	0.38	0.99
	Tobacco	0.58	0.72	0.99	0.33	0.59	0.99

slope is not significantly different from one which implies that predicted and actual production are in the same direction.

To sum up, it may be stated that the supply elasticity of production for the nine crops studied are positive in the region. The elasticity coefficients estimated are statistically significant and plausible in most cases. The supply elasticities for area are inelastic but more elastic than the yield elasticities, and therefore, acreage has contributed more to total production as compared to yield. Mechanization and investment in irrigation contribute significantly to the increase in production by facilitating more area under crop and improving yields.

Conclusions and Policy Implications

Empirical knowledge regarding the supply elasticity of regional agricultural production is important to better understand the responsiveness of farmers to prices and other incentives. This study has provided quantitative estimates of the short- and long-run supply elasticity coefficients and has tested several relevant hypotheses. There were a number of problems regarding specification of expected prices and the segregation of the impact of prices and mechanization on production in estimating supply functions. These problems were addressed after carefully examining the available data and methodology. The study provides results relevant for price and income policy decisions for Balochistan agriculture. Furthermore, the study presents methods of supply analysis for regions.

Weather conditions are frequently hypothesized to be a major contributor to variation in production and yield. However, this study was not able to fully determine the importance of rainfall in explaining regional supply. The supply models in which seasonal rainfall variables were included performed better but the coefficients of rainfall were insignificant. Also, own-price coefficients frequently lacked the expected sign and were statistically insignificant. Therefore, the initial idea of analyzing rainfed and irrigated farming separately, was dropped. Similarly, acreage and yield response models for rainfed areas were not considered for further analysis. While the supply elasticities in irrigated areas were greater and generally statistically significant, when compared to rainfed areas, results were not always consistent. However, this finding is based on a short series of data and, therefore, before arriving at more definite conclusions, it needs to be verified with additional data.

The extent of technological change in Balochistan province was analyzed. Time as a trend variable is frequently used for capturing technological change (i.e. high-yielding varieties, fertilizer and pesticide use, etc.). But time did not show any significant impact on production, acreage, or yield apart from other independent variables.

The study provided strong evidence in favor of the hypothesis that regional supply elasticities in Balochistan for crop production, acreage, and yield response are positive and highly significant. This suggests rejection of the notion of perversity of farmers in supply response. However, the coefficients of supply elasticity (production) obtained varied depending upon the specification of expected prices. Based on knowledge of the situation and the conditions obtained in the region, elasticities calculated in this study are considered plausible.

The supply elasticities of area were inelastic and were statistically significant in most cases. This result is similar to area supply elasticities found in other research for individual crops under varied agro-economic conditions. The supply elasticities of yield were positive but were smaller in magnitude compared to acreage elasticities. Therefore, these results would imply the importance of expanding area under cultivation in past development strategies versus the improvements in production technologies.

The findings of this study indicate that price policy can be an effective device in increasing production to the extent shown by the elasticity coefficients. This finding can be used for input price policy and policies on the regional import (or transfer) of foodgrains and the improvement of incomes of farmers. Also, the results indicate that area supply response was more than yield response but it is uncertain how long this result can be maintained. Therefore, for long-term planning, efforts should include improved yield response by providing access to high-yielding and drought resistant varieties for crops grown in the region, access to other improved inputs, incentives through input prices, and timely availability of inputs along with effective extension services.

Though the scope of this study was restricted to Balochistan province, the results are reasonable for many areas having similar agro-economic and institutional characteristics. It would be productive to investigate in detail farmers' price-expectation behavior and to test alternative hypotheses regarding the basis of price expectation; this is necessary for estimating 'true' supply elasticities.

The technique of pooling time-series and cross-sectional (regional) data may be examined for further supply analysis. But the implications of prices and supply being determined jointly in various districts need to be understood before using this technique.

Because the foundation of supply analysis is imbedded in input markets, the nature of such markets with respect to mobility of resources and other constraints in resource supply needs to be examined.

CHAPTER V

SUMMARY, POLICY IMPLICATIONS, AND FURTHER RESEARCH

Summary

Economic development is best conceived as an economy-wide process. The distribution of growth over different types of economic activity and of income over socioeconomic groups is basic to this process. There is growing concensus among economists that reliable perspectives on economic development are unlikely to be obtainable from models which do not describe the structure of basic demand and supply forces evolving in the economy. This study represents a broad attack on the role of agricultural commodity demand and supply in economic development for the province of Balochistan, Pakistan.

Household demand as a link in this chain is important for a number of reasons: First, because the commodity composition of personal demand varies with prices and income, it follows that a regional economy with growing per capita income may require a changing balance among its productive activites. Regional economic planning must cater to this change. Second, because the regional import and export content of consumer goods varies, a changing pattern of demand may have implications for external trade and for financial management of the region. Third, governments may wish to redistribute income to improve general welfare of low income regions. Such a change will affect the structure of aggregate consumer demand in ways that will need to be anticipated. Fourth, domestic savings need to be mobilized to make feasible the growth targets of developing regions such as Balochistan. Because savings are the surplus of income over consumption, a proper understanding of demand behavior necessarily implies an addition to knowledge concerning savings behavior. Fifth, until recently, the bulk of the models of economic development have been based on the assumption that commodity prices are of little or no significance in determining the crucial aspects of economic behavior. Sixth, the price of food is a politically sensitive issue in developing countries and regions. The behavior of food prices under various conditions of shortage or glut depends on the responsiveness of consumers' demand to the price of food. Used with due care, the results of this study give some guidelines as to the likely orders of magnitude for the relevant responses in a developing region at a given stage of development. This study provides information on the changes in the commodity composition of demand as real per capita income and prices grow.

This study differs from previous work in two ways: first, savings and demand patterns are treated within a single integrated framework; second, all of the consumer's demand decisions are modeled simultaneously, using the demand systems approach. Although this approach is not unique, none of the earlier works used it in the context of a data base widely dispersed over the development spectrum. With the use of relatively powerful techniques of estimation, this difference in approach was sufficient to reveal some systematic tendencies in demand and savings behavior.

Our analysis allows for a joint treatment of saving and the allocation of expenditure. The goodness of fit , precision of estimates, and ability of the fitted system to predict the average saving ratio at mean sample values make the system an adequate tool to characterize broad tendencies in both household saving and the allocation of expenditure. The results reported in Chapter III indicate how a unit increase in total expenditure or "income" per capita by income group, is allocated among food and non-food commodities. The demand for a commodity other than food is more responsive to an income increase. The analysis in this study confirmed the following key findings obtained using HIES data:

a) The percentage of income spent on food is highest at low income levels.

b) The demand for a commodity is much more responsive to changes in its own price at high income levels than at low income levels.

c) A change in the price of food has an effect on both saving and the allocation of expenditure, but this effect is much more important at low income levels than at high income levels.

d) Estimates of total subsistence expenditure and subsistence expenditure on food increase with income but at a slower rate than income itself.

e) Subsistence expenditures are lower for households in lower socioeconomic classes.

f) Consumption patterns of rural and urban households are significantly different.

Estimating the own- and cross-price elasticities of regional supply of different crops can help policymakers to obtain the desired level and composition of agricultural commodities. In this study attempts are made to estimate the own- and cross-price elasticites of major food and cash crops grown in Balochistan by incorporating the supply response relationships among these crops. The assumption of homogeneity of degree zero of the supply response function allowed the normalization of crop prices with respect to fertilizer price in each equation. Using the price ratios in the regression equation reduced the multicollinearity problem among different crop prices that might be a major detriment in estimating the own- and cross-price elasticities together.

The assumption of interdependence among all the crops allowed the use of Zellner's Seemingly Unrelated Regression Method. This improved the estimated coefficients compared to the OLS procedure in terms of their standard errors.

Farmers are responsive to output and fertilizer price changes and they adjust their resources not only in a crop experiencing a price change, but also in other crops that may be grown in the area. Short-run own price elasticities of all the food and cash crops are significant in most cases at less than the 20 percent significance level. A price change in one crop affects the production of other crops. This suggests that a careful analysis of price changes in any crop is necessary because this can affect the level of production of not only that one crop but may change the composition of all the crops.

Fertilizer price is a significant determinant of crop production. The long-run fertilizer price elasticities of supply are higher in cash crops compared to food crops.

Production of cash crops is quite elastic in the long-run, with long run own price elasticities greater than one.

Cross price elasticities depend upon the turn around time of a crop after the harvest of the previous crop, relative acreage share of a crop in a cropping zone, and percentage of the total area of a crop in other zones. Wheat price does not affect the production of any other crops in a competitive way.

Food crops having relatively low own supply price elasticities and have little effect on the production of other crops. On the other hand, cash crops have higher own price elasticities but the price changes of these crops strongly affect the production of other crops.

Technology (investment in irrigation infrastructure and mechanization etc.) is an important non-price factor affecting crop production. Per annum growth rates in the production of food crops such as wheat, rice and chickpeas are highest: 10 percent, 16 percent and 31 percent, respectively. Production of potatoes and onions increased by 11 percent and 13 percent, respectively, and production of melons increased by 3.7 percent per annum during the last 17 years.

Policy Implications

Cash crops are more responsive to own price changes than are food crops. Hence, there is relatively more potential to increase the production of cash crops by increasing their prices than in the case of food crops. However, the price changes of these crops strongly affect the production of other crops due to high negative cross price elasticities.

So, a price support for one cash crop may hurt the output of other crops. Food crops have very low own price elasticities, hence there is little potential to increase output by manipulaing their prices and this will have little effect on production of other crops.

Fertilizer prices have a significant effect on production, especially of cash crops. Low fertilizer prices stimulate production of all the crops. If the same objective is to be achieved through price support, prices of all the crops need to be increased. This clearly provides an option to increase production through low input prices or relatively sharp increases in input supplies, rather than price supports which can invoke considerable criticism from consumers. Subsidies on inputs may be one way to keep input prices low. However, a subsidy creates inefficiency, resulting in welfare loss to the society, as well as anomalies in the system. The objective of providing inputs at low prices to all producers can also be achieved, at no society cost, by promoting competition among private sector input suppliers, which will reduce the effective input prices. Clear evidence of the success of the privatization policy is the bumper production after deregulating the pesticide market. Although pesticide prices apparently increased after deregulation, open market competition removed the bureaucratic anomalies which restricted the supply of pesticides to only a few farmers at a low price, but to all other farmers at higher effective prices. The open market mechanism also improved the access of each farmer to input supplies, and his recognition of the importance of timeliness in input application.

Technology (investment in irrigation and mechanization, etc.) is an important non-price factor affecting crop production. Technology increased wheat and rice production by almost 10-15 percent per annum from 1975-1991. Production of potatoes and onions increased by 11.2 percent and 13.2 percent, respectively, and production of melons increased by 15.5 percent per annum. This implies a need to strengthen agriculture research and other infrastructure so that the flow of new inputs and technologies can continue to maintain growth in productivity. Moreover, there is a need for economic analysis of technological change.

Further Research

The analysis can be extended in several directions. First, it should be disaggregated for different cropping zones. Second, it should be done separately for acreage and yield. Third, other crops, such as oilseeds, fodder, fruits, vegetables and pulses should also be included in the analysis. This is possible only at a disaggregated level because, as noted earlier, a crop with only a small share in a system does not affect the output of the major crop. Fourth, the analysis of rice should be disaggregated into coarse and fine grain rice.

To estimate a more precise supply response at the national and regional levels, statistics on production and prices should be improved. Currently, there is not an appropriate data system for collecting farm level prices. Supply elasticities will be more realistic if farmgate, rather than wholesale, prices are used in estimation.

More comprehensive policies in addition to pricing policies are needed to stimulate agricultural production in rainfed regions of the country. Yield increases will have to take over from area expansion in the future. Timely access to modern inputs such as seeds, fertilizer, improved production technology, and credit must be facilitated. Fertilizer use in

Balochistan is abysmally low; only 20 kilograms of fertilizer were applied per hectare of cropped area in 1990/91, less than 20 percent of the national average. The major reasons for the low fertilizer use are high prices faced by producers and inefficient distribution systems. Very little information is available on the improved seed supply, but it appears that producers use most of the seed from their own harvests. Agricultural research, which has had such positive results for rice and wheat in irrigated areas, has considerable potential in rainfed regions for improving yields, increasing tolerence to pests and droughts, and developing new varieties better suited to local ecologies and environments.

The ability to maintain agricultural production at current levels is threatened. Rural poverty, combined with increasing population densities and inadequate agricultural intensification, is responsible for much of the forced exploitation of agricultural resources and the breakdown of indigenous istitutions for managing common property resources. Agricultural intensification is essential to meet future needs, raise the living standards of the rural population and reduce the degradation of resources but agricultural intensification does not have to lead to environmental degradation. Some alternative technologies and farming practices already exist that involve appropriate crop rotations, mixed farming systems with crops and livestock, integrated pest management, disease and pest-resistant varieties, balanced application and correct timing and placement of fertilizer, and minimum or zero tillage. Many of these options can be cometitive in terms of profitability to farmers. However, additional agricultural research with more emphasis on biotechnology is needed, especially for the more marginal and degraded areas.

Rural infrastructure coverage is very low and of poor quality and is a limiting factor to agricultural growth. Improved rural infrastructure will have positive effects on both factor and product marketing by reducing costs, promoting timely deliveries, improving efficiency, and reducing price fluctuations. Strong relationships exist between infrastructure and agricultural production. High marketing costs due to limitations in transport and communications hinder intra- and inter-regional trade and market operations. Infrastructure construction and maintenance must be important components of an agricultural and rural development strategy. Furthermore, as urbanization proceeds, efficient infrastructure and marketing channels will be essential to ensure easy flow of food from rural to urban areas to feed the urban population.

To overcome poverty, food insecurity, and malnutrition in a sustainable manner in rainfed areas, government must make this the overriding goal of development and must make a long-term commitment to transfer resources to facilitate agricultural development in the arid and semi-arid regions. Expanded external assistance is needed not only for its high economic rates of return but also because it is essetial to meet future food requirements without degrading natural resources in rural regions.

References

Adesina, Akinwumi A. and B.W. Brorsen. "A Risk Responsive Acreage Response Functions for Millet in Niger." *Agricultural Economics-IAAE,* 1(1987):229-239.

Ahmad, E. and Ludlow, S. "Aggregate and Regional Demand Response Pattern in Pakistan." *Pakistan Development Review.* 26:4(1987): 645-655.

Ahmad, E., H. M. Leung and N. Stern. 1984. Demand Response and the Reform of Indirect Taxes in Pakistan. University of Warwick, Development Economics Research Centre, Discussion Paper No. 50.

Ahmad, E., S. Ludlow, and N. Stern. "Demand Response in Pakistan: A Modification of the Linear Expenditure System for 1976." *Pakistan Development Review.* 27:3(1988): 293-308.

Ahmak, E., H. M. Leung and N. Stern. 1984. "Demand Response and the Reform of Indirect Taxes in Pakistan." University of Warwick, Development Economics Research Centre. Discussion Paper No. 50.

Alderman, H. "Estimates of Consumer Price Responses in Pakistan Using Market Prices as Data." *Pakistan Development Review.* 27:2(1988): 89-107.

Ali, M.S. "Household Consumption and Saving Behavior in Pakistan: An Application of the Extended Linear Expenditure System." *Pakistan Development Review.* 24:1(1985): 23-38.

Askari, Hossein and John T. Cummings. Agricultural Supply Response. New York: Praeger, 1976.

Baltas, Nicholas C. "Supply Response for Greek Cereals." *European Review of Agricultural Economics,* 14(1987):195-210.

Behrman, J.R. Supply Response in Underdeveloped Agriculture. New York:North Holland, 1968.

Braulke, Michael. "A Note on the Nerlove Model of Agricultural Supply Response." *International Economic Review,* 23(1982):241-244.

Burney, N.A. and M. Akmal. "Food Demand in Pakistan: An Application of the Extended Linear Expenditure System." *Journal of Agricultural Economics.* 42(1991): 185-194.

Bussink, W.C.F."A Complete Set of Consumption Coefficients for West Pakistan." *Pakistan Development Review.* 10:2(1970): 193-231.

Capps, Jr., O. "Linking Demand Systems to Macroeconomics." Department of Agricultural Economics, Texas A&M University, February, 1994.

Cochrane, Willard. "Conceptualizing the Supply Relation in Agriculture." *Journal of Farm Economics*, 37 (1955): 1161-1176.

Colman, David. "A Review of the Arts of Supply Response Analysis." *Review of Marketing and Agricultural Economics*, 51(1983):201-230.

Davis, T. G. 1982. "Hydrology in Northern Balochistan." Publication by United Nations Development Program, 73/032.

Deaton, A. and J. Muellbauer. Economic and Consumer Behavior. The Cambridge University Press, New York, 1980.

Dhrymes, P.J. Econometrics, Statistical Productions and Applications. Harper and Row, New York, 1970.

Eastwood, D.A. and J.A.Craven. "Food Demand and Savings in a Complete, Extended Linear Expenditure System." *American Journal of Agricultural Economics.* 63(1981): 544-549.

Falcon Walter, P. "Farmers' Response to Price in a Subsistence Economy: The Case of West Pakistan". *American Economic Review*, May, 1964.

Food and Agriculture Organization (FAO) 1983. Report of the assistance to rangeland and livestock development survey in Balochistan. FAO Technical Cooperation Program, TCP/PAK/0107, FAO, Islamabad, Pakistan.

Gardner, Bruce L. "Future Prices in Supply Analysis." *American Journal of Agricultural Economics*, 58 (1976): 81-84.

Goldberger, A.S. Econometric Theory. J. Wiley & Sons, New York, 1964.

Government of Balochistan. (Various issues, 1974-75 to 1991-92). Agricultural Statistics of Balochistan. Directorate General of Agriculture Department, Balochistan Statistics Wing, Quetta, Pakistan.

Government of Pakistan. 1972. Census of Agriculture, 1971, All Pakistan Report, Economic Affairs and Statistics Division, Agricultural Census Organization, Gulberg III, Lahore.

Government of Pakistan. 1981. Census of Agriculture, 1980, Balochistan Province, Economic Affairs and Statistics Division, Agricultural Census Organization, Gulberg III, Lahore.

Government of Pakistan. 1984. Pakistan Census of Agricultural Machinery, All Pakistan Report, Agricultural Census Organization, Statistics Division, Gulberg III, Lahore.

Government of Pakistan. 1986. Pakistan Census of Livestock. Agricultural Census Organization, Statistics Division, Gulberg III, Lahore.

Government of Pakistan. 1988. Report of the National Commission on Agriculture, Islamabad.

Government of Pakistan. 1990. Pakistan Statistical Yearbook. Federal Bureau of Statistics, Islamabad.

Government of Pakistan. 1992. Agricultural Statistics of Pakistan. Ministry of Food, Agriculture and Livestock, Food and Agriculture Division, Islamabad, Pakistan.

Government of Pakistan. 1993. Pakistan Economic Survey, 1992-93. Finance Division, Economic Advisor's Wing, Islamabad.

Government of Pakistan. "Report of the National Commission on Agriculture." Ministry of Food and Agriculture, Islamabad, March, 1988.

Government of Pakistan. "Economic Survey of Pakistan." Ministry of Finance and Economic Affairs, Islamabad, 1992-93.

Green, Robert C. "A Linear CET Commodity Supply Response Model for Thirteen Agricultural Field Crops in the U.S." Ph.D Dissertation, Texas A & M University, 1978.

Greene, William H. Econometric Analysis. Second Edition. New York: Macmillan, 1993.

Gujarati, D.N. Basic Econometrics. McGraw-Hill Book Company, 1988.

Henneberry, S. R. "A Review of Agricultural Supply Responses for International Policy Models." Department of Agricultural Economics, Oklahoma State University/USAID, Stillwater, Oklahoma, 1986.

Houck, J. P. and M. E. Ryan. 1972. Supply Analysis for Corn in the United States: The impact of changing Government Progarms, American Journal Agricultural Economics. 54(1972):184-91

Jennings, A.N. and R.J. Young. "Generalisation of the Nerlove Supply Model Using Time Series Methodology: An Application to Potato Plantings in Great Britain." *Journal of Agricultural Economics*, 31(1980):99-111.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lutkepohl, and T. C Lee. Introduction to the Theory and Practice of Econometrics. Second Edition, New York: John Wiley & Sons, 1988.

Lluch, C. "The Extended Linear Expenditure System." *European Economic Review*, 4:1(1973): 21-32.

Lluch, C., A. A. Powell, and R. A. Williams. "Patterns in Household Demand and Saving." New York: Oxford University Press, 1977.

Just, Richard E. "A Method for Investigating the Importance of Government Intervention." *American Journal of Agricultural Economics*, 55 (1973):441-42.

Kang, Taehoon and B. Wade Brorsen. Valuing Target Price Support Programs with Average Option Pricing. *American Journal of Agriculture Economics.* 77: forthcoming.

Lidman, Russell, and D. Lee Bawden. 1974. The Impact of Government Programs on Wheat Acreage. *Land Economics*, 50 (November):327-335.

Mahmood, A. and Forest Walters. 1990. Pakistan Agriculture: A Description of Pakistan's Agricultural Economy. Economic Analysis Network (EAN), Government of Pakistan, Islamabad.

Mahmood, K., M. Munir and S. Rafique. 1991. Rainfed Farming Systems and Socio-Economic Aspects in Kalat Division (Highland Balochistan). Pakistan Journal Agriculture and Social Science, Vol. 5, No. 2, January-June, 1991.

Mahmood, K., and A. Rodriquez. 1993. Marketing and Processing of Small Ruminants in Highland Balochistan. Small Ruminant Research, 10(1993):93-102, USA.

Morzuch, B. J., R. D. Weaver, and P. G. Helmberger. "Wheat Acreage Supply Response Under Changing Farm Programs." *American Journal of Agricultural Economics*, 62 (1980): 29-37.

Nerlove, Marc. "Estimates of the Elasticities of Supply of Selected Agricultural Commodities." *Journal of Farm Economics*, 38 (1956): 496-509.

_____________. "Distributed Lag and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations." *Journal of Farm Economics*, 40 (1958a): 301-311.

Parks, Richard N. "Efficient Estimation of a System of Regression Equations When Disturbances are Both Serially and Contemporaneously Correlated." *Journal of the American Statistical Association*, 62 (1967):500-509.

Pindyk, R.S. and Daniel L. Rubinfeld. Econometric Models and Economic Forecasts. Third Edition, New York: McGraw Hill, Inc., 1991.

Penn, J. B. and George B. Irwin. "A Simultaneous Equation Approach to Production Response: Delta Region." *Southern Journal of Agricultural Economics*, 3 (1971): 115-121.

Prais, S. J. and H. S. Houthakker. "The Analysis of Family Budgets. The Cambridge University Press, New York, 1955.

Rafiq, M. 1976. Crop Ecological Zones of Nine Countries of the Near East Region. Food and Agriculture Organization (FAO), Rome, Italy.

Reed, Michael R., and Steven K. Riggins. "A Disaggregated Analysis of Corn Acreage Response in Kentucky." *American Journal of Agricultural Economics*, 63 (1983): 708-711.

Rees, D. J., J. G. Nagy, S. H. Raza, K. Mahmood, B. A. Chowdry and J. D. H. Keatinge. 1988. The Dryland Arable Farming System of Upland Balochistan: A Case Study. In: "International Symposium on Problems and Prospects of Winter Cereals and Food Legumes Production in High Elevation Areas of West and South-east Asia and North Africa." July 6-10, 1987, Ankara, Turkey. ICARDA, Aleppo, Syria.

Ryan, Mary E. and Martin E. Abel. "Supply Response of U.S. Sorghum Acreage to Government Programs." *Agricultural Economics Research*, 25 (1973a): 45-54.

SAS Institute Inc. 1990. SAS/ETS™ Users' Guide, Version 6 Edition. Cary, NC:SAS Institute, Inc., 1990.

Schmitz, Andrew. "Canadian Wheat Acreage Response." *Canadian Journal of Agricultural Economics*, 16 (June 1968).

Sharples, J.A. "The Representative Farm Approach to Estimation of Supply Response." *American Journal of Agricultural Economics*, 51(1969):353-361.

Shumway, C. Richard and Anne A. Chang. "Texas Field Crop Supply Response : Application of a Linear CET Supply Model," in Supply and Input Choice Response by Multiple Product Firms: New Approaches. Department of Agricultural Economics and Rural Sociology, No. 137, Pennsylvania State University, pp. 22-41, 1978.

Talug, C. 1989. Agricultural Extension at the Arid Zone Research Institute 1986-89

Tomek, W. G. and K. L. Robinson. Agricultural Product Prices. Second Edition, Ithaca:Cornell University Press, 1985.

Traill, Bruce. "Risk Variables in Econometric Supply Response Models." *Journal of Agricultural Economics*, 29(1978): 53-61.

Tweeten, L. Supply Response in Pakistan. Report Prepared by Department of Agricultural Economics, Oklahoma State University and Abt Associate, Inc. Under Contract No. DAN-4084-C-00-3087-00. Agricultural Policy Analysis Project, USAID, Washington, D.C. 1986.

Whittaker, James K., and Robert L. Bancroft. "Corn Acreage Response - Function Estimation with Pooled Time-Series and Cross-Sectional Data." *American Journal of Agricultural Economics*, 61 (1979): 551-553.

Wolgin, J.M. "Resource Allocation and Risk : A Case Study of Smallholder Agriculture in Kenya." *American Journal of Agricultural Economics*, 57(1975):622-630.

Zellner, Arnold. "An Efficient Method of Estimating Seemingly Unrelated Regression Equations: Some Exact Finite Sample Results." *Journal of the American Statistical Association*, 58(1963): 977-992.

2

VITA

Khalid Mahmood

Candidate for the Degree of

Doctor of Philosophy

Thesis: EFFECTS OF CROP PRODUCTION SYSTEMS ON THE WELFARE OF RURAL HOUSEHOLDS IN BALOCHISTAN, PAKISTAN

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Hafizabad, Pakistan, March 20, 1958, the son of Chaudhry Muhammad Yasin and Zainab Chaudhry.

Education: Graduated from Government College, Hafizabad, September, 1977; received a Bachelor of Science (Hons) degree in Agriculture from University of Agriculture, Faisalabad in December 1982; received a Master of Science (Hons) in Agricultural Economics from UA, Faisalabad in December 1985; completed requirements of the Doctor of Philosophy degree at Oklahoma State University in December 1995.

Professional Experience: Scientific Officer, Pakistan Agricultural Research Council (PARC), 1985-90; Counterpart Scientist to Advisors from ICARDA, 1986-90 at Arid Zone Research Institute, Quetta, Balochistan. Deputy Director, Planning, Pakistan Agricultural Research Council (PARC), May 1995 to present.

Professional Affiliations: Member of American Agricultural Economics Association, Southern Agricultural Economics Association, Pakistan Association of Agricultural Social Scientists, and International Agricultural Economics Association.