Chapter 2

AGRICULTURE, LAND, AND PRODUCTIVITY IN PAKISTAN

Sohail J. Malik, Shujat Ali, Khalid Riaz, Edward Whitney, Mehrab Malek, and Ahmad Waqas

Introduction

Much of Pakistan's comparative advantage in agriculture resides in its rich natural resource endowment. Pakistan is home to the high mountains of the Karakoram and Hindu Kush ranges of the Himalaya Mountains, and entire civilizations have been fed by their melting glacial waters and rich alluvial soils for millennia. Pakistan boasts the world's largest gravity-fed irrigation system—a network of rivers, barrages, and canals that make up the Indus Basin Irrigation System (IBIS)—as well as the world's largest earthen dam at Tarbela, which provides nearly a quarter of the country's electrical power.

But agriculture in Pakistan also faces growing water scarcity and degradation of its natural resource base. The country ranges across vast stretches of arid and semiarid lands, where water constraints mean that agriculture is largely driven by the low-input, low-yield production of crops and livestock. Approximately 92 percent of the country's land area is located in semiarid to arid agroclimatic zones (Pinckney 1989). Major portions of the country are constrained by decreasing soil fertility, soil salinization, waterlogging, erosion, and a host of other challenges. The low potential for expanding agricultural production into these natural resource–constrained areas implies that agricultural production in the short to medium term will have to come from intensification on existing agricultural land.

There is huge potential for intensifying agricultural production in Pakistan through technical change and improvements in the ways in which inputs are used. Much can be gained just by efforts to close the large gaps between the potential (controlled-experimental) yields, the achievable (progressive-farmer) yields, and the national yield averages (for example, PARC 2011). Unfortunately, yield gap reductions and annual output targets for a few major crops have been the mainstay of agricultural policy analysis in Pakistan, ultimately painting an overly simplified picture of the potential in Pakistan's agricultural sector. Rarely do these analyses take into account the high variability in Pakistan in terms of agroclimatic conditions, soil quality, water resource availability, landholding sizes and tenure status, input and output market development, and access to public services and infrastructure. This variability—and the potential for growth and development that this variation offers Pakistan's wider economy—is generally masked in the aggregate statistics on agriculture production in Pakistan, and insufficient consideration of these factors lies at the heart of some of the more worrisome trends presented in this chapter.

Thus, this chapter looks beyond the aggregate statistics to provide a more nuanced understanding of the agricultural sector's diversity, its contribution to Pakistan's economic growth and development, and the underlying constraints to accelerating its growth. The chapter proceeds as follows. The first section describes Pakistan's agroclimatic diversity. The second section looks at the agricultural sector, its subsectors, and trends in agricultural-sector growth. The third section examines the total factor productivity trends and analyzes crop-specific growth trends to gain an understanding of why agricultural growth has been less than optimal. The fourth section draws attention to the centrality of land tenureship and landholding size in the discussion of agricultural-sector growth. The last section presents concluding remarks.

Pakistan's Agroclimatic Diversity: A Changing Landscape

Spatial and temporal variations in temperature, moisture, soil quality, slope, and other factors shape both land use and agricultural livelihood strategies in Pakistan. While several agroclimatic classification systems exist for Pakistan, the most widely cited classification is based on nine zones, developed by Pinckney (1989).[1] These zones capture the closely related dimensions of (1) geographic and climatic conditions, including access to surface water or groundwater irrigation, (2) the farming systems and practices employed by farmers who work the land, and (3) the cultivation of crops associated with the two main agricultural seasons. These seasons are the monsoon-fed

1 In keeping with Pinckney's (1989) analysis, we use the term *agroclimatic zone* throughout this chapter. Note, however, that agroecological zones, as opposed to agroclimatic zones, are defined on the basis of soil and landform characteristics in addition to climatic characteristics. Together, these characteristics holistically determine land suitability and potential production and environmental impact, and, by definition, they allow for the coexistence of several agroclimatic divisions within the same agroecological zone (FAO 1996).

kharif season, which occurs from April to November and supports cotton, rice, maize, sorghum, and sugarcane cultivation, and the drier, cooler rabi season, which occurs from November to April and sustains wheat, barley, and oilseeds production. For the purposes of this book, the main agroclimatic zones are defined as Barani Punjab, Mixed Punjab, Low-Intensity Punjab, Rice/Wheat Punjab, and Cotton/Wheat Punjab; Cotton/Wheat Sindh and Rice/Other Sindh; Southern KPK and Foothills/Plains KPK; and Balochistan (see Annex A, Table A2.1 for a mapping of districts to agroecological zones).[2]

The relative sizes of these zones in terms of the land area and cultivated acreage, the distribution of rural population, and the level of urban agglomerations illustrates the wide diversity found in Pakistan. Three of the agroclimatic zones in Punjab encompass the most urbanized areas, with rural populations ranging from only 3.1 percent to 19.8 percent. Two-thirds of the country's cultivated area is also situated in three of the five agroclimatic zones of Punjab. Further, Sindh and Punjab together account for 87 percent of cropped area (Table 2.1; Figure 2.1). Cotton/Wheat Punjab is the largest zone, followed by Rice/Wheat Punjab and Mixed Punjab. These are followed by Low-Intensity Punjab, Cotton/Wheat Sindh, and Foothills/Plains KPK.

The wide variation in the acreage and output under each of the five major crops (wheat, rice, maize, cotton, and sugarcane) and a category that aggregates all the other cereals for the year 2010/2011 in each of these agroclimatic zones is highlighted in Table 2.2.[3] These data help define the structure of the acreage and output of these crops in Pakistan.

Perhaps not surprisingly, the Cotton/Wheat Punjab agroclimatic zone is the largest producer of wheat and cotton in terms of both acreage and output (Table 2.2). Rice/Wheat Punjab dominates rice production, accounting for nearly half of total rice acreage and nearly 45 percent of output. Barani Punjab is the leading producer of other cereals. Mixed Punjab produces nearly 30 percent of all sugarcane, grown on nearly the same percentage of acreage. KPK Plains/Foothills accounts for 40 percent of all maize acreage and

2 This classification is based on areas that are more suitable for rice cultivation and those that are better suited to cotton growth. The cotton- or rice-specific zones include Rice/Wheat Punjab, Cotton/Wheat Punjab, Cotton/Wheat Sindh, and Rice/Other Sindh. Mixed Punjab zone contains a balanced allocation between rice and cotton. Barani areas include the rainfed regions of Punjab and are classified as a separate zone. Low-Intensity Punjab is termed as such due to the nature of irrigation facilities in the area and the resultant low cropping intensity. Southern KPK, Plains KPK, and Balochistan constitute independent zones, as they contribute only a minuscule percentage of the aggregate wheat production (Pinckney 1989; Arif and Ahmad 2001).

3 The existing literature on Pakistan lists four major crops (GoP 1988); as we show later in this chapter, in recent years, maize has emerged as the fifth major crop.

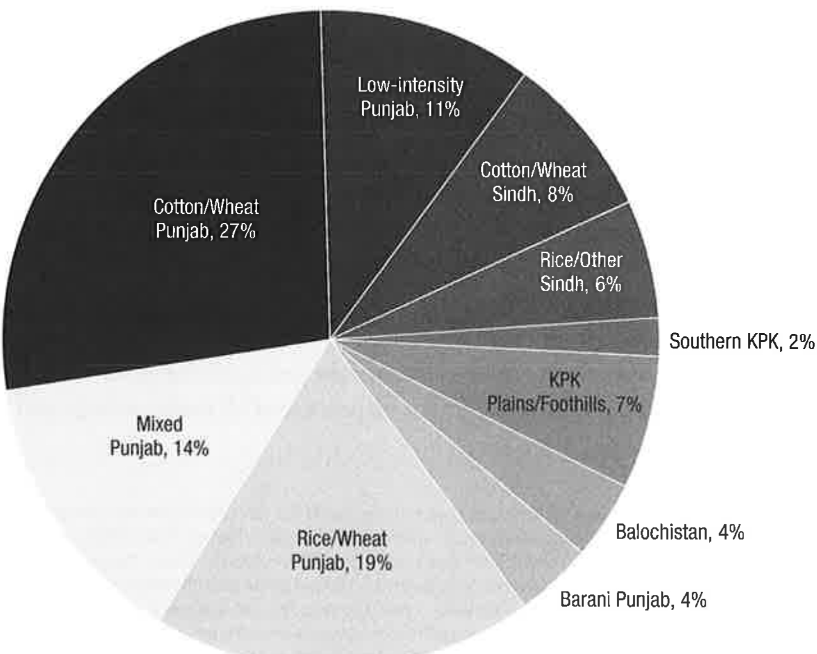
TABLE 2.1 Area, acreage under cultivation, rural population, and urban agglomeration rank of agroclimatic zones, 2010

Zone	Total area (km^2)	Area in zone (% of total)	Area under cultivation (million ha)	Area cultivated (% of area cultivated)	Rural population (% of total)	Urban agglomeration index rank
Barani Punjab	23,205	3.02	609	3.8	19.8	3
Rice/Wheat Punjab	28,945	3.76	3,013	18.8	3.1	1
Mixed Punjab	34,866	4.53	2,213	13.8	7.9	2
Cotton/Wheat Punjab	66,758	8.68	4,342	27.1	50.1	4
Low-Intensity Punjab	52,890	6.87	1,694	10.6	53.5	5
Cotton/Wheat Sindh	79,356	10.31	1,284	8.0	75.0	8
Rice/Other Sindh	61,589	8.01	931	5.8	64.2	6
KPK	77,038	10.01	1,351	8.4	71.6	7
Balochistan	344,712	44.81	611	3.8	93.3	9

Source: Authors, based on data from GoP (2010a, 2010b).

Notes: KPK = Khyber Pakhtunkhwa; km = kilometers; ha = hectares.

FIGURE 2.1 Agroclimatic zones' share of total cultivated area, 2010/2011



Source: Authors, based on data from GoP (2010a, 2010b).

Note: KPK = Khyber Pakhtunkhwa.

TABLE 2.2 Share of acreage and output of leading crops by agroclimatic zone (%), 2010/2011

	Wheat		Rice		Maize		Cotton		Other cereals		Sugarcane	
Agroclimatic zone	Acreage	Output	Acreage	Output	Acreage	Output	Acreage	Output	Acreage	Output	Acreage	Output
Barani Punjab	5.2	2.8	0.1	0	8.4	3.4	0	0	22.8	24.2	0	0
Rice/Wheat Punjab	18.7	18.5	49.1	44.2	5.8	7.8	0.7	0.3	13.5	13.9	11.6	9.7
Mixed Punjab	14.1	15.2	12.8	9.6	17.6	28.1	7.6	4.7	6.6	6.7	29.6	28.7
Cotton/Wheat Punjab	23.1	25.8	10	12.4	21.6	38.9	62.2	54.8	8.7	8.8	18	20.6
Low-Intensity Punjab	13.7	13.1	2.4	3.1	0.7	0.3	11.3	8.6	15.4	9.9	7.3	7.2
Total Punjab	*74.8*	*75.4*	*74.4*	*69.3*	*54.1*	*78.5*	*81.8*	*68.4*	*67*	*63.5*	*66.5*	*66.2*
Cotton/Wheat Sindh	7.8	11	5.2	9.2	0.2	0.0	13.9	24.4	2.8	3.1	9.7	10.3
Rice/Other Sindh	5.2	6.3	10.3	17	0.1	0.0	3.1	6.5	5	4.4	14.3	15.7
Total Sindh	*13.0*	*17.3*	*15.5*	*26.2*	*0.3*	*0.0*	*17.0*	*30.9*	*7.8*	*7.5*	*24.0*	*26.0*
Southern KPK	2.3	1.1	0.4	0.4	4.5	1.6	0.0	0.0	6.7	6.7	2.4	2
KPK Plains/Foothills	5.9	3.4	1.6	1.3	40.5	19.6	0.0	0.0	5.1	6.1	6.9	5.6
Total KPK	*8.2*	*4.5*	*2*	*1.7*	*45*	*21.2*	*0*	*0.0*	*11.8*	*12.8*	*9.3*	*7.6*
Total Balochistan	*3.9*	*2.9*	*8.2*	*2.8*	*0.6*	*0.2*	*1.2*	*0.6*	*13.3*	*16.2*	*0.1*	*0.1*
Total Overall (%)	100	100	100	100	100	100	100	100	100	100	100	100
Total Overall (quantity)[a]	8,793	24,833	2,333	4,696	940	3,485	2,686	1,947	302	221	944	52,853

Source: Authors, based on data from GoP (2013).

Note: KPK = Khyber Pakhtunkhwa.

[a] "Total quantity" units are thousands of acres for acreage, and thousands of metric tons for output.

TABLE 2.3 Variability of crop yields in selected cereal crops by agroclimatic zone, 2010/2011

Agroclimatic zone	Wheat (kg/ha)	Rice (kg/ha)	Maize (kg/ha)
Barani Punjab	1,500	1,574	1,483
Rice/Wheat Punjab	2,802	1,814	4,976
Mixed Punjab	3,033	1,516	5,921
Cotton/Wheat Punjab	3,153	2,491	6,671
Low-Intensity Punjab	2,684	2,544	1,713
Cotton/Wheat Sindh	3,978	3,556	667
Rice/Other Sindh	3,400	3,330	571
Southern KPK	1,275	1,760	1,354
KPK Plains/Foothills	1,634	1,685	1,795
Balochistan	2,140	683	1,075
Coefficient of Variation (%)	**31.39**	**38.16**	**77.35**
Mean	**2,584**	**2,088**	**2,721**
SD	**811.2**	**796.8**	**2104.7**

Source: Authors, based on data from GoP (2013).

Note: KPK = Khyber Pakhtunkhwa.

yet contributes only 20 percent of total maize output, while Cotton/Wheat Punjab produces 39 percent of all maize output with only 20 percent of total maize acreage.

There is considerable variation in crop yields by agroclimatic zone (Table 2.3). For example, wheat yields were highest in Cotton/Wheat Sindh and Rice/Other Sindh, despite the fact that these are not the largest zones for these crops. Maize yields were highest in Cotton/Wheat Punjab, Mixed Punjab, and Rice/Wheat Punjab, close to or above 5,000 kilograms/hectare (kg/ha), while the rest of the zones averaged far lower, at approximately 1,500 kg/ha. Maize yields increased by 3.7 percent annually between 1981 and 2012, albeit with wide variation across zones. The three zones with the highest growth rates witnessed maize yield growth rates above 5 percent during this period, with the largest share of the growth occurring in the last 12 years. The largest growth of maize yields also occurred in the Punjab zones (Annex B, Table B2.2).

Between 2000 and 2012, annual growth rates of output in these zones were influenced by changes in both the mix of crops produced and their yields. For Cotton/Wheat Punjab, annual growth of output—estimated at 4 percent per year—was driven primarily by maize production, which increased by 17.3 percent, followed by sugarcane (8.1 percent) and rice (5.7 percent). In

TABLE 2.4 Cultivated area by water source and irrigation type, 2010

Cultivated area, by irrigation type	Punjab	Sindh	KPK	Balochistan	Pakistan
Total cultivated area (thousand acres)	27,034.0	7,643.5	4,453.1	3,491.9	42,622.5
Rainfed (%)	17.6	6.6	41.8	37.0	19.7
Irrigated (%)	82.4	93.1	57.4	62.2	80.0
Area with irrigation facilities					
Canal irrigation (%)	18.9	86.2	52.0	30.1	36.1
Canal and tube well (%)	58.2	10.3	4.9	3.5	40.7
Tube well only (%)	22.0	1.7	11.8	35.4	17.8
Other (%)	0.2	0.2	16.4	5.6	1.8
Not irrigated (%)	0.6	0.5	13.7	18.2	2.7

Source: Authors, based on data from GoP (2010a).

Note: KPK = Khyber Pakhtunkhwa.

Low-Intensity Punjab, where annual output growth also reached 4 percent during the same period, sugarcane production was the primary driver of growth (7.3 percent). Both Barani Punjab and Rice/Other Sindh experienced growth in wheat output (4.7 percent and 9.8 percent, respectively). For Rice/Wheat Punjab, maize and cotton production grew annually by 19.7 percent and 11.1 percent, respectively, during this period. In KPK Plains/Foothills, the decline in rice production (–3.8 percent) was offset by a 4.1 percent annual growth in wheat production (Annex Table B2.2).

Because of differences in climate, soil type, and water supply, a broad range of production potentials and farming systems are found in Pakistan. While some areas within Pakistan are endowed with greater agroclimatic potential, agriculture is located primarily in the irrigated areas of the Indus River basin, highlighting the importance of irrigation for the agricultural sector (Chapter 4 discusses water and irrigation issues). The extent to which geography and agroclimatic potential are shaping agricultural production patterns and trends in Pakistan is explored throughout this chapter.

Productivity across this agroclimatic diversity is inextricably linked to water, particularly that supplied by Pakistan's investments in large-scale surface irrigation in the Indus River basin, the largest contiguous irrigation network in the world (Briscoe and Qamar 2005). The storage reservoirs, barrages, and canals irrigate approximately 18 million hectares of agricultural land in Pakistan (Archer et al. 2010). Of this, approximately 36 percent of the area is irrigated with canal water, 40 percent with a mix of canal water and tube well irrigation, and 18 percent with solely tube well water (GoP 2010a; Table 2.4).

Since independence in 1947, cultivated area has increased by approximately 50 percent, primarily due to increases in water supply at the farm level (Qureshi 2004).

However, the system is increasingly beset by inefficiencies associated with conveyance losses because of poor lining of the canal system, flooding during the monsoon season, waterlogging, salinity, silting, and insufficient storage capacity in the reservoir and canal system that limit the ability to moderate the oscillation between floods and droughts (Qureshi et al. 2010, 2008; Kamal 2009; Briscoe and Qamar 2005; Bhutta and Smedema 2007). These issues have received extensive attention from administrators, hydrologists, and engineers since independence, but long-term solutions (discussed in Chapter 4) continue to challenge policy making in Pakistan.

Finally, the line between Pakistan's rural areas—inclusive of its agro-climatic diversity and the rural economy it sustains—and its urban and peri-urban environments is increasingly blurred. Changes in population densities, access to transportation, and infrastructure are playing a significant role in redefining the rural farm and nonfarm economy in Pakistan. Rural areas are now better connected to urban agglomerations, and a significant share of rural households have become peri-urban (Arif and Hamid 2009; Arif 2003). This change has been facilitated by an increase in the extent of paved roads by 55 percent between 1990 and 2011, largely carried out in the 1990s. These roads present a major opportunity to develop linkages via improved transportation infrastructure and greater urbanization to facilitate rural access to labor markets, and improved access to product markets, thus allowing rural households to more easily buy and sell goods. Past investments in rural electrification and overall energy expansion have presented similar opportunities, and new investments are expected to lead to higher economic growth, for example via the growth in the number of businesses or farms that use electricity, have access to information, and gain flexibility in labor hours.

Consider the following: First, the share of the urban population in Pakistan has increased significantly because of the establishment of new cities and improvement in road infrastructure between cities. Lahore, Faisalabad, and Gujranwala grew into more networked cities and agglomerated corridors within Punjab. According to our agglomeration index analysis,[4] only 6 percent

---

4 Urban populations are defined as those living within one hour of a city of at least 500,000 people (major city) with a population density of 150 people per square kilometer; peri-urban populations are those living within one to three hours of a major city with a population density of 150 people per square kilometer; rural populations are those that are more than three hours from a major city.

TABLE 2.5 Population and percentage urban by province, 1965–2010

	1965		1994		2010	
Province	Total population (thousands)	Urban population (%)	Total population (thousands)	Urban population (%)	Total population (thousands)	Urban population (%)
Islamabad	554.8	—	1,241.3	96.9	1,734.9	97.9
Punjab	34,120.6	10.4	76,465.5	30.7	107,007.5	39.1
Sindh	13,847.6	5.9	31,066.7	35.1	43,528.0	38.6
Khyber Pakhtunkhwa	8,332.5	—	18,688.7	16.7	26,172.0	25.8
Balochistan	2,825.7	—	6,618.4	10.9	9,556.8	12.7
FATA	1,470.2	—	3,307.5	6.7	4,647.4	7.4
AJK	991.4	—	2,226.6	—	3,120.8	0.3
Disputed area	4,344.0	—	9,753.5	0.0	13,679.0	0.6
Gilgit Baltistan	1,147.1	—	2,610.9	—	3,697.9	—
Pakistan	**67,633.9**	**6.4**	**151,979.0**	**26.1**	**213,144.3**	**32.3**

Source: Authors, based on data from GoP (2010b).

Note: — = data not available; FATA = Federally Administered Tribal Areas; AJK = Azad Jammu and Kashmir.

of the total population of Pakistan was urban in 1965, compared to 32 percent in 2010 (Table 2.5).[5] In Punjab approximately 10 percent of the population was urban in 1965, compared to 39 percent in 2010. In Sindh, 6 percent of the population was urban in 1965, compared to 39 percent in 2010.

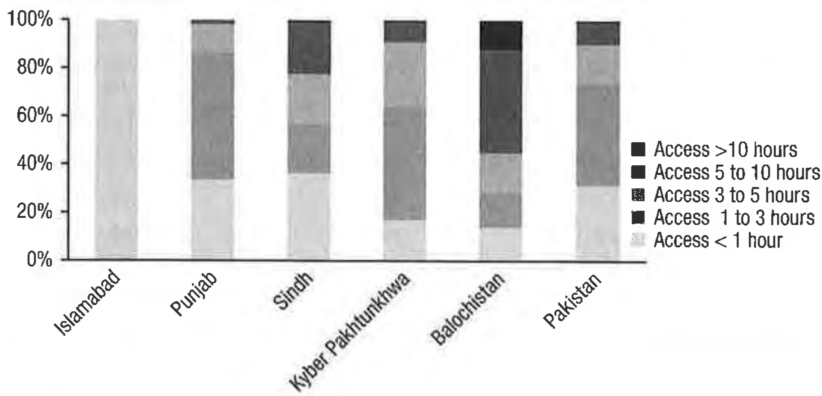
Second, between 1965 and 1994, the share of the population living more than 10 hours from a city of at least 500,000 population (considered a major city for economic agglomeration analysis in Pakistan)[6] decreased from 13.5 percent to 1.2 percent. Similarly, only 24 percent of the population was within three hours' travel time to a major city in 1965, compared to more than 70 percent of the population in 1994. Accessibility within one hour of a major city increased from 20.3 percent in 1994 to 31.4 percent in 2010 (Figure 2.2).

Efficient transportation networks within and between major cities of Pakistan help to link rural goods to peri-urban activities and manufacturing services, and facilitate national and international trade in urban areas. According to the Government of Pakistan (2010b), total road length increased by 13 percent between 1996 and 2011. A large focus of the investment (almost 70 percent) was on primary paved roads. In addition, unpaved roads were

5 For this analysis, 1961 census data is paired with 1965 road and rail infrastructure data, 1998 census data is paired with 1994 infrastructure data, and population projections are paired with 2010 infrastructure data.

6 For more details on the methodology, see Kedir, Schmidt, and Waqas (2015).

FIGURE 2.2 Access times to a city of at least 500,000 population by province, 2010



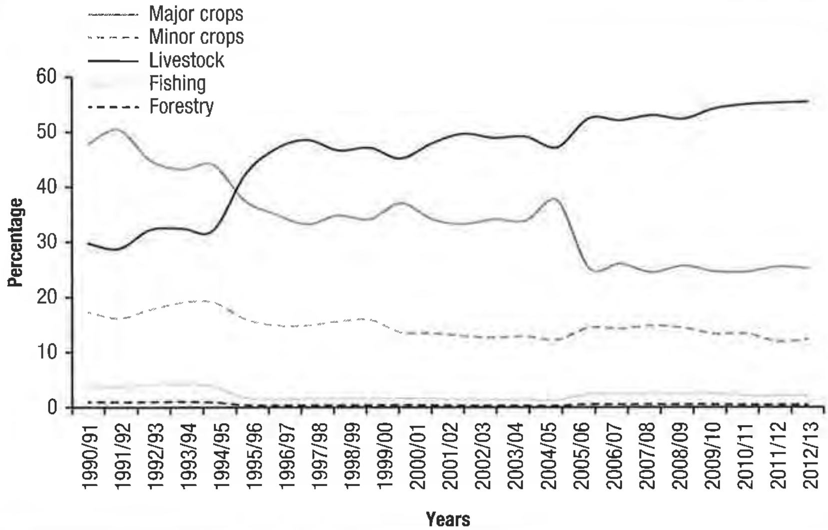
Source: Kedir, Schmidt, and Waqas (forthcoming).

converted to paved roads in order to improve degraded transportation systems in key areas.

Pakistan's Agricultural Sector

Concurrent with these trends in urbanization, Pakistan's economy has undergone a steady process of structural transformation. In the decade that followed independence in 1947, agriculture accounted for over 60 percent of the country's gross domestic product (GDP) (GoP 1988). By 2014 that share had declined to about 21 percent, but significant variability in the annual growth rates of agriculture—characterized by short-lived booms (episodes of growth above 5 percent per year) followed by busts—tend to affect the wider economy. Although the correlation between this variability and the variability in economic growth has been declining in recent years (Ahmed and Gautam 2013), its persistence demonstrates how Pakistan's fortunes are still closely tied to agriculture. Add to this the fact that nearly 47 percent of the country's labor force is still directly associated with agriculture (GoP 2014), and it should be clear why agricultural growth still merits attention from economists, development practitioners, and others working on issues of food security, employment generation, and poverty reduction (Husain 2005; Malik 2005). An appreciation of the diversity and complexity of agriculture in Pakistan is key to translating this attention into actionable programs for investment and development.

FIGURE 2.3 Shares of agricultural subsectors in agricultural GDP, 1990/1991–2012/2013



Source: Authors, based on data from GOP (2014).
Note: All shares measured at constant factor cost.

The agricultural sector is conventionally defined in Pakistan to include major crops (wheat, cotton, rice, and sugarcane), minor crops, livestock, forestry, and fisheries. Until the early 1990s, the combined (major and minor) crop subsectors contributed over two-thirds of the agricultural GDP, while livestock contributed approximately 30 percent.[7] By 2013/2014 the share of livestock's contribution to agricultural GDP had increased to 56 percent, while that of the combined crop subsectors had declined to 38 percent, with major crops accounting for 26 percent and minor crops for 12 percent (Figure 2.3). The GDP of all subsectors grew at slower rates during 2000–2009 as compared to those observed during the 1990s. In particular, the production of the major crops—accounting for over 53 percent of the country's total crop area—grew marginally more slowly, averaging 2.8 percent during 2000–2009 compared to 3.0 percent during 1990–1999. Only in the period 2000–2013 did the production of major crops increase slightly, with an

7 All GDP comparisons presented here are based on real values with the base year of 2005/2006. See GoP (2014).

TABLE 2.6 Average production for crops and livestock, 2010–2013, and growth rates, 1990–2013

Agricultural subsector	Average production (thousands of MT)	Annual growth rate (%)		
	2010–2013	1990–1999	2000–2009	2010–2013
Major Crops	n.a.	**3.0**	**2.8**	**3.7**
Wheat	24,075.2	2.5	1.5	1.4
Rice	5,860.6	4.2	3.4	–6.8
Cotton	2,172.8	0.3	0.6	0.3
Sugarcane	56,707.0	5.0	0.9	8.9
Minor Crops	n.a.	**4.3**	**1.1**	**–0.9**
Maize	3,881.8	3.9	9.0	9.0
Bajra	313.5	0.5	7.4	2.0
Jowar	140.5	–1.5	–3.1	–7.2
Barley	68.6	0.5	–4.0	–2.4
Gram	507.8	2.4	3.1	7.0[a]
Mung	95.9	5.3	5.8	–7.9
Mash	10.9	-4.9	–6.0	0.0
Masoor	11.8	2.6	–9.5	0.6
Potato	3,341.1	9.0	5.2	2.6
Onion	1,777.5	5.3	0.4	–0.2[a]
Livestock	n.a.	**6.2**	**4.6**	**3.5**
Milk[b]	38,102.3	6.0	3.6	3.2
Beef	1,741.0	3.1	5.5	3.4
Mutton	622.8	0.2	–1.0	2.2
All agriculture	n.a.	**4.6**	**3.7**	**2.8**

Source: Authors, based on data from GoP (2013).

Notes: MT = metric tons. n.a. = not applicable. Bajra is pearl millet, masoor is red lentils, and jowar is sorghum.

[a] Growth rates given are for the period 2010–12 only due to data availability.

[b] Milk is measured in thousands of metric tons of calculated human consumption.

annual growth rate of 3.7 percent, although this occurred concurrently with an average decline of 0.9 percent in the growth rate of minor crops (Table 2.6).

Despite several data-related anomalies in these trends—the unexplained surges in livestock's contribution to agricultural GDP in 1995 and 2005 (see Malik 2005)—the long-term trends indicate that the sources of agricultural-sector growth have changed in recent years. In particular, livestock production has expanded dramatically relative to that of major crops (Annex B,

TABLE 2.7 Growth of area cultivated and yield of selected crops, 1990–2014

	Area cultivated 2014 (thousands of ha)	Share of area in total (%)	Area cultivated growth rate			Yield 2014 (MT/ha)	Yield growth rate		
			(FY90–FY00)	(FY00–FY10)	(FY10–FY14)		(FY90–FY00)	(FY00–FY10)	(FY10–FY14)
Major Crops									
Wheat	9,039	47.6	0.65	1.02	–0.48	2.80	2.51	1.11	1.71
Rice	2,789	14.7	1.82	2.25	–0.90	2.44	3.06	1.91	2.05
Cotton	2,806	14.8	1.34	0.20	–1.34	0.77	–1.97	1.71	2.44
Sugarcane	1,173	6.2	2.36	0.25	5.86	56.67	1.49	1.25	1.68
Minor Crops									
Maize	1,117	5.9	1.24	0.81	4.50	4.05	2.36	9.13	3.51
Other food grains	744	3.9	–1.55	–0.08	–3.14	0.65	1.15	0.42	0.84
Gram	975	5.1	0.16	1.75	–2.38	0.49	3.45	1.43	3.25
Tobacco	50	0.3	1.82	0.67	–2.43	2.16	1.33	1.33	1.00
Others (not specified above)	280	1.5	1.67	–3.02	–14.77	0.76	–3.92	0.47	4.56
Total	**18,973**	**100.0**	**0.92**	**0.86**	**–0.60**	**5.61**	**2.62**	**1.23**	**1.82**

Source: Authors, based on data from GoP (2013).

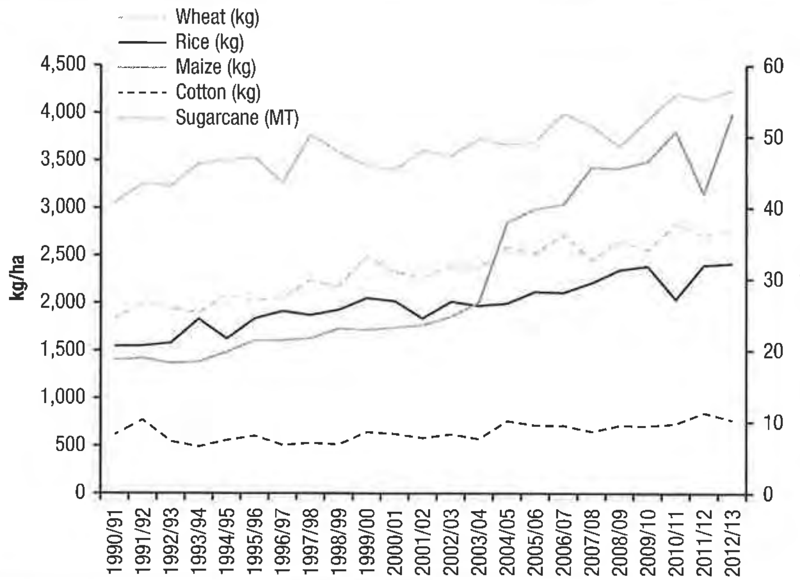
Note: MT = metric tons, ha = hectares. Growth rates are calculated as logarithmic estimates of annual growth based on data from 1990 to 2014.

Table B2.1). These trends have emerged despite the fact that government policy has focused primarily on the four major crops—wheat, rice, cotton, and sugarcane—which together made up only 26 percent of total agricultural GDP in 2014.

Several trends in the crop subsector are worth highlighting. First, while the shares in GDP of the various crops have declined over time, production levels have kept pace with population growth. Based on official data not reported here, the value of production on a per capita basis has remained more or less steady for most crops, with wheat production per capita showing a modest upward trend in recent years. This is due largely to the fact that the declining growth rates in production for most crops over time have been matched by a decreasing rate of population growth.

Second, while wheat remains the central commodity of Pakistan's agricultural sector, the rate of growth in wheat output is declining. Since 1996–1997, wheat has consistently been the largest contributor to agricultural GDP among all crops. Production has increased from approximately 16 million tons per year in the 1990s to 20 million tons in 2000–2009, and to 24 million tons in 2010–2013. However, the growth rate of output declined from 2.5 percent

FIGURE 2.4 Yield per hectare of major crops and maize, 1990/1991–2012/2013



Source: Authors, based on data from GoP (2013).
Note: kg = kilograms; ha = hectares; MT = metric tons.

per year in the 1990s to 1.5 percent in 2000–2009, and to 1.4 percent in 2010–2013. During this period, the growth rate of wheat yields has also stagnated. Other major crops showed similar production and yield trends (Table 2.7; Figure 2.4).

Third, despite the demonstrated potential of several minor crops—particularly high-value fruit and vegetables for domestic and export markets (Riaz 2009)—the contribution of minor crops to agricultural GDP declined during 2000–2010 an average of 1.3 percent per year and continued to decline at 0.9 percent per year during 2010–2014. Meanwhile the area of vegetables, orchards, and other crops under cultivation has remained almost constant since 1990, as has the area of the major crops such as wheat and cotton (Table 2.8). The major exception to this trend has been maize—primarily a feed crop—for which production increased rapidly between 1990 and 2013, almost tripling in quantity and growing at an average rate of 9 percent per year.

These rather straightforward observations raise several questions. Is there room for complacency around production and yield growth for wheat and

TABLE 2.8 Cropped areas (thousands of ha) and percentage shares of total cropped area by farm size, 1990–2010

	All farms			Under 0.5 ha			2 to under 5 ha			20 ha and above		
Crop	1990	2000	2010	1990	2000	2010	1990	2000	2010	1990	2000	2010
Total cropped area	21,340	23,422	27,482	297	212	888	6,981	7,659	9,304	3,455	3,103	3,071
Grains (%)	58	59	63	69	73	69	61	61	62	53	50	56
Wheat (%)	38	40	42	41	43	45	39	41	42	35	36	38
Cotton (%)	13	14	14	7	6	10	12	13	14	15	14	13
Wheat + Cotton (%)	51	54	56	48	49	55	51	54	56	50	50	51
Pulses (%)	5	5	5	1	1	2	3	4	5	8	11	7
Sugarcane (%)	3	4	4	1	1	2	4	4	4	3	4	6
Oilseed (%)	2	2	2	0	1	1	2	2	2	3	2	3
Fodder (%)	13	11	9	14	14	12	14	12	10	9	7	5
Vegetables (%)	2	2	2	3	2	2	2	2	2	3	4	4
Orchards (%)	2	2	2	2	1	1	1	1	1	4	4	4
Other crops (%)	1	1	1	1	1	1	1	1	1	1	1	1

Source: Authors, based on data from GoP (1990, 2000, 2010a).

Note: ha = hectares.

the other major crops? Does the relatively low rate of diversification into high-value crops and more-traditional minor crops such as pulses and legumes constrain agricultural-sector growth, the development of the rural economy, and poverty reduction efforts? And are there lessons to be learned from the successes in maize production or in selected market niches such as high-value fruits and vegetables? These questions are examined in detail below and considered from a variety or perspectives throughout the book.

Total Factor Productivity and Overall Agricultural Growth

Estimates of total factor productivity (TFP) growth for the agricultural sector can provide useful insights into what is driving the trends discussed above, even though such estimates tend to be aggregate values and mask enormous variations, as this discussion will demonstrate. TFP growth provides a broad indication of agricultural-productivity growth by estimating the portion of agricultural output that is not explained by the quantities of inputs used in production. In effect TFP growth measures changes in the efficiency and intensity of input use: where output growth exceeds total input growth, TFP is increasing. Importantly, TFP helps to determine if agricultural-sector growth is driven by the increasingly intensive use of inputs—resulting from interventions in input costs and investments in agricultural infrastructure—or by productivity improvement that comes from combining the factors of production (labor, land, and capital) in more economically or technically efficient ways, for example through applications of science, improvements in the quality of human capital, or changes in institutions and incentives.

Studies of agricultural total factor productivity measurement have looked at the issue of TFP in Pakistan from several vantage points and used various types of data and methods (see Touseef and Riaz 2013). Each approach has its strengths and limitations (see Annex C), making it important to interpret changes in TFP in light of the levels of aggregation, coverage, and methodological approaches employed. Table 2.9 summarizes the key features of previous studies on agricultural productivity growth in Pakistan. Most studies found positive TFP growth rates for agriculture in Pakistan, although studies vary in terms of geographic coverage (all Pakistan versus provincial analysis), subsectors (crops only versus crops and livestock), and methodology. Except for Ahmed (2001) and Kiani (2008a, 2008b, 2008c), studies employed a descriptive approach involving either the Törnqvist-Theil index or arithmetic index.

We compute TFP growth of the entire agricultural sector, including both crop and livestock sectors, using the Törnqvist-Theil (T-T) index for the period 1960/1961–2012/2013, extending the earlier analysis by Ali and Byerlee (2002). Data are drawn from published statistics in the Economic Surveys of the Ministry of Finance, the Agricultural Statistics of Pakistan of the Ministry of Food Security and Agricultural Research (GoP 2014, 2013), and unpublished data collected by the Agriculture Policy Institute of the Ministry of National Food Security and Research. The extent of coverage here is dictated by the availability of data from the latter source. The coverage of crop sector output includes wheat, rice, cotton, sugarcane, maize, gram, mung beans, green lentils, red lentils, millet, sorghum, potatoes, and onions. Coverage of livestock sector output includes beef, mutton, and milk. Standard inputs such as labor, capital, and land as well as intermediate inputs such as fertilizer and pesticides are included.

Figure 2.5 and Figure 2.6 present our estimates of TFP growth rates for Pakistan's agricultural sector as a whole by period. The analysis by period indicates that the highest rate of TFP growth was achieved during 1966–1970, which is the period during which improved rice and wheat cultivars were

TABLE 2.9 Studies on total factor productivity in Pakistan's agricultural sector

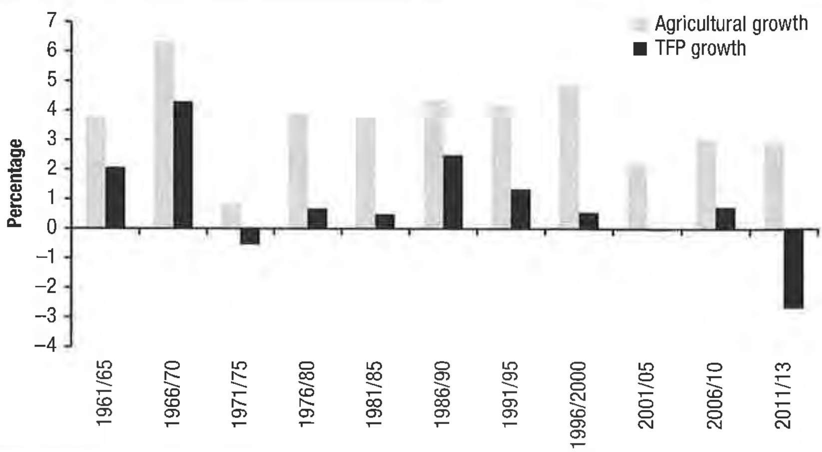
Study	Period of analysis	Geographic coverage/ sector of analysis	Estimation methodology and nature of data	Average annual TFP growth rate (%)
Wizarat (1981)	1953–79	Pakistan/crop sector	Arithmetic index/annual time series	1.10
Rosegrant and Evenson (1993)	1957–85	Pakistan/crop sector	Törnqvist-Theil index/ annual time series	1.07
	1957–65			1.65
	1965–75			1.86
	1975–85			–0.36
Khan (1994)	1980–93	Pakistan/crop sector	Arithmetic index/annual time series	2.10
Khan (1997)	1960–96	Pakistan/crop sector	Törnqvist-Theil index/ annual time series	0.92
Ali (2004)	1960–96	Pakistan/crop and livestock sectors	Arithmetic index/(Weights 1960/61)	2.17
			(Weights 1980/81)	0.40
			Törnqvist-Theil index/ annual time series	2.30
Saboor et al. (2006)	1960–2002	Pakistan/crop and livestock sectors	Arithmetic index/annual time series	4.6
Ahmed et al. (2008)	1965–2005	Pakistan/crop sector	Growth accounting/annual time series	0.28
Ali and Byerlee (2002)	1966–94	Punjab/crop and live-stock sectors	Törnqvist-Theil index/ cross-sectional	1.26
Ahmed (2001)	1991–99	Punjab/crop sector	Cobb–Douglas Production frontier/cross sectional	1.97
Kiani (2008a)	1970–2004	Punjab/crop sector	Malmquist index/annual time series	–1.38[a]
Kiani (2008b)	1970–2004	Sindh/crop sector	Törnqvist-Theil index/ annual time series	1.8
Kiani (2008c)	1970–2004	Balochistan/crop sector	Törnqvist-Theil index/ annual time series	1.5
Touseef and Riaz (2013)	1960–2006	Balochistan, KPK, Punjab, Sindh/crops, forestry, livestock, and fisheries sectors	Malmquist index/annual time series	0.99

Source: Authors, based on Touseef and Riaz (2013) and Ahmad, Chaudry, and Ilyas (2008).

Note: KPK = Khyber Pakhtunkhwa; TFP = total factor productivity.

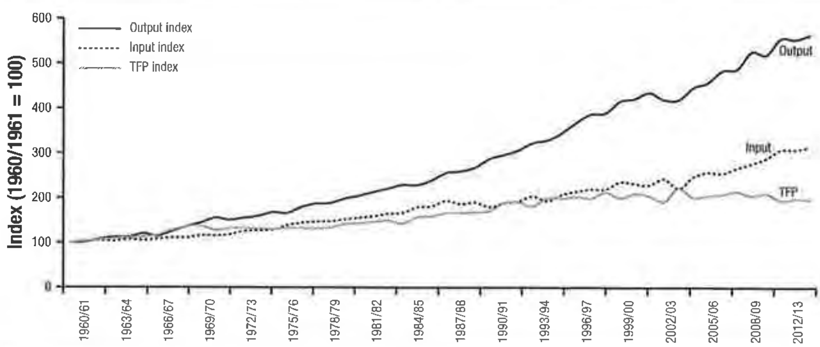
[a] Only provincial average reported. District-level TFP growth rates are detailed in Kiani (2008a).

FIGURE 2.5 Growth rates of agricultural production and TFP, 1961–1965 to 2011–2013



Source: Authors, based on data from GoP (2013).
Note: TFP = total factor productivity.

FIGURE 2.6 Growth of agricultural inputs and outputs and TFP, 1960/1961–2012/2013



Source: Authors, based on data from GoP (2013).
Note: TFP = total factor productivity.

introduced in irrigated agricultural zones as part of the Green Revolution. Immediately thereafter, the TFP growth rate decreased, and after experiencing a low growth rate throughout the late 1970s and early 1980s, it increased again to 2.5 percent in 1986–1990. This was the last time of rapid growth in aggregate TFP to date. Moreover, beginning from about 2002–2003 and continuing to 2011–2013, these estimates suggest that agricultural-sector growth has been driven largely by increases in input use, while TFP growth has declined.

But because aggregate TFP growth estimates are of only limited use to gain an understanding of what is driving agricultural-sector trends discussed earlier, a province-level analysis may be more informative. Touseef and Riaz (2013) provide this, despite the difficulty in compiling, from official statistics, provincial input and output data beyond major and minor crops. The TFP indexes estimates by Touseef and Riaz (2013) show that there were considerable variations in patterns of TFP change among the provinces during the period 1960–2006 (Table 2.10). The estimates indicate that TFP growth was negative in the two main agricultural provinces, Punjab and Sindh, with average TFP declines estimated at −0.50 and −0.18 percent per year, respectively. They further indicate that TFP growth in Balochistan and KPK was positive during the same period, at 0.60 and 0.16 percent per year, respectively.

Several common themes emerge from the findings of the studies discussed here. First, agricultural productivity growth in Pakistan has been largely driven by increases in input use rather than technical change. For example, for the Punjab crop sector, Kiani (2008a) reported a −1.38 percent average rate of TFP change during 1970–2004. Ali and Byerlee (2002) estimate that TFP declined 1.04 percent during the Green Revolution period, 1966–1974, although they did find positive TFP growth for the entire study period (1966–2003). These findings are consistent with our results and those of Touseef and Riaz (2013), presented above. Second, the absence of sustained TFP growth and the trend toward input intensification is closely linked to resource degradation. Concerns over increasing resource-use inefficiency and resource degradation were raised by Ali and Byerlee (2002) and Murgai, Ali, and Byerlee (2001), and these trends seem to continue more than a decade later.

Finally, spatial TFP patterns exhibit sensitivity to degree of intensification. For example, Ahmed (2001) found that the highest rates of TFP growth were observed in the mung bean–wheat zone, followed by the barani (rainfed) zone, where constraints on irrigation limited the possibilities for intensification. On the other hand, the lowest TFP growth was observed in the intensively irrigated rice-wheat zone, and more generally, in areas with higher cropping intensities. These findings are consistent with those of Murgai (1999) and Pagiola (1995), who studied the Indian Punjab and Bangladesh, respectively.

In short, agriculture in Pakistan may be experiencing resource-degrading growth that is driven by intensive input use, with limited growth because of technological change. But can we say more about this growth pattern? If technological change has not been a key driver of agricultural growth, can

TABLE 2.10 Growth in agricultural TFP by province, 1960–2006

Province	Malmquist TFP index	Efficiency change	Technical change	Pure efficiency change	Scale change
Punjab	0.771	1.000	0.771	1.000	1.000
Sindh	0.917	1.000	0.917	1.000	1.000
KPK	1.075	1.000	1.075	1.000	1.000
Balochistan	1.275	1.000	1.275	1.000	1.000
Average	**0.989**	**1.000**	**0.989**	**1.000**	**1.000**

Source: Touseef and Riaz (2013).

Note: KPK = Khyber Pakhtunkhwa, formerly North-West Frontier Province; TFP = total factor productivity.

we decompose the trends to account not only for technological change and input use but also for crop-specific changes in areas under cultivation? To do this, we draw on work by Saeed (1976) and a more contemporary approach to decomposition analysis provided by Taffesse (2009) to examine the respective role of changes in yields and area allocated to crop production.[8]

Results of our decomposition analysis draw attention to two key trends (Table 2.11). First, for wheat production, the effect of changes in area dominates over the effect of changes in yield in nearly all zones. Second, for maize production, the effect of changes in yield dominate over the effect of changes in area. Traditionally maize has been the main staple crop in the KPK zone and certain parts of the Barani zone. Yet maize has grown much more rapidly in the nontraditional maize zones. The effect of yields on maize production are highest in nontraditional maize zones such as the Cotton/Wheat Sindh, Mixed Punjab, and Rice/Wheat Punjab zones, where acreage was shifted away from sugarcane and other crops toward maize.

Land Tenure, Agricultural Growth, and Productivity

Agricultural-sector growth, technological change, and productivity are closely tied to issues associated with land: land is central to almost all economic and social dimensions of rural livelihoods in Pakistan (Qureshi, Qureshi, and Salam 2004; Renkow 1993; Nabi, Hamid, and Zahid 1986). A variety of land policy and tenure laws have been created since British rule in Pakistan, but

8 Specifically, we decompose growth as

$$dQ_i \cong A_i dy_i + y_i dA_i$$

where, for crop i, Q represents total output, A represents total acreage allocated, and y represents yield.

TABLE 2.11 Decomposition of growth of production of major cereals by agroclimatic zone, 1981/1982–2011/2012 (%)

		Production of:					
		Wheat		Rice		Maize	
Agroclimatic zone	Period	Area effect	Yield effect	Area effect	Yield effect	Area effect	Yield effect
Barani Punjab	1981/1982–2011/2012	88.89	11.11	n.a.	n.a.	59.83	40.17
	1981/1982–1989/1990	84.27	15.73	n.a.	n.a.	78.27	21.73
	1990/1991–1999/2000	92.08	7.92	n.a.	n.a.	33.24	66.76
	2000/2001–2011/2012	87.69	12.31	n.a.	n.a.	68.47	31.53
Rice/wheat Punjab	1981/1982–2011/2012	86.80	13.20	45.27	54.73	55.68	44.32
	1981/1982–1989/1990	94.16	5.84	7.05	92.95	63.95	36.05
	1990/1991–1999/2000	76.78	23.22	72.00	28.00	−3.13	103.13
	2000/2001–2011/2012	93.14	6.86	32.84	67.16	52.60	47.40
Mixed Punjab	1981/1982–2011/2012	88.52	11.48	20.75	79.25	63.53	36.47
	1981/1982–1989/1990	104.35	−4.35	51.18	48.82	50.99	49.01
	1990/1991–1999/2000	96.60	3.40	13.78	86.22	67.86	32.14
	2000/2001–2011/2012	71.52	28.48	11.00	89.00	72.78	27.22
Cotton/wheat Punjab	1981/1982–2011/2012	102.18	−2.18	25.55	74.45	30.25	69.75
	1981/1982–1989/1990	121.25	−21.25	27.37	72.63	56.71	43.29
	1990/1991–1999/2000	86.05	13.95	59.64	40.36	20.55	79.45
	2000/2001–2011/2012	89.91	10.09	10.86	89.14	30.25	69.75
Low-intensity Punjab	1981/1982–2011/2012	88.06	11.94	23.73	76.27	10.69	89.31
	1981/1982–1989/1990	94.96	5.04	19.64	80.36	36.45	63.55
	1990/1991–1999/2000	86.07	13.93	46.06	53.94	15.58	84.42
	2000/2001–2011/2012	78.96	21.04	18.30	81.70	−1.14	101.14
Cotton/wheat Sindh	1981/1982–2011/2012	88.96	11.04	48.76	51.24	0.70	99.30
	1981/1982–1989/1990	99.38	0.62	45.73	54.27	0.70	99.30
	1990/1991–1999/2000	95.62	4.38	64.78	35.22	−0.10	100.10
	2000/2001–2011/2012	71.37	28.63	18.51	81.49	−1.05	101.05
Rice/other Sindh	1981/1982–2011/2012	71.24	28.76	35.36	64.64	1.72	98.28
	1981/1982–1989/1990	77.69	22.31	23.64	76.36	-9.92	109.92
	1990/1991–1999/2000	85.88	14.12	53.26	46.74	−23.55	123.55
	2000/2001–2011/2012	60.77	39.23	20.19	79.81	33.30	66.70
Southern KPK	1981/1982–2011/2012	51.59	48.41	22.92	77.08	−3.94	103.94
	1981/1982–1989/1990	43.85	56.15	−5.51	105.51	−13.20	113.20
	1990/1991–1999/2000	13.32	86.68	23.74	76.26	8.36	91.64
	2000/2001–2011/2012	70.55	29.45	30.04	69.96	−11.46	111.46
KPK plains/foothills	1981/1982–2011/2012	77.15	22.85	59.39	40.61	67.66	32.34
	1981/1982–1989/1990	61.27	38.73	29.66	70.34	24.83	75.17
	1990/1991–1999/2000	75.01	24.99	63.71	36.29	102.51	−2.51
	2000/2001–2011/2012	103.26	−3.26	70.86	29.14	64.13	35.87
Balochistan	1981/1982–2011/2012	8.75	91.25	24.20	75.80	−1.18	96.63
	1981/1982–1989/1990	−11.87	111.87	14.11	85.89	0.70	99.30
	1990/1991–1999/2000	−18.20	118.20	24.20	75.80	−4.71	104.71
	2000/2001–2011/2012	88.96	11.04	43.88	56.12	55.97	44.03

Source: Authors, based on data from GoP (2013).

Note: n.a. = not applicable; KPK = Khyber Pakhtunkhwa.

current policies still reflect their colonial antecedents. Importantly, the sale and purchase of land is governed by the law of *haq shufa*, which dictates that the first right of purchase goes to family or neighbors (Qureshi 2004). The persistent land tenure issues in parts of Pakistan, combined with relatively thin markets for land sales, necessarily affect the willingness of a farmer to invest in productivity-enhancing inputs, services, and infrastructure. This willingness is determined by a range of factors, including the ability to gain access to land through ownership, use rights, or rental markets; access to markets for inputs, equipment, and credit; access to public services and infrastructure such as extension and irrigation; and the transaction costs associated with securing access to all of these essentials. Policy makers and researchers alike have given much attention to the relationships between land, productivity, and poverty for several decades in Pakistan (for example, Jacoby and Mansuri 2009; Qureshi et al. 2004; Renkow 1993). They have been informed by a rich literature on these issues (for example, Jin and Deininger 2009; Deininger, Jin, and Nagarajan 2008; Binswanger, Deininger, and Feder 1995; Binswanger 1994). This section presents a brief overview of land and land tenure in Pakistan, and the challenges they present for agricultural-sector growth and development.

During the period immediately before the consolidation of British rule in 1858, rural elites acquired large tracts of agricultural land in Punjab and surrounding areas. After British rule was consolidated, officials recognized the elites' proprietary land rights in order to gain political support and cooperation (Naqvi, Khan, and Chaudhry 1987). In addition, the British granted large areas of land (*jagirs*) to individuals who helped conquer areas of what are today Punjab and Sindh. Thus, the existence of landlords with large tracts of land became widespread and set the pattern for Pakistan.

During British rule, two land tenure systems developed: a landlord-tenancy (*zamindari*) system and a peasant-proprietor system (Qureshi and Qureshi 2004).[9] Whereas the landlord-tenancy system was characterized by absentee landlords and verbal or customary tenancy arrangements, the peasant-proprietorship provided peasants with ownership rights and allowed farmers to cultivate land as they saw fit. The landlord-tenancy system was tied to colonial rule, and two subsystems developed: revenue-free land estates granted by the government to *jagirdars* (those who assisted the British in

9 Other systems also existed in the region, for example the *mahalwary* system, which was more common in eastern Punjab (today the state of Punjab in India), which required peasants to pay land revenues directly to the British.

consolidating their administrative control) and estates in which landowners (*zamindars*) were required to pay a land tax to the government. Under the *jagirdari* system, tenant farmers were classified in two categories: occupancy tenants who had permanent, heritable, and transferable rights to cultivate *jagir* land; and tenants-at-will, or *haris*, who held no legal rights. Under the *zamindari* system, a majority of the land held by landowners was rented or parceled out and cultivated by sharecroppers and tenants, on whom the tax burden fell (Nabi, Hamid, and Zahid 1986; Qureshi and Qureshi 2004).

Contracts between tenant and landlord were typically verbal and usually short-term. Tenants were shifted among different plots on the land so that a single individual was not listed on a particular plot for more than one year, and were often required to provide free labor to the landlord in addition to a significant share of their plot's output. This led to bonded labor arrangements in which workers were tied to an employer at very low wages or to repay debts at very high interest rates. These arrangements still exist today in some parts of Pakistan: a study in 2000 found that the majority of the 1.7 million landless agricultural workers in Sindh were in a debt bondage arrangement (Agrodev 2000; Qureshi 2004).

Pakistan's efforts to address land issues began in 1950 with the introduction of successive national and provincial acts and orders designed to effect a more equitable redistribution of tenure rights (see Chapter 1). Pakistan implemented three major land reforms—in 1959, 1972, and 1977. Provisions included prescribed terms for the manner in which production inputs and outputs were shared between landlords and tenants, legal occupancy rights for tenants, curtailment of the conditions under which tenants could be evicted, and ceilings on individual landholdings; other tenure reforms were also introduced (Gazdar 2009; Naqvi, Khan, and Chaudhry 1987; Nabi, Hamid, and Zahid 1986).[10] The 1959 and 1972 land reforms attempted to redistribute land from large landowners—who accounted for about 8 percent of total cultivated area in Pakistan—to tenants, smallholders, and the landless. However, much of the redistributed land was of poor quality and was never allocated to its intended beneficiaries, resulting in relatively little change in landholding concentration or tenure. The 1977 land reforms were never implemented. In effect, land reforms have had little success in changing the status quo in Pakistan and almost no impact on production or productivity (Gazdar 2009;

10 See Jacoby and Mansuri (2008, 2006) for a more comprehensive discussion of land tenure policy and the effects of tenancy arrangements on production.

TABLE 2.12 Number and area of farms by ownership type, 2000–2010

Ownership	2000	2010
Number of farms (thousands)	6,620.1	8,264.5
Owned	77.6%	81.6%
Tenant	14.0%	11.1%
Owner cum tenant	8.4%	7.3%
Total area (thousand of acres)	50,425.2	52,910.1
Area cultivated by owners	73.3%	74.5%
Area solely tenant farmed	12.2%	11.1%
Area owner cum tenant	14.5%	14.3%
Average size of cultivated area (acres)	6.2	5.2

Source: Authors, based on data from GoP (2000, 2010a).

Naqvi, Khan, and Chaudhry 1989; Nabi, Hamid, and Zahid 1986). Since these reforms, only minor amendments to land laws have occurred, and high levels of land concentration remain common throughout most of Pakistan, owing partly to the political power of large landowners (Qureshi 2004; Husain 1999; Nabi, Hamid, and Zahid 1986; Heston and Kumar 1983).

As a result, land ownership in Pakistan remains characterized by owner-cultivators, sharecropping arrangements, or some combination of the two. In 2010, 82 percent of farms, making up 75 percent of the country's farm area, were operated by owner-cultivators, while 11 percent of farms, making up 11 percent of the area, were operated under tenancy arrangements, with the remaining farms and area under a combination of the two (Table 2.12). While studies suggest that owner cultivation has increased at the expense of sharecropping since the 1950s (Cheema and Naseer 2010; Nasim, Dinar, and Helfand 2014), the ability of large landowners to protect their landholdings through various legal mechanisms makes it difficult to assess the true extent of its persistence (Ali 2015). For example, a land sale transaction on inherited land with a nonfamily member can be impeded by the right of first refusal. Sales of small plots can be hindered by high transaction costs, even if all parties are willing to accept the terms of the sale. Historically, there has been a lack of explicit land titles, and informal and customary rights have been in force, contributing to high transaction costs. While land rights are individually allocated today, due to these historical factors, land markets in Pakistan remain thin, and land fragmentation is high (Qureshi and Qureshi 2004; Heston and Kumar 1983).

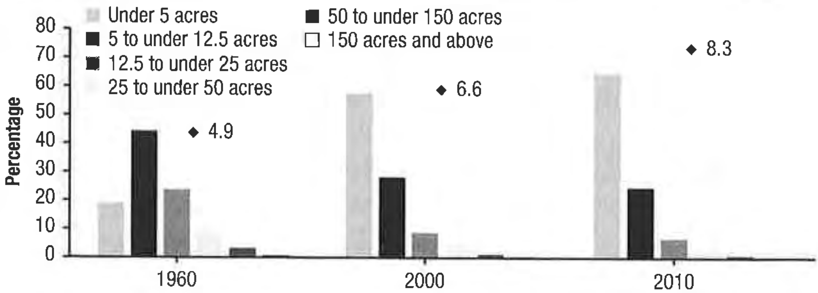
Access to rural credit is an issue closely related to land markets in Pakistan. Credit markets allow farmers to combine factors of production and enhance farm-level productivity, but only where those markets function effectively, and particularly where they serve the needs of small-scale owner-cultivators. There is rich body of literature that examines credit constraints in rural Pakistan and their effects on productivity growth, poverty reduction, and the wider rural economy (see Zubeiri 1989; Malik, Mushtaq, and Gill 1991; Qureshi, Nabi, and Faruqee 1996; Malik 1999; Malik and Nazli 1999; Amjad and Hasnu 2007). All the studies point to the challenges posed by credit constraints or the institutional architecture of both formal and informal credit sources: the Zarai Taraqiati Bank (ZTBL), the primary source of formal agricultural credit; and the commission agents; input dealers; professional moneylenders; and landlords who extend informal loans in cash or kind. Further exploration of Pakistan's credit markets is needed.

All of this points to the persistent policy challenge for Pakistan: how to improve the allocation of land to more productive uses. Here, Pakistan faces the difficult reality that land rarely changes hands outside of inheritance, limiting the scope for alternatives to owner cultivation or sharecropping. Small farmers face the dual challenges of entrenched large landholders on the one hand, and increasing fragmentation of smallholder landholdings on the other hand. Much evidence suggests that transaction costs associated with the sale and purchase of land are a key constraint to individual efforts to consolidate land into economically viable units, an obstacle that is possibly exacerbated by speculative prices that exceed the discounted value of potential agricultural earnings from land (Qureshi et al. 2004; Ahmed and Gautam 2013). In 2000, for example, only 0.2 percent of agricultural land was sold, according to data from the Pakistan Rural Household Survey (2001–02) (PIDE 2001).[11]

Predictably, the persistence of high transaction costs in land sales, thin rental markets, and land inheritance requirements has been accompanied by increased fragmentation of landholdings, with growing concerns that average farm sizes are quickly falling below the minimum sustainable operational level. According to Agricultural Census data, between 1960 and 2010, the proportion of farms under 5 acres increased from 19 percent to 65 percent, while the proportion of farms between 5 and 25 acres decreased from 68 percent to 32 percent (Figure 2.7; Table 2.13). By 2010, only 3.8 percent of farms were larger than 25 acres, while farms of larger than 25 acres make up 34 percent of all farm area in Pakistan. This suggests that growth in the

11 The small percentage of sales of land is also confirmed by data from IFPRI/IDS (2012).

FIGURE 2.7 Distribution of private farms by size and total number of farms, 1960–2010



Source: Authors, based on data from GoP (2000, 2010a).
Note: The total number of farms, in millions, is denoted by diamond-shaped markers.

number of farms under 5 acres has resulted from the fragmentation of farms in the 5 to 12.5 acre and the 12.5 to 25 acre categories—farms that were otherwise considered to be an important and economically viable source of agricultural output growth in Pakistan. Meanwhile, the number of farms larger than 50 acres has remained relatively constant throughout this period, and increased slightly from 2000 to 2010, suggesting that fragmentation has not occurred among large landholders.

Between 1990 and 2010, the average size of farms in the now predominant category of farms under 5 acres declined from 2.2 acres to 1.9 acres, with a more significant decline seen in KPK, from 1.9 acres to 1.5 acres (Table 2.14). This decrease in size further suggests that the land fragmentation process is intensifying within already fragmented landholdings. These trends are further exacerbated by growing inequality associated with land tenure. Nearly 92 percent of all rural households in Pakistan fall in the category of "landless or less than 5 acres of land operated," with nearly 95 percent of households in this category classified as poor, according to data from the 2010/2011 HIES (GoP 2011) (Table 2.15).

In sum, while farmers with larger landholdings have been able to protect the size of their holdings from fragmentation, their neighbors with medium- and small-size landholdings, because of their poor economic status, are forced to subdivide and fragment their landholdings by following inheritance laws. This means that over generations, their farms become smaller and smaller and the plots become farther apart, making it impossible for farmers to farm efficiently. The farm families with larger farms do not subdivide as quickly as those with the medium- and small-size farms. As medium and

TABLE 2.13 Percentage of farms and farm area by farm size, 1960–2010

Farm size in acres (hectares)	Share of farms (%)						Farm area (%)					
	1960	1972	1980	1990	2000	2010	1960	1972	1980	1990	2000	2010
<5 (< 2)	19.0	28.2	34.1	47.5	57.6	64.7	3.0	5.2	7.1	11.3	15.5	19.2
5–12.5 (2–5)	44.3	39.9	39.4	33.4	28.1	24.8	23.6	25.2	27.3	27.5	27.9	28.8
12.5–25 (5–10)	23.8	21.1	17.3	12.2	8.8	6.8	27.0	26.6	24.7	21.5	19.1	17.7
25–50 (10–20)	9.0	7.7	6.5	4.7	3.9	2.6	19.0	18.8	17.8	15.8	16.3	12.7
50–150 (20–61)	3.3	2.7	2.4	1.8	1.2	1.0	16.0	15.1	14.7	13.9	9.6	10.5
>150 (>61)	0.5	0.4	0.3	0.3	0.2	0.2	11.5	9.1	8.5	10.1	11.6	11.1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Authors, based on data from GoP (1960, 1972, 1980, 1990, 2000, and 2010a).

TABLE 2.14 Percentage of farms and farm area by province, 1990 and 2010

Source and province	All farms			Under 5.0 acres		
	Number of farms (%)	Farm area (%)	Average size (acres)	Number of farms (%)	Farm area (%)	Average size (acres)
Census 1990						
Punjab	58	61	9.2	56	57	2.2
Sindh	16	19	10.7	11	14	2.9
KPK	21	13	5.5	31	26	1.9
Balochistan	5	6	11.8	2	2	1.7
Pakistan	100	100	8.8	100	99	2.2
Pakistan (total numbers and acres)	*5,070,960*	*44,410,269*		*2,404,103*	*5,270,622*	
Census 2010						
Punjab	64	55	5.6	63	64	1.9
Sindh	13	19	8.8	12	15	2.4
KPK	19	11	2.9	23	18	1.5
Balochistan	2	15	9.7	2	3	2.4
Pakistan	100	100	6.4	100	100	1.9
Pakistan (total numbers and acres)	*8,064,479*	*52,910,408*		*5,350,946*	*10,184,052*	

Source: Authors, based on data from GoP (1990, 2010a).

Note: Totals may not add to 100 due to rounding. KPK = Khyber Pakhtunkhwa.

TABLE 2.15 Distribution of rural households by household status, land cultivated, and poverty status, 2010

Household status	Rural households		Poor rural households	
	Number	% of total	Number	% of total
Farm households	524,829	2.6	281,684	3.5
Nonfarm households	12,896,993	64.1	5,218,954	64.8
Farm/nonfarm households	6,705,084	33.3	2,559,312	31.8
Total	20,126,906	100.0	8,059,950	100.0
Land cultivated				
Landless and less than 5 acres	18,481,146	91.8	7,631,516	94.7
5 to 12.5 acres	1,208,359	6.0	359,142	4.5
12.5 to 25 acres	335,979	1.7	64,783	0.8
25 to 50 acres	64,237	0.3	2,852	0.0
50 acres plus	37,184	0.2	1,658	0.0
Overall	20,126,906	100.0	8,059,950	100.0

Source: Authors, based on data from GoP (2011).

small farms become smaller and smaller, those sizes and the scarcity of other resources make it difficult for them to be economically sustainable, let alone to increase productivity.

Conclusions

Somewhat paradoxically, this chapter has illustrated how Pakistan's agriculture is changing while, at the same time, remaining in somewhat of a state of stasis. The country's agroclimatic diversity and endowment of natural resources remain its greatest asset, but it is fast becoming a nation plagued by acute water scarcities (see Chapter 4). Agricultural production and productivity continue to grow, albeit slowly, but increasingly growth is on the back of unsustainable input intensification patterns rather than technological change. Growth in rural infrastructure, transportation networks, and urban agglomerations are reducing the time, effort, and cost of linking production to consumption, yet agricultural diversification into commodities that serve urban demand remains limited.

Public policy clearly has a role to play in addressing these paradoxes. But shifts in attention given to agricultural policy since independence are closely tied to the observed fluctuations in Pakistan's agricultural growth rates. For example, the growth in TFP during 1966–1970 is clearly attributable to the initial gains made by the Green Revolution—technical change driven by technology transfers and investments in research and extension, and supported by a range of policy incentives designed to encourage productivity growth. The next upswing during 1986–1990 occurred at a time when agriculture received renewed attention on the national development agenda after having been marginalized in the late 1970s and early 1980s. This growth was likely associated with the convening of the National Agriculture Commission, the publication of the Agricultural Commission Report, and subsequent policies designed to encourage agricultural productivity growth, many of which are discussed in detail in other chapters (GoP 1988). The subsequent slowdown in TFP growth, to just 0.56 percent during 1996–2000, may similarly be associated with a decline in the attention paid to agricultural policy, as may be the case since 2001—when TFP growth has averaged just 0.35 percent per year and was a negative 2.67 percent in 2011–2013. This is partly explained by the declining official budgetary allocations to agriculture in the Public Sector Development Program and a lack of support for new reform initiatives designed to encourage a greater role for the private sector in Pakistan's agriculture.

The verdicts are fairly clear: agriculture has not performed to its full potential and functions in a low productivity trap. Scope for technological change exists, but the gains associated with the Green Revolution have long disappeared, indicating the need to redouble efforts to introduce farmers to new productivity-enhancing technologies and practices. Scope for diversification also exists, but current policies do not explicitly encourage a move out of low-value food staples and into higher-value crops and livestock where agroclimatic conditions and market infrastructure are otherwise conducive. Furthermore, the continued fragmentation of cropped area from the economically viable medium-size farms into smaller and economically unviable farms continues unabated, with little chance of addressing the weak institutions and high transaction costs found in local land markets or the political power issues that allow large landowners to protect their landholdings.

There have been many strategies and policies designed to address these constraints in recent decades, from the land reforms introduced in 1950 to the detailed recommendations of the National Commission on Agriculture in 1987. All were emblems of the government's commitment to agricultural development and productivity growth. Unfortunately, policy makers continue to emphasize aggregates—output targets for the major crops only—that obfuscate the importance of Pakistan's socioeconomic and agroclimatic diversity. Furthermore, their strategies have fallen short when it comes to translating good intentions into action by federal and provincial governments to develop subsector-specific priorities, integrate these priorities into overall national economic policy, and recognize the need for commensurate financial resource allocations. To identify policies appropriate to a particular subsector and allocate the necessary resources to them requires good data and sound policy analysis that turns such data into implementable policy steps. Additionally, better monitoring and evaluation of such data are necessary for fine-tuning, replicating, and improving public policies, investments, and programs to encourage agricultural-sector growth, productivity improvement, and poverty reduction in Pakistan.

References

Agrodev. 2000. *Sindh Rural Development Project: Final Report Prepared for Planning and Development.* The Government of Sindh and the Asian Development Bank, Agrodev Canada, Inc.

Ahmad, K., M. A. Chaudry, and M. Ilyas. 2008. "Trends in Total Factor Productivity in Pakistan Agricultural Sector." *Pakistan Economic and Social Review* 46 (2): 117–132.

Ahmed, M. 2001. "Agriculture Productivity Growth Differential in Punjab: A District Level Analysis." *The Pakistan Development Review* 40 (1).

Ahmed, S. A., and M. Gautam. 2013. *Agriculture and Water Policy: Toward Sustainable Inclusive Growth.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/17864 License: CC BY 3.0 IGO.

Ali, M. 2015. *Development, Poverty, and Power in Pakistan: The Impact of State and Donor Interventions on Farmers.* New York: Routledge.

Ali, M., and D. Byerlee. 2002. "Productivity Growth and Resource Degradation in Pakistan's Punjab: A Decomposition Analysis." *Economic Development and Cultural Change* 50 (4).

Amjad, S., and S. Hasnu. 2007. "Smallholders' Access to Rural Credit: Evidence from Pakistan." *The Lahore Journal of Economics* 12 (2): 1–25.

Archer, D. R., N. Forsythe, H. J. Fowler, and S. M. Shah. 2010. "Sustainability of Water Resources Management in the Indus Basin under Changing Climatic and Socioeconomic Conditions." *Hydrology and Earth System Sciences* 14: 1669–1680.

Arif, G. M. 2003. "Urbanization in Pakistan: Trends, Growth and Evaluation of the 1998 Census." In UNFPA, *Population of Pakistan: An Analysis of 1998 Population and Housing Census,* edited by A. R. Kemal, M. Irfan, and N. Mahmood. Islamabad: Pakistan Institute of Development Economics.

Arif, G. M., and M. Ahmed. 2001. *Poverty across the Agro-Ecological Zones in Rural Pakistan.* Islamabad: Pakistan Institute of Development Economics.

Arif, G. M., and S. Hamid. 2009. "Urbanization, City Growth and Quality of Life in Pakistan." *European Journal of Social Sciences* 10 (2).

Bhutta, M. N., and L. K. Smedema. 2007. "One Hundred Years of Waterlogging and Salinity Control in the Indus Valley, Pakistan: A Historical Review." *Irrigation and Drainage* 56: 581–590.

Binswanger, H. 1994. "Agricultural and Rural Development: Painful Lessons." *Agrekon: Agricultural Economics Research, Policy and Practice in Southern Africa* 33, Issue 4.

Binswanger, H., K. Deininger, and G. Feder. 1995. "Power, Distortions, Revolt and Reform in Agricultural Land Relations." In *Handbook of Development Economics* 3B: 2659–2772.

Briscoe, J., and U. Qamar. 2005. *Pakistan's Water Economy: Running Dry.* Washington, DC: World Bank.

Capalbo, S. M., and J. M. Antle. 1988. *Agricultural Productivity: Measurement and Explanation.* Washington, DC: Resources for the Future.

Chambers, R. G. 1988. *Applied Production Analysis: A Dual Approach*. Cambridge: Cambridge University Press.

Cheema, A., and F. Naseer. 2010. "Poverty, Mobility and Institutions in Rural Sargodha: Evidence for Social Protection Reforms." Report submitted to the Planning and Development Department (P & DD) of Government of Punjab.

Deininger, K., S. Jin, H. K. Nagarajan. 2008. "Efficiency and Equity Impacts of Rural Land Rental Restrictions: Evidence from India." *European Economic Review* 52 (5): 892–918.

FAO (Food and Agriculture Organization of the United Nations). 1996. *Agro-ecological Zoning: Guidelines*. http://www.fao.org/docrep/w2962e/w2962e-03.htm. Accessed May 15, 2015.

Faruqee, R. 1995. *Government's Role in Pakistan Agriculture: Major Reforms Are Needed*. Policy Research Working Paper 1468. Washington, DC.: World Bank.

GoP (Government of Pakistan). 1960. *Agricultural Census*. Islamabad: Agricultural Census Wing, Pakistan Bureau of Statistics.

———. 1972. *Agricultural Census*. Islamabad: Agricultural Census Wing, Pakistan Bureau of Statistics.

———. 1980. *Agricultural Census*. Islamabad: Agricultural Census Wing, Pakistan Bureau of Statistics.

———. 1988. *Report of the National Commission on Agriculture*. Islamabad: Ministry of Food and Agriculture, Government of Pakistan.

———. 1990. *Agricultural Census*. Islamabad: Agricultural Census Wing, Pakistan Bureau of Statistics.

———. 2000. *Agricultural Census*. Islamabad: Agricultural Census Wing, Pakistan Bureau of Statistics.

———. 2010a. *Agricultural Census*. Islamabad: Agricultural Census Wing, Pakistan Bureau of Statistics. http://www.pbs.gov.pk/content/agricultural-census-wing.

———. 2010b. *Pakistan Economic Survey 2009–10*. Islamabad: Ministry of Finance. http://www.finance.gov.pk/survey_0910.html.

———. 2011. *Household Integrated Economic Survey (HIES)*. Pakistan Bureau of Statistics, Islamabad.

———. 2013. *Agricultural Statistics of Pakistan 2011–12*. Islamabad: Ministry of National Food Security and Research.

———. 2014. *Pakistan Economic Survey 2013–14*. Islamabad: Ministry of Finance,.

Gazdar, H. 2009. *The Fourth Round, and Why They Fight On: An Essay on the History of Land and Reform in Pakistan*. Karachi: Collective for Social Science Research.

Heston, A., and D. Kumar. 1983. "The Persistence of Land Fragmentation in Peasant Agriculture: An Analysis of South Asian Cases." *Explorations in Economic History* 20: 199–220.

Husain, I. 1999. *Pakistan: The Economy of an Elitist State.* Karachi: Oxford University Press.

———. 2005. *Current Issues in Pakistan's Economy.* Karachi: State Bank of Pakistan.

IFPRI/IDS (International Food Policy Research Institute/Innovative Development Strategies [Pvt.] Ltd.). 2012. Pakistan Rural Household Panel Survey 2012 Rounds 1 and 1.5 dataset. Washington, DC/Islamabad: IFPRI/IDS.

Jacoby, H. G., and G. Mansuri. 2006. *Incomplete Contracts and Investment: A Study of Land Tenancy in Pakistan.* Policy Research Working Paper Series 3826. Washington, DC: World Bank.

———. 2008. "Land Tenancy and Non-contractible Investment in Rural Pakistan." *Review of Economic Studies* 75 (3): 763–788.

———. 2009. "Incentives, Supervision, and Sharecropper Productivity." *Development Economics* 88 (2): 232–241.

Jin, S., and K. Deininger. 2009. "Land Rental Markets in the Process of Rural Structural Transformation: Productivity and Equity Impacts from China." *Comparative Economics* 37 (1): 629–646.

Kamal, S. 2009. *Pakistan's Water Challenges: Entitlement, Access, Efficiency and Equity in Kugelman:* Running on Empty: Pakistan's Water Crisis. Washington, DC: Woodrow Wilson International Center for Scholars.

Kedir, M., E. Schmidt, and A. Waqas. Forthcoming. *Pakistan's Changing Demography: Urbanization and Peri-urban Transformation over Time.* PSSP Working Paper. Islamabad: PSSP.

Kiani, A. K. 2008a. "An Empirical Analysis of TFP Gains in the Agricultural Crop Sector of Punjab: A Multi Criteria Approach." *European Journal of Scientific Research* 24 (3): 339–347.

Kiani, A. K. 2008b. "TFP and MIRR in the Agricultural Crop Sub-Sector of Sindh." *European Journal of Social Sciences* 7 (1): 43–57.

Kiani, A. K. 2008c. "TFP and MIRR Using Almon Distributed Lag Model: A Case Study of Balochistan (1970–2004)." *European Journal of Scientific Research* 23 (1): 49–60.

Malik, S. J. 1999. *Poverty and Rural Credit: The Case of Pakistan.* Islamabad: Pakistan Institute of Development Economics.

———. 2005. *Agriculture Growth and Rural Poverty: A Review of the Evidence.* The Asian Development Bank Working Paper Series. Working Paper 2. Islamabad: Asian Development Bank, Pakistan Resident Mission.

Malik, S. J., M. Mushtaq, and M. A. Gill. 1991. "The Role of Institutional Credit in the Agricultural Development of Pakistan." *The Pakistan Development Review* 30 (4): 1039–1048.

Malik, S. J., and H. Nazli. 1999. "Rural Poverty and Credit Use: Evidence from Pakistan." *The Pakistan Development Review* 38 (4): 699–716.

Murgai, R. 1999. *The Green Revolution and Productivity Paradox: Evidence from the Indian Punjab.* World Bank Policy Research Working Paper 2234. Washington, DC: World Bank.

Murgai, R., M. Ali, and D. Byerlee. 2001. "Productivity Growth and Sustainability in Post–Green Revolution Agriculture: The Case of the Indian and Pakistan Punjabs." *World Bank Research Observer* 16 (2): 199–218.

Nabi, I., N. Hamid, and S. Zahid. 1986. *The Agrarian Economy of Pakistan: Issues and Policies.* Karachi: Oxford University Press.

Naqvi, S. N. H., M. H. Khan, and M. G. Chaudhry. 1987. *Land Reforms in Pakistan: A Historical Perspective.* Islamabad: Pakistan Institute of Development Economics.

———. 1989. *Structural Change in Pakistan's Agriculture.* Islamabad: Pakistan Institute of Development Economics.

Nasim, S., A. Dinar, and S. Helfand. 2014. *Allocative Inefficiency and Tenure Arrangement in Irrigated Agriculture in Pakistan.* PSSP working paper 015. Islamabad: International Food Policy Research Institute.

Pagiola, S. 1995. *Environmental and Natural Resource Degradation in Intensive Agriculture in Bangladesh.* Environment Economic series 15, Washington DC: World Bank.

PARC (Pakistan Agricultural Research Council). 2011. *PARC Annual Report 2010–11.* Islamabad: PARC.

PIDE (Pakistan Institute of Development Economics). 2001. *Pakistan Rural Household Survey, Round 1 2001–02.* Islamabad: Pakistan Institute of Development Economics; World Bank.

Pinckney, T. 1989. *The Demand for Public Storage of Wheat in Pakistan.* IFPRI Research Report 85. Washington, DC: IFPRI.

Qureshi, M. G., and S. K. Qureshi. 2004. "Impact of Changing Profile of Rural Land Market in Pakistan on Resource Allocation and Equity." *The Pakistan Development Review* 43 (4): 471–492.

Qureshi, M. G., S. K. Qureshi, and A. Salam. 2004. "Impact of Changing Profile of Rural Land Market in Pakistan on Resource Allocation and Equity." *Pakistan Development Review* 43 (4): 471–492.

Qureshi, S. 2004. *Rural Land Markets in Pakistan: Institutions and Constraints.* Background paper for Pakistan Rural Factor Markets Study, World Bank Report 30381-PK. Washington, DC: World Bank.

Qureshi, S., P. G. McCornick, M. Qadir, and Z. Aslam. 2008. "Managing Salinity and Waterlogging in the Indus Basin of Pakistan." *Agricultural Water Management* 95 (1): 1–10.

Qureshi, S., P. G. McCornick, A. Sarwar, and B. R. Sharma. 2010. "Challenges and Prospects of Sustainable Groundwater Management in the Indus Basin, Pakistan." *Water Resource Management* 24: 1551–1569.

Qureshi, S., I. Nabi, and R. Faruqee. 1996. *Rural Finance for Growth and Poverty Alleviation*. Policy Research Paper 1593. Washington DC: World Bank.

Renkow, M. 1993. "Land Prices, Land Rents, and Technological Change: Evidence from Pakistan." *World Development* 21 (5): 791–803.

Riaz, K. 2009. "Revealed Comparative Advantage Analysis of Pakistan's Agricultural Exports." *Applied Economics* 19 (2): 103–127.

Saeed, Z. 1976. "Growth of Crop Output in Pakistan—An Analysis by Component Elements." *Pakistan Development Review* 3: 319–329.

Taffesse, A. S. 2009. *Cereal Production in Ethiopia: Recent Trends and Sources of Growth*. Washington, DC: IFPRI.

Thirtle, C., and P. Bottomley. 1992. "Total Factor Productivity in U.K. Agriculture, 1967–90." *Journal of Agricultural Economics* 43 (3): 381–400.

Touseef, H., and K. Riaz. 2013. "Agricultural TFP Growth: A Provincial Level Analysis." *Journal of Social Sciences* (GC University, Faisalabad) 15 (2).

Wen, G. J. 1993. "Total Factor Productivity Change in China's Farming Sector: 1952–1989." *Economic Development and Cultural Change* 42 (1): 1–41.

Zubeiri, Habib A. 1989. "Production Function, Institutional Credit and Agricultural Development in Pakistan." *The Pakistan Development Review* 28 (1): 43–56.

Annex A: Classification of Districts into Agroclimatic (Crop) Zones

TABLE A2.1 Classification of districts into agroclimatic zones

Zone	Districts
Barani Punjab	Attock, Rawalpindi, Islamabad, Jhelum, Chakwal
Mixed Punjab	Sargodha, Khushab, Faisalabad, Toba Tek Singh, Jhang, Okara
Low-intensity Punjab	Mianwali, Bhakkar, M. Garh, Layyah, D.G. Khan, Rajanpur
Cotton/wheat Punjab	Sahiwal, Pakpattan, Multan, Lodhran, Khanewal, Vehari, Bahawalpur, Rahimyar, Khan, Bahawalnagar
Rice/wheat Punjab	Gujrat, M.B. Din, Sialkot, Narowal, Gujranwala, Hafizabad, Sheikhupura, NanKana Sahib, Lahore, Kasur
Cotton/wheat Sindh	Khairpur, Ghotki, Sukkur, N. Feroze, Nawabshah, Sanghar, Thar parkar, Mirpur khas, Umarkot
Rice/other Sindh	Jacobabad, Kashmore, Shikarpur, Larkana, K.S.Kot, Dadu, Jamshoro, Hyderabad, Matiari, Tando Allahyar, T.M. Khan, Badin, Thatta, Karachi
Southern KPK	Peshawar, Kohat, Hangu, Karak, D.I. Khan, Tank, Bannu, Lakki Marwat, Mohmand Agency, Northern Waziristan, Southern Waziristan, F.R. Peshawar, F.R. Kohat, F.R. Bannu, F.R. D.I. Khan
Plains/foothills KPK	Charsadda, Nowshera, Mardan, Swabi, Mansehra, Battagram, Abbottabad, Haripur, Kohistan, Malakand, Swat, Bunir, Shangla, Dir Lower, Dir Upper, Chitral, Khyber, Kurram, Orakzai, Bajour
Balochistan	All districts

Source: Authors, adapted from Pinckney (1989).

Note: KPK = Khyber Pakhtunkhwa

Annex B: Agricultural Production Shares and Growth Rates

TABLE B2.1 Average share of crops and livestock in value of agricultural production and growth of share (%), 1990–2013

	Average share in value			Growth in share
Crop	1990–1999	2000–2009	2010–2013	1990–2013
Wheat	18.8	18.1	17.5	–6.9
Rice	6.4	5.8	5.9	–7.8
Cotton	10.2	11.1	13.9	36.3
Sugarcane	6.5	4.9	5.7	–12.3
Maize	1.7	1.5	2.0	17.6
Bajra	0.3	0.2	0.1	–66.7
Jowar	0.3	0.1	0.1	–66.7
Barley	0.1	0.1	0	–100.0
Gram	3.3	4.0	1.9	–42.4
Mung	0.2	0.1	0.1	–50.0
Mash	0.1	0	0	–100.0
Masoor	0.1	0	0	–100.0
Potato	0.6	1.3	1.1	83.3
Onion	0.5	1.3	0.9	80.0
Milk	35.2	39.3	38.0	8.0
Beef	6.5	5.9	7.5	15.4
Mutton	9.2	6.2	5.3	–42.4

Source: Authors, based on data from GoP (2014).

Note: Values are computed by multiplying the total production in the year by the average wholesale price in that year.

TABLE B2.2 Annual growth in acreage and production by crop and agroclimatic zone (%), 1981/1982–2011/2012

		Wheat		Rice	
Agroclimatic zone	Period	Acreage	Production	Acreage	Production
Barani Punjab	1981/1982–2011/2012	–0.54	0.26	0.05	2.00
	1981/1982–1989/1990	–1.10	2.56	–4.41	–4.90
	1990/1991–1999/2000	0.13	0.06	4.14	5.54
	2000/2001–2011/2012	0.12	4.72	0.14	1.49
Rice/wheat Punjab	1981/1982–2011/2012	0.90	3.31	1.14	2.17
	1981/1982–1989/1990	0.36	4.16	1.82	–0.08
	1990/1991–1999/2000	1.12	4.81	2.05	5.64
	2000/2001–2011/2012	1.04	2.14	–0.24	0.80
Mixed Punjab	1981/1982–2011/2012	0.19	2.48	2.08	2.55
	1981/1982–1989/1990	0.83	4.56	2.25	1.94
	1990/1991–1999/2000	0.08	3.58	1.79	3.13
	2000/2001–2011/2012	–0.43	0.13	2.31	2.83
Cotton/wheat Punjab	1981/1982–2011/2012	0.81	2.07	2.61	4.85
	1981/1982–1989/1990	1.77	1.10	1.26	0.00
	1990/1991–1999/2000	1.06	5.87	7.12	10.35
	2000/2001–2011/2012	–0.51	0.30	0.88	5.68
Low intensity Punjab	1981/1982–2011/2012	1.40	3.33	1.17	3.11
	1981/1982–1989/1990	2.23	4.82	1.84	0.33
	1990/1991–1999/2000	1.05	4.57	1.63	5.47
	2000/2001–2011/2012	0.88	1.57	0.75	3.32
Cotton/wheat Sindh	1981/1982–2011/2012	–0.45	1.46	–2.18	–0.59
	1981/1982–1989/1990	0.09	0.60	–2.40	–6.13
	1990/1991–1999/2000	0.59	2.73	–0.63	5.32
	2000/2001–2011/2012	0.87	2.30	–2.10	–0.50
Rice/other Sindh	1981/1982–2011/2012	0.94	2.94	0.84	2.29
	1981/1982–1989/1990	0.41	–0.23	0.12	1.30
	1990/1991–1999/2000	1.30	3.03	0.80	3.25
	2000/2001–2011/2012	4.34	9.78	3.61	4.15
Southern KPK	1981/1982–2011/2012	–1.94	–2.19	0.59	2.11
	1981/1982–1989/1990	–0.27	–0.63	0.50	4.88
	1990/1991–1999/2000	–1.53	–3.63	–1.36	–1.04
	2000/2001–2011/2012	–2.57	–0.03	3.37	3.32
KPK Plains/foothills	1981/1982–2011/2012	1.14	2.19	–1.34	–0.97
	1981/1982–1989/1990	2.91	4.78	–1.47	–0.18
	1990/1991–1999/2000	0.27	0.65	1.08	1.23
	2000/2001–2011/2012	0.16	4.05	–3.33	–3.82
Balochistan	1981/1982–2011/2012	1.91	3.19	2.08	2.03
	1981/1982–1989/1990	3.58	6.57	2.00	–0.02
	1990/1991–1999/2000	0.82	–1.70	3.17	3.94
	2000/2001–2011/2012	1.51	2.67	1.51	2.10
National	1981/1982–2011/2012	0.58	2.35	0.82	1.86
	1981/1982–1989/1990	1.05	2.72	0.72	–0.70
	1990/1991–1999/2000	0.68	3.77	1.76	4.69
	2000/2001–2011/2012	0.37	1.64	0.56	1.97

Source: Authors, based on data from GoP (2013).

Note: KPK = Khyber Pakhtunkhwa

Maize		Cotton		Sugarcane		All crops
Acreage	Production	Acreage	Production	Acreage	Production	Acreage
1.05	3.06	–3.40	–1.02	–2.21	–0.73	–1.59
1.45	2.86	–4.41	–3.67	–7.41	–6.58	–0.52
3.48	5.22	0.00	1.84	2.26	4.59	0.39
–0.89	1.78	0.21	4.52	0.00	0.09	–3.59
1.57	6.91	–2.32	0.66	0.03	0.85	0.79
1.35	1.64	–6.24	0.60	–0.16	0.07	0.65
–3.24	–1.38	–6.42	–4.31	1.50	1.36	1.35
6.96	19.65	5.52	11.07	0.15	1.39	0.43
1.03	6.16	–0.20	2.79	0.75	1.71	0.24
1.07	1.84	–0.37	9.54	–1.50	–1.63	0.47
1.87	6.64	–4.06	–5.73	4.03	4.94	0.45
0.79	9.88	2.84	5.43	–0.37	1.04	–0.22
3.29	8.63	1.61	4.51	–0.91	0.98	1.07
–1.33	–0.77	3.79	11.82	–6.89	–7.34	1.86
6.19	11.23	0.57	–0.18	–0.64	0.39	1.10
6.71	17.32	0.26	2.47	4.15	8.09	0.12
0.35	1.11	3.15	5.79	1.75	3.99	1.46
3.74	3.70	3.38	10.45	–3.93	–3.78	1.64
–3.03	–1.64	6.02	6.75	4.81	6.23	2.16
1.04	2.16	0.14	0.16	3.88	7.33	0.62
–9.55	–9.82	–2.75	1.29	0.42	1.61	–1.87
–1.55	–2.67	–1.18	–3.61	3.62	4.78	–0.73
–8.50	–7.52	2.11	8.12	–0.15	3.72	–0.35
–15.94	–16.98	–5.99	–0.08	–2.41	–1.87	–2.63
–3.91	–1.35	–3.53	1.72	0.17	0.88	0.35
2.44	0.92	–2.63	–4.24	4.51	6.41	0.68
–6.96	–6.45	–1.31	5.57	–1.50	0.71	0.20
–3.61	3.07	–3.37	6.88	–1.47	0.02	2.57
–1.40	–2.25	–7.59	–5.03	–3.06	–2.67	–2.18
–0.93	–3.00	–9.50	–6.79	–8.10	–7.34	–1.10
–1.12	–1.45	–9.34	–7.44	–2.54	–2.51	–1.76
–1.17	–1.75	1.32	4.08	–0.01	0.29	–2.33
1.10	2.67	–8.22	–6.37	2.85	3.17	1.00
3.78	5.89	–100.00	–100.00	8.65	9.69	3.12
0.99	1.40	0.00	0.00	1.26	2.19	0.61
–0.99	0.16	0.00	0.00	–0.01	–0.32	–0.47
2.69	3.48	17.23	18.95	–2.21	–0.68	1.81
7.50	8.59	–4.41	0.00	–10.07	–5.46	3.18
–5.71	–3.97	58.49	60.86	4.81	6.28	1.04
6.74	7.22	7.55	6.60	0.67	–0.21	1.61
1.21	4.97	0.80	3.70	0.21	1.37	0.39
1.94	2.84	1.79	7.68	–1.12	–0.32	0.88
1.30	3.38	1.14	1.56	1.34	2.56	0.77
0.91	7.95	–0.28	1.98	0.40	2.07	–0.12

Annex C: Estimating Total Factor Productivity

TFP studies can be broadly divided into the following categories: (1) highly aggregated national-level studies, often having a limited coverage of agricultural products, and at times restricted to only crop agriculture; (2) studies that use a descriptive approach to productivity measurement and employ index numbers such as the Törnqvist-Theil index; and (3) studies that use a normative approach involving the estimation of frontier production functions or data envelopment analysis, both of which use an external norm (such as a best-practice frontier formed by observations from other regions) as the reference for measuring productivity. The aggregative national studies generally fail to capture important regional productivity differentials, particularly if their coverage of inputs or outputs is limited. This, in turn, can limit the relevance of TFP growth analysis to the wider analysis of agricultural policy.

There are two techniques that are commonly applied to computing total factor productivity using a descriptive approach: the arithmetic index and the Törnqvist-Theil index. The arithmetic index is the ratio of a total output index to a total input index, considered the simplest measure of TFP for the agricultural sector. The input index is a linear aggregation of inputs, weighted by input shares in total input cost, and assumes that production functions are linear and homogeneous and that labor markets are competitive (Wen 1993).

More widely used is the Törnqvist-Theil (T-T) approximation of the Divisia index. Based on Chambers (1988), Capalbo and Antle (1988), and Thirtle and Bottomley (1992), the T-T formulation can be written as:

$$\ln(TFP_t / TFP_{t-1}) = 1/2\sum(R_{it} + R_{it-1})\ln(Y_{it} / Y_{it-1}) \\ -1/2\sum(S_{jt} + S_{jt-1})\ln(X_{jt} / X_{jt-1})$$

where R_{it} is the share of output i in total revenue, Y_{it} is output i, S_{jt} is the share of input j in total input cost, and X_{jt} is input j, all in period t. In this specification, revenue shares for the output index and cost shares for the input index are updated for every time period. We use this approach in the analysis set forth in this chapter.