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Agriculture and Water Policy: Toward Sustainable Inclusive Growth

Syud Amer Ahmed and Madhur Gautam

Abstract

This paper reviews Pakistan's agriculture performance and analyzes its agriculture and water policies. It discusses the nature of rural poverty and emphasizes the reasons why agricultural growth is a critical component to any pro-poor growth strategy for Pakistan. It supports these arguments by summarizing key results from recent empirical analysis where the relative benefits of agricultural versus non-agricultural led growth are examined. The results also provide an illustration of farm and non-farm linkages. It summarizes recent performance of the agriculture sector, and discusses key characteristics of its sluggish productivity growth. Three key issues related to increasing productivity are discussed: namely technology, water use and water management, and policy reforms related to markets and trade that can strengthen the enabling environment and contribute to the promotion of diversification towards high value agriculture

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Executive Summary

1.   Pakistan's economy has grown substantially over the past decade, with an average real GDP growth rate of about 4.9 percent per year. Growth in agricultural value added has been lower at 3.3 percent per year. As is the case in transforming economies, the transition from an agrarian economy to a developed economy is accompanied by a decline in the share of primary agriculture with a commensurate increase in the share of manufacturing and services. Pakistan has also experienced this trend, with the share of agriculture value added in real GDP declining from 46 percent in 1960 to 26 percent in 2000 and 21 percent in 2010 (World Bank, 2011a).

2.   Nevertheless, the agricultural sector is important for inclusive growth. Only 17.5 percent of the poor are in urban areas, with the remainder representing a range of different rural households. 39 percent of the poor are rural non-farm income dependent households, 9.7 percent are from households of landless farmers, 11.8 percent are from households of agricultural wage laborers, 20.1 percent are small farm households, and 1.9 percent of the poor coming from medium to large farm households. The performance of the agricultural sector also has a strong impact on non-farm activity growth in reducing poverty. Studies of growth linkages have suggested that non-farm incomes rise by an additional 0.35 to 0.85 dollars for every dollar increase in agricultural income (Haggblade et al., 1991; Hazell et al., 2012).

3.   While Pakistan's poverty rate has continued to fall over the decade, agriculture's poor performance in recent years has limited its contributions to poverty reduction. The percentage of the population below the national poverty line declined from 34.7 percent to 21.9 percent between 2001-02 and 2005-06, and this declining trend continued till 2007-08 to 17.2 percent (World Bank, 2012a). Of the 12.8 percentage point decline in the poverty headcount ratio between 2001-02 and 2005-06, growth in farm income accounted for 2.8 percentage points (Inchauste and Winkler, 2012). When the poverty reduction between 2001-02 and 2007-08 is considered, farm income growth was responsible for 3.2 percentage points of the reduction.

4.   Economy wide modeling work by IFPRI (2012) suggests that there is potential for agriculture-led growth to be more poverty reducing than non-agriculture-led growth. An economic growth strategy focusing on TFP growth in crop and livestock sectors is found to be more inclusive than a strategy targeting TFP growth in industry or services alone. Households that depend on agricultural wages do almost as well as in any other scenario. A livestock focused growth strategy tends to benefit households with large farms. In contrast, growth led by productivity improvements in services appears to be harmful to incomes for rural households that do not own farms. To put these in context, note that less than 2 percent of the poor are from medium to large farm households, while rural non-farm households and rural households involved in agriculture represent 39 percent and 42 percent of the poor, respectively.

5.   A strategy to promote broad based agricultural growth can directly improve agricultural incomes (especially among the landless and smallholder farmers) by narrowing the wide yield gaps that currently exist and by diversifying towards high-value agricultural products. The Planning Commission (2009) estimates that average yields tend to be far below the Progressive Farmer yields that represent the achievable upper bound. The national

average yields of major crops like wheat and rice are currently only about 55 percent of Progressive Farmer yields, which represent the highest achievable yields in Pakistan. These yield gaps are even greater for some commercial crops like sugarcane in Sindh (73 percent). Despite the large potential for improvement, yield growth has been steadily declining over the years. For example, rice yields grew at an average annual rate of 5.24 percent in 1960s and 3.16 percent in 1990s, whereas they have only been growing at 1.68 percent per year this past decade. A similar pattern can be seen in the case of wheat, which had average annual yield growth of 2.92 percent in 1960s and 1.99 percent in 1990s. This growth rate is now only 1.1 percent per year.

6.   Pakistan's agricultural output growth rate has been decelerating, and is reflected in its declining TFP growth rate. In earlier decades, Pakistan's average annual output growth rate was as high as 4.8 percent (in the 80s), making it a global leader in agricultural growth. In the past decade, however, agricultural output growth rate has shrunk to a more modest 3.34 percent. In earlier decades, Pakistan's TFP growth was responsible for a substantial share of the output growth. For example, in the 1960s, 1980s, and 1990s TFP accounted for 44 percent, 67 percent, and 37 percent, respectively, of the output growth. In contrast, TFP now accounts for less than a fifth of the output growth. Relative to other countries, agricultural TFP growth since the 1990s has been very slow, but has mildly picked up more recently. Pakistan's TFP growth has gone from being among the best in the world in the 1980s to being the lowest among regional and Asian comparators (Bangladesh, India, Sri Lanka, and China).

7.   Closing current yield gaps are also the best strategy to adapt to climate change, which is expected to put additional stress on the agriculture sector. Yu et al. (2012) consider a range of climate change scenarios to estimate impacts on the economy. Production impacts in the crop sub-sector vary by crop and region. Crop production declines are greatest in Sindh, where it declines by 10 percent on average. In the most extreme case, Sindh's crop production shrinks by 36 percent. In contrast, Punjab's crop production shrinks by only 5 percent in the worst case scenario. Yu et al. (2012) estimate that if crop yields were to improve by 20 percent over the next two decades, then GDP, agricultural GDP, and household incomes would rise by 2.6 percent, 11.6 percent, and 3.4 percent, respectively, more than compensating for the effects of climate change. Furthermore, the 20 percent yield improvement over 20 years is a realistic goal, given that wheat and rice yields improved by 1-2 percent per year over the 1989-99 period. Even after a 20 percent improvement in wheat and rice yields, there would still be a substantial yield gap between the average achieved yield and what is currently achievable in the best case scenario.

8.   Much of the high historical growth in yields and productivity can be attributed to major scientific breakthroughs in technology, as during the Green Revolution, resulting from the investments in agricultural research undertaken by the national agricultural research system. Agricultural R&D in Pakistan has historically been led by the public sector, and has proven to be a good investment. Estimated internal rates of return from investments in agricultural research have ranged between 57 percent to 65 percent, with most of the returns coming from Green Revolution research. However, there are severe technical capacity constraints to the current agricultural research system. According to ASTI data, public investment in agricultural research has been on the decline. It is currently about 0.21 percent of agricultural GDP and ranks at the bottom of agricultural R&D spending as a share of agricultural GDP in the region. Only 15 percent of agricultural research staff trained holds

PhDs, which is low relative to the educational attainment of researchers in the rest of South Asia (Beintema et al. 2007). Qualified research staff is discouraged from public research agencies due to institutional disincentives such as limited promotion opportunities and low salaries.

9.   The technical capacity constraints are compounded by inefficiencies generated by the institutional environment. The Pakistan Agricultural Research Council (PARC) coordinates the activities of a large agricultural research network of public national and provincial agricultural research bodies, institutes and experimental stations. PARC does not conduct agricultural research itself although the National Agricultural Research Center is under its administration. With the passing of the 18th Amendment to the Constitution, the public agricultural system has now devolved from the federal to the provincial level, allowing research to have a greater focus on the needs of local farmers and environmental conditions.

10.   In addition to technology, a critical factor in improving the crop yields is water availability and the performance of the irrigation system. About 95 percent of Pakistan's arable land is currently irrigated, up from 64 percent in 1960 and 72 percent in 1980. However, farmers' access to water is less than it could be due to major limitations of the water allocation system. At the farm level, access to canal water is determined by physical location along the canal and through the *warabandi* water allocation system of administratively set rotations. Access to canal water then becomes contingent on access to land, and the location of that land. There might not be enough water by the time it gets to land at the tail end of distributaries or watercourses, especially if upstream farmers have illegally access to water (Yu et al., 2012).

11.   Another critical challenge to the irrigation system under the current water management system is that it is financially unsustainable. The canal irrigation management system recovers only a quarter of its annual operating and maintenance costs, with the shortfall expected to increase with rising costs and stagnant *Abiana* (water charges per acre of crops irrigated) (Planning Commission, 2012). The collection rate of assessed *Abiana* is also low—at only 60 percent of assessed values—and the resulting budget gap is about Rs. 5.4 billion annually. The system is thus subsidized by the federal government. The current *Abiana* for different crops might also be distorting farmer decisions, since they do not reflect the relative profitability of each crop. For example, comparing the *Abiana* for rice and cotton—two major export crops—it can be seen that their irrigation charges per acre are about the same, even though rice requires 60 percent more water than cotton. There might thus be possible overproduction of rice.

12.   Recognizing the importance of a robust and efficient water management system, the Government of Pakistan implemented reforms in the 1990s to enhance water use efficiency, streamline water resources management, and facilitate participation by users. However, the reforms have not been completely successful. At the provincial level, the devolution of autonomy from the Public Irrigation Departments (PIDs) to Provincial Irrigation and Drainage Authorities (PIDAs) is incomplete, with the PIDs maintaining managerial control over the PIDAs through a range of mechanisms. At the local level, Farmers' Organizations (FOs) that are meant to help manage distributor and minor canals have no input into the *Abiana* setting process. FOs also vary widely in their role as charge collectors, since charges are set by management and the FOs may or may not have any voice in this process. The lack

of clarity in the role and mandate of the FOs has contributed to the inefficiencies in *Abiana* collection that are damaging the financial sustainability of the system.

13.   The irrigation system is highly inefficient as is demonstrated by the substantial seepage losses which occur in almost every component of the delivery system. The overall efficiency of the system is 35 percent, and improving the canal system's efficiency from 35 percent to 50 percent could boost growth substantially. Yu et al. (2012) estimated that GDP and GDP from the agriculture sector would decline by 1.1 percent and 5.1 percent on average, under climate change. Even modest improvement to the canal system's efficiency would increase GDP by 0.94 percent and agricultural GDP by 4.22 percent, on average.

14.   Another limitation to water access is at the provincial level due to institutional features such as the 1991 Provincial Water Allocation Accord. Since 1991, water inflows have been apportioned among the provinces by the Indus Water Accord, allocating flows among the provinces based on a 5-year record of pre-Accord historical canal diversions. Relaxation of the institutional rigidities of the Accord can allow for a more market-based allocation of water leading to aggregate economic benefits. Yu et al. (2012) estimate that by relaxing the allocation constraints of the Accord, Punjab and Sindh would gain Rs. 83 billion and Rs. 82 billion in revenue, respectively, although other provinces would collectively lose about Rs. 7 billion. Relaxing the conditions of the Accord by itself, without complementary policy may thus lead to outcomes that are not necessarily pro-poor. The complementary policy would need to compensate groups that the Accord relaxation would harm, such as farmers in Baluchistan and Khyber Pakhtunkhwa, or producers of crops that are not irrigated.

15.   International and domestic trade are critical to improving agricultural production, but face challenges to their growth. Agricultural exports directly account for more than 11 percent of Pakistan's exports, with exports of downstream industries like textiles accounting for more than another 40 percent of export revenue (Planning Commission, 2009).

16.   However, policies introduced in the past five years have steadily eroded the effects of trade liberalization that Pakistan implemented between 1996 and 2003. Pakistan had simplified its tariff structure and state trading monopolies for agricultural products had been abolished. However, exceptions were introduced in 2006, and a number of the more important reforms in agriculture were reversed, especially with regard to wheat, sugar and fertilizer. The use of SROs (Statutory Regulatory Orders) has also expanded since 2006. SROs and new regulatory duties have been used to provide exemptions to normal tariffs in some cases, while increasing tariffs for others. The resulting trade regime is thus highly discretionary and uncertain, leading to significant and unpredictable output and input price distortions.

17.   Major crops like wheat, rice, sugar, and cotton are implicitly taxed by various policy induced price distortions introduced in most years. The implicit tax on crop production depresses production despite implicit net input subsidies. For example, basmati rice had negative ERPs between 2008 and 2010, when farm income would have been higher by 21 percent to 40 percent under a no-intervention regime. The case of sugar also illustrates the same. The significant increase in the world price of refined sugar raised the parity price, but the increase in general sales tax applied to sugar offset the higher border prices. Sugar's parity prices are thus approximately double the observed farm gate price discouraging production.

18.   The benefits of some domestic trade policies have also been unclear, as is illustrated by the public procurement of wheat. Government procurement of wheat is extensive, and involves federal, provincial and district level agencies. The government sets the procurement price with expected procurement targets that the Pakistan Agricultural Storage and Services Corporation (PASSCO) and Provincial Food Departments are responsible for meeting. Provincial governments (mainly Punjab and Sindh) and PASSCO procure about 20 percent of total wheat production each year (Prikhodko and Zrilyi, 2012). All procured wheat is then sold to flour millers in the same wheat marketing year, with the government absorbing the costs of procurement, storage, and financing. Millers are able to buy the subsidized wheat at below market prices, and then sell the flour at open market prices, which are the prices faced by consumers. This price stabilization role is perhaps one reason that wheat stocks have risen in the recent past, which has led to exports at subsidized prices in years of high wheat production.

19.   The impact of these procurement policies on consumer welfare needs to be carefully analyzed. On the one hand the wheat market interventions have insulated the domestic market from global price volatility, but the rise in real prices of wheat over time has likely hurt net buyers while benefiting the net-sellers. Furthermore, the market intervention is often fiscally costly and can also lead to perverse outcomes like subsidized exports.

20.   There is substantial scope for accelerating broad-based agricultural growth to fully exploit its potential for poverty reduction. To achieve this, policy actions are required to promote technology and innovation, improve water use management and put in place the right trade policies.

1. Technology and innovation are critical to improve agricultural productivity. Key actions required for this are substantial reforms to the current national agricultural research system. First, the system requires fundamental institutional reforms to make it more efficient and effective. With efforts under way to develop provincial agricultural research institutions, the role of PARC and the NARC needs to be adjusted to exploit their comparative advantage of being federal institutions able to facilitate federal funding, intra-provincial knowledge, and capacity building. Second, with the shift in primary activities from the federal to the provincial levels and from policy coordination to agricultural research, then there is a need to reflect these activities human resource and performance incentives. This may require moving personnel from the center to the provincial institutions, or even changing the composition of the staff, to increase the percentage of scientific research staff for example. Third, these reforms will require additional spending in agricultural research and development, whether for supporting agricultural research in provincial research centers or capacity building of science staff, with the exact composition of additional spending depending on the nature of the institutional reforms.

2. To improve water use efficiency, the most important intervention would be institutional reform of the entire management system. Given the system's high dysfunction, clarifying the institutional environment would be a prerequisite for any other intervention under consideration, such as revising the *Abiana*. The reforms to the water management system include completely devolving authority to the relevant scale, clarifying the roles and mandates of each authority, and providing sufficient

resources and capacity building to allow the devolved authorities to fulfill their mandates.

3. To improve international trade of agricultural products, the trade regime must be simplified**.** This will require removing unpredictable and discretionary instruments like SROs, shifting to a lower set of uniform tariffs, and simplifying the trade regime by removing alternative trade policy instruments like export taxes. These would reduce uncertainty, volatility, and the policy bias against agricultural products like rice and sugar. From a practical perspective, the reforms will require the identification of a realistic timetable for reform, as well as the identification of WTO compliant instruments that may still be appropriate to protect national interests.

4. To improve domestic trade of agricultural products while protecting food security, distortions in domestic markets of commodities like wheat need to be removed. The simplest set of reforms would be to reduce the wheat procurement volume, while designing and implementing complementary social safety net programs. The wheat procurement contraction would reduce the effective subsidy to wheat producers and decrease the fiscal burden. If food price stability is important, price bands can be implemented using rules-based adjustable tariffs that set floor and ceiling prices to follow world prices. In parallel, social safety net programs that target food insecure groups can be established, with the programs having clearly defined triggers and graduation requirements.

Introduction

21.   Pakistan's economy has grown substantially over the past decade with an average real GDP growth rate of about 4.9 percent per year between 2000 and 2010, while agricultural value added has grown at a lower rate of 3.3 percent per year (World Bank, 2011a). As is the case in transforming economies, the transition from an agrarian economy to a developed economy is accompanied by a decline in the share of primary agriculture with a commensurate increase in the share of manufacturing and services. Pakistan has also experienced this trend, with the share of agriculture value added in real GDP declining from 46 percent in 1960 to 26 percent in 2000 and 21 percent in 2010 (World Bank, 2011a).

22.   Nevertheless, agriculture remains a socio-economically and politically important sector at the current stage of Pakistan's transformation process. Agriculture accounts for more than 40 percent of total employment[1] (World Bank, 2011a), though the sector's contribution to overall employment is likely to be much higher considering downstream activities through supply chains, transportation, and the processing sectors it contributes to. Agriculture also contributes substantially both directly and indirectly to foreign exchange revenue. Agricultural exports directly account for more than 11 percent of Pakistan's exports, with exports of downstream industries like textiles accounting for more than another 40 percent of export revenue[2].

23.   Historically, the sector has done well at the national level due to technologies of Green Revolution. A combination of expanded input use, investments in land and water resources, and rapid improvements in total factor productivity over the years have been the main sources of past growth. The slowdown since 1995, however, is a cause for concern. This is of particular importance going forward because global markets have become much more unreliable (with high and volatile prices), resource degradation (of soil and water in particular) has increased, and the uncertainty associated with the impact of climate change on agricultural production poses a serious threat to food security. Pakistan has made substantial progress in reducing food insecurity, most recently illustrated by the recent downgrading of its status from 'Alarming' to 'Serious' in the Global Hunger Index[3] (IFPRI, 2011). Yet, substantial food and nutrition security challenges remain. For example, 26 percent of the population is estimated to be undernourished, with the rate of undernourishment higher among children at 38 percent (Food Security Portal, 2012).

24.   While Pakistan's poverty rate has continued to fall over this period, agriculture's sluggish performance in recent years has limited its contributions to poverty reduction. The percentage of the population below the national poverty line declined from 34.7 percent to 21.9 percent between 2001-02 and 2005-06, and this declining trend continued till 2007-08 to 17.2 percent (World Bank, 2012a)[4]. Of the 12.8 percentage point decline in the poverty

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1 Employment in agriculture as a share of total employment was 44 percent in 2008 (World Bank, 2011a)

2 Based on data for 2006-07 from Planning Commission (2009)

3 The GHI is a weighted index based on the proportion of undernourished as a percentage of the population, the prevalence of underweight children under the age of five; and the mortality rate of children under the age of five.

4 The poverty headcount rates at the national poverty line are very similar to the poverty headcount rates measured at the $1.25 a day (PPP) poverty line. For example, the poverty rate was 35.87 percent in 2002 and 21.4 percent in 2008 at the $1.25 a day line, versus 34.7 percent and 17.2 percent at the national poverty line (World Bank, 2011a). Poverty rates are substantially higher when the $2 a day (PPP) poverty line is considered, with poverty rates of 73.9 percent in 2002 and 60.2 percent in 2008.

headcount ratio between 2001-02 and 2005-06, growth in farm income accounted for 2.8 percentage points (Inchauste and Winkler, 2012). When the poverty reduction between 2001-02 and 2007-08 is considered, farm income growth was responsible for 3.2 percentage points of the reduction.

25.   Robust growth of the agricultural sector as part of a broader strategy that enhances both farm and non-farm income and employment is imperative for inclusive, pro-poor growth. The performance of the agricultural sector also has a strong impact on the ability of non-farm activity growth in reducing poverty. So, if the local economy is growing slowly, this will be reflected in the non-farm sector's growth. Rural non-farm activities also tend to be closely related to the agricultural sector at lower-income levels, since higher agricultural incomes would translate into higher spending on local non-farm goods and services. Studies of growth linkages have suggested that non-farm incomes rise by an additional 0.35 to 0.85 dollars for every dollar increase in agricultural income (Haggblade et al., 1991; Hazell et al., 2012).

26.   This paper reviews some of the key issues to stimulate such growth. The paper discusses rural poverty in more detail, and emphasizes the reasons why agricultural growth is a critical component to any pro-poor growth strategy in Pakistan. It supports these arguments by summarizing key results from recent empirical analysis where the relative benefits of agricultural versus non-agricultural led growth are examined. The results also provide an illustration of farm and non-farm linkages. It then summarizes recent performance of the agriculture sector, and discusses key characteristics of its sluggish productivity growth. It moves on to describe the three key issues related to increasing this productivity: namely technology, water use and water management, and policy reforms related to markets and trade that can strengthen the enabling environment and contribute to the promotion of diversification towards high value agriculture. While it is important to also understand the dynamics of the rural labor markets, especially as it relates to inclusive agricultural growth, a detailed analysis is beyond the scope of this paper, and is thus not addressed here.

Rural Poverty and Role of Agriculture in Inclusive Growth

27.	Pakistan's poverty headcount has been steadily declining over the past decade, although there are substantial and persistent differences between poverty rates in urban and rural areas. Pakistan's overall poverty rate has declined from 34.5 percent in 2001-02 to 17.2 percent in 2007-08. This poverty reduction has not been equal across urban and rural areas with rural poverty remaining much higher than urban poverty (Figure 1). The discrepancies between rural and urban poverty are particularly pronounced in some provinces. For example, the 2008 rural poverty rate tends to be double the urban poverty rate in Punjab and more than two and half a times in Sindh.

28.	Despite a fall in the national poverty rate, the rate of rural poverty reduction has tended to lag behind urban poverty reduction, with rural poverty still twice as high as urban poverty. IFPRI (2012) estimates that only 17.5 percent of the poor live in urban areas; the remainder representing a range of different rural households. About 39 percent of the poor are rural non-farm income dependent households, 9.7 percent are from households of landless farmers, 11.8 percent from households of agricultural wage laborers, 20.1 percent are small farm households, and 1.9 percent of the poor come from medium to large farm households.

Figure 1	Poverty Head Count Ratio at National Poverty Line
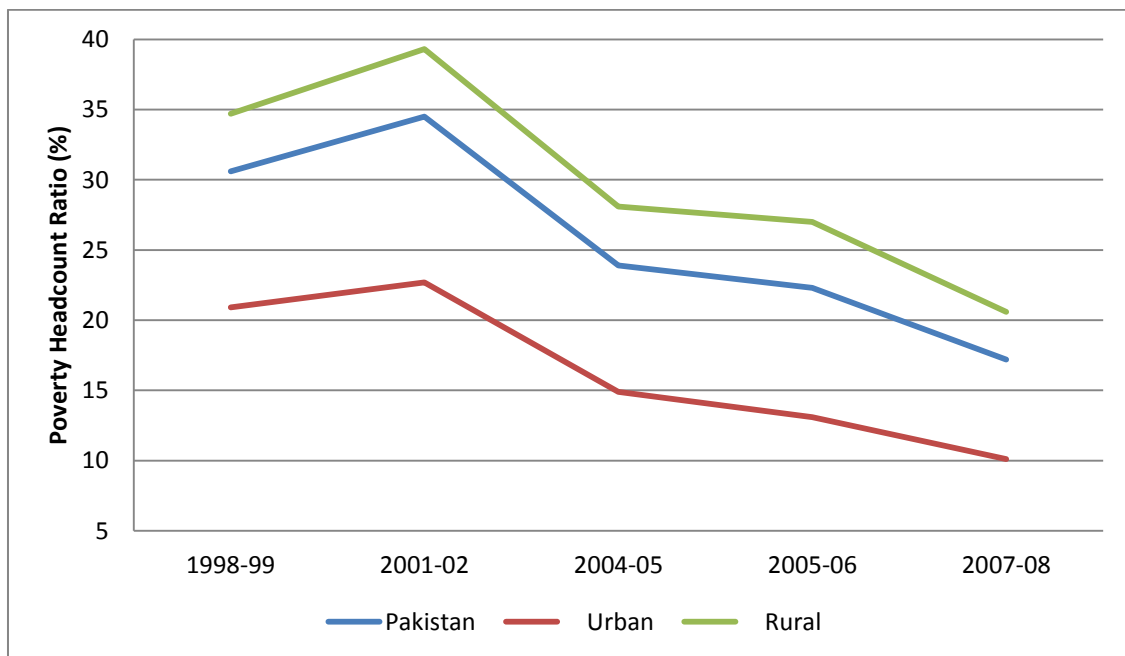
Source: World Bank (2012a)

29.	About half of the rural poor tend to be in non-farm activities (Figure 2), and there is a close relationship between land ownership and rural poverty. Many of the rural poor are landless or own only small amounts of land. Anwar et al. (2004) estimated the poverty headcount of rural non-farm households to be about 48 percent, second only to that of landless farmers (55 percent), but greater than that of farmers with less than a hectare of land (32 percent). There is virtually no poverty among farm households with more than a hectare of land, emphasizing the strong relationship between land ownership and poverty. This is exacerbated by the highly unequal distribution of land in Pakistan. The Gini

coefficient of land holdings in Pakistan is about 0.66 – a figure which has remained relatively constant between 1970 and 2000 (World Bank, 2007a). This estimate does not account for the fact that 63 percent of households were landless in 2000. When these landless households are accounted for in the Gini coefficient estimation, the value rises to 0.86, higher than that of other South Asian countries. Relating land ownership to farm size, World Bank (2007a) also found that in 2000, 61 percent of farm households owned less than 2.0 hectares of holdings, representing about 15 percent of total land holdings. In contrast, 2 percent of households owned holdings greater than 20.2 hectares, representing 30 percent of total land holdings.

Figure 2   **Distribution of Poverty by Household Type**
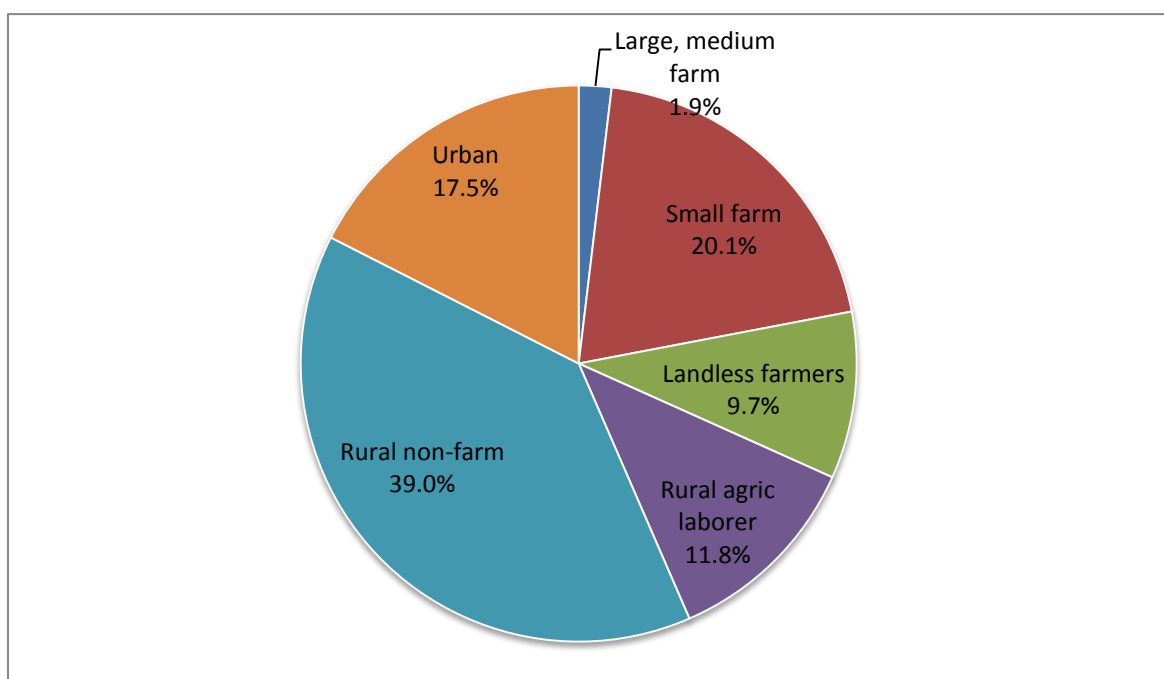
Source: IFPRI (2012)

30.   The current characteristics of rural poverty and the land rights regime in Pakistan pose a major challenge to faster poverty reduction. The majority of rural poor are landless, and even among those farming, poverty is significantly higher among sharecroppers (i.e., landless who are operating land under tenancy arrangements) than landowners (Malik, 2005). However, land is rarely bought and sold, and the status quo of unequal land distribution tends to be maintained. The World Bank (2007a) noted that the inequality in landholdings by province[5] remained relatively unchanged from the 1970s to 2000s. The study argues that the low rate of transactions is due in large part to high transactions costs and prices in excess of the discounted value of potential agricultural earnings from the land. Since the landless do not have access to credit—with land being the most commonly accepted collateral for formal loans—they are unable to generate financing to acquire land in the first place. This is characteristic of the barriers to land acquisition, and contributes to the status quo of highly unequal distribution of land.

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5 Inequality in land holdings was measured as a Gini coefficient. Punjab tended to have the lowest Gini coefficients, while North West Frontier Province (now Khyber Pakhtunkhwa) tended to have the highest.

31.   Pakistan's population growth rate can be expected to contribute to the steady rise of small farms as land is divided into smaller plots in successive generations. In 1973, the average farm size was 5.3 ha and there were 1.06 million small (less than two hectare) farms. By 2000, the average farm size had shrunk to 3.1 ha, while the number of small farms had more than tripled (Headey et al., 2010; Hazell et al., 2012). The evidence on the impact of declining farm sizes on land productivity is mixed (Kiani, 2008, finds a negative but insignificant correlation between farm size and productivity). Small and large farms are more productive than medium farms, with the smaller farms associated with higher intensity and irrigation and large farms with capital intensive production. Despite potentially higher productivity *per se* (that is higher output per cultivated unit of land) of smaller farms, say through better access to technology and more intensive cultivation, the impact on household incomes may be limited due to limited scope for diversification and limited access to resources (Malik, 2005). Given that small farm households also tend to have a higher poverty rate, with no significant changes in access to services, technology, markets and credit, the growth in the number of small farms could result in continuing high levels of poverty.

32.   The high population growth rate and slow transition of labor out of agriculture also puts pressure on rural economy to produce sufficient employment for new workers. Hazell et al. (2012) estimate the necessary labor exit rates out of agriculture[6] given varying levels of agricultural growth. The authors use a stylized partial equilibrium model where the exit rate from agriculture is a function of the employment share of rural workers in agriculture, the rural growth rate, the growth rate of the agricultural sector, and an agricultural employment elasticity of 0.2. It is then estimated that if the average annual agricultural growth rate was 3.88 percent per year, then the exit rate for labor out of the sector would have to be 1.88 percent in the 2010-20 period, and 1.49 in the 2020-30 period, in order to maintain full rural employment. If the agricultural growth rate is a more sluggish 1.94 percent per year, then these exit rates would need to be 2.3 percent and 1.91% per year for the 2010-20 and 2020-30 periods, respectively.

33.   Expansion of the rural non-farm sector would contribute towards generating employment and reducing poverty although its contributions depend to a large extent on the success of the agricultural sector as well. There are several constraints to the development of the rural non-farm sector. The rural non-farm sector tends to be largely services, essentially serving local markets. So, if the local economy is growing slowly, this will be reflected in the non-farm sector's growth.

34.   A balanced approach that expands incomes of both farm and non-farm incomes is thus necessary, as is illustrated by a recent analysis[7] carried out by IFPRI (2012). The analysis suggests that there is potential for agriculture-led growth to be more poverty reducing than nonagriculture-led growth by comparing the economic impacts of historical total factor productivity (TFP) growth to the economic impacts under counterfactual scenarios where TFP growth is accelerated. IFPRI (2012) considers five counterfactual

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[6] The exit rate is defined as the sum of labor absorption into the rural nonfarm economy and out-migration to urban areas, and must be equal to the difference between growth rate in the rural work force and the projected growth rate in agricultural employment.

[7] The analysis uses a comparative static single-region computable general equilibrium simulation model of Pakistan based on a 2007-08 Social Accounting Matrix and HIES survey data.

scenarios that test the sensitivity of the Pakistani economy to rapid growth (through increases in TFP) in four broad sectors: crops, livestock, industry, and services. In the first four scenarios, total factor productivities of sectors in each of these broad groups are increased by 10 percent, individually. So, the first scenario increases TFP of only crops, the second of only livestock, the third of only industry, and the fourth of only services. The fifth scenario increases the productivity of all sectors simultaneously.

35.   A 10 percent TFP increase in services sector would lead to a 5.4 percent increase in GDP, while 10 percent TFP increases in crops and livestock lead to GDP increases of 1.8 percent and 1 percent, respectively (Figure 3). The impacts on overall GDP is not surprising, because of the relative sizes of the various subsectors. Services account for 53 percent of the 2010 value added (share of total GDP), while crops and livestock only account for 9.43 percent and 11.43 percent, respectively (IFPRI, 2012). To make the relative contributions more comparable, it is necessary to neutralize the scale effect. This is done by normalizing the poverty and income results by the GDP changes arising in each of the scenarios, in order to have a fair comparison of marginal impacts given the relative differences in the sizes of the crop, livestock, industry, and services sectors.

36.   This approach allows an assessment of the sensitivity of household per capita incomes by household type to a one percent GDP improvement from each of the five counterfactual scenarios. They show that GDP growth originating in crop and livestock sectors tends to be the most poverty reducing among the alternative scenarios. The growth 'elasticity' of household per capita income for all households is 1.22 and 1 for the crop TFP and livestock TFP led scenarios. In contrast, the growth elasticities of household per capita income are only 0.25 and 0.8 when industry and services TFP led growth are considered (Table 1). These distributional impacts suggest that targeting crop and livestock sectors can lead to more inclusive growth relative to an approach that targets industry or services. This is more clearly shown in Figure 4 which compares the distributional impacts for the two extreme cases of crops and services on different categories of households.

Figure 3   GDP Growth & Value Added by Broad Sector due to 10% TFP Improvements in Sectors
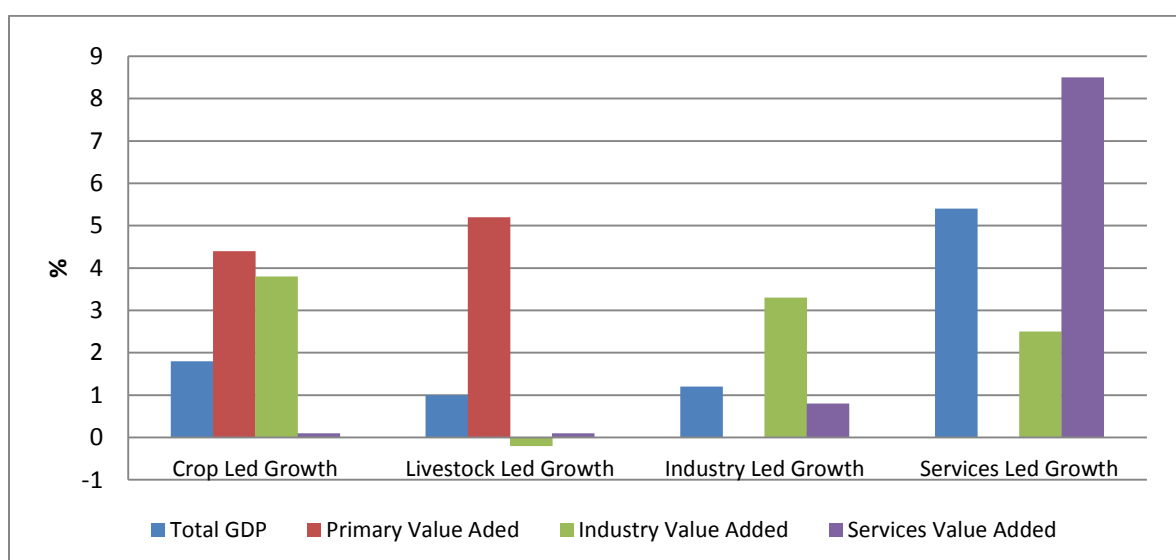
Source: IFPRI (2012)

Table 1	HH Sensitivities of per Capita Incomes due to 1% GDP Growth Arising from TFP			
Household Type*	**Crop**	**Livestock**	**Industry**	**Services**
Medium-Large Farms(241.7)	-1.3	1.6	1.8	1.2
Small-Dry Farms (67.0)	0.9	0.3	1.7	0.5
Agricultural Wage Laborers (48.0)	2.4	1.6	2.5	-0.4
Non-Farm Poor (38.0)	2.2	1.5	1.9	-0.1
Non-Farm Non-Poor (66.2)	2.1	1.7	1.3	-0.1
Urban Poor (37.0)	1.4	1.4	0.8	0.4
Urban Non-Poor (158.8)	1.2	0.8	-1.9	1.5
Total (88.2)	1.2	1.0	0.3	0.8

Note: *Numbers in parentheses indicate base level household income per capita in 1000s of Rs.
Source: Authors' calculations from IFPRI (2012) model simulation result.

Figure 4	Distributional Impacts on per capita incomes of 1% GDP growth
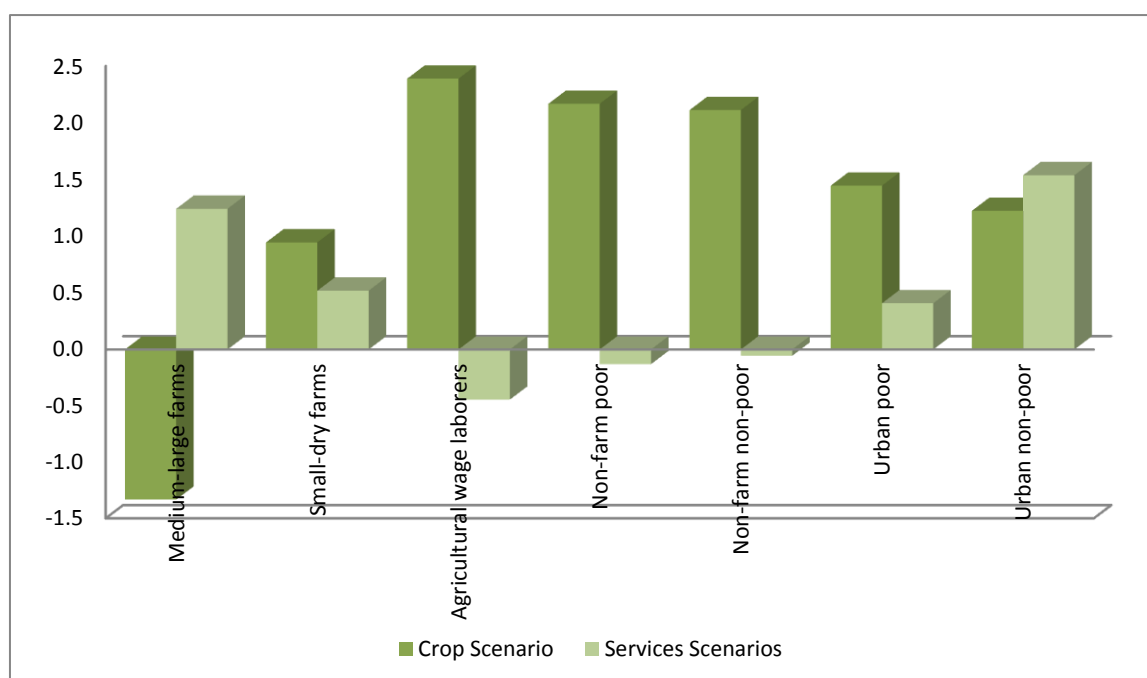
Source: Authors' calculations from IFPRI (2012) model simulation results

37.   GDP growth being led by improvements in the crop sector will thus lead to the greatest improvements in household income per capita for rural non-farm households and the urban poor. Households that depend on agricultural wages do almost as well as in any other scenario. When growth is due to livestock sector TFP improvements, households with large farms tend to experience substantial improvements in income. In contrast, growth led by productivity improvements in services will be harmful to incomes for rural households that do not own farms. To put these into context, recall from Figure 2 that less than 2 percent of the poor are from medium to large farm households, while rural non-farm households and rural households involved in agriculture represent 39 percent and 42 percent of the poor, respectively. Growth led by productivity in the crop and livestock sectors would thus be a powerful mechanism of poverty reduction.

38.   IFPRI (2012) conducts additional simulations which suggest that investment strategies that focus on non-agricultural sectors while ignoring the agriculture sector may exacerbate income inequality. The study considers three additional simulations, comparing the relative benefits of a development strategy that focuses on growth in non-agricultural sector versus one that relies on all sectors, thereby estimating the additional effect of agricultural investments. The non-agricultural sector investment scenario doubles the rate of historical productivity in those sectors, while the all-sector scenario doubles productivity in all sectors, including agriculture. In the non-agricultural investments scenario, household per capita incomes increase by 9.3 percent on average, while medium to large farms and urban non-poor have income increase of 11.7 percent and 10.3 percent, respectively. These are in contrast to the income increases of 6.7 percent for agricultural wage laborers, 7.6 percent for non-farm poor and 8.6 percent for urban poor—the types of households most likely to be in poverty. In the scenario where investments are made in all sectors, household incomes increase by 11.2 percent to 12.6 percent, and are much more uniform across household types.

Agricultural Performance

39.   Broad based agricultural growth can directly improve agricultural incomes (especially among the landless and smallholder farmers) by narrowing the wide yield gaps that currently exist and by diversifying towards high-value agricultural products. The Planning Commission (2009) estimates that average yields tend to be far below the Progressive Farmer yields that represent the achievable upper bound (Figure 5). The yield gaps range from 31 percent in the case of cotton to 73 percent in the case of sugarcane grown in Sindh. These crops represent major shares of Pakistan's crop production (Figure 6) and narrowing the yield gap for major cereals (rice and wheat) and for high value crops (cotton and sugarcane) would substantially boost agricultural GDP.

Figure 5	**Average National Yields and Yield Gaps as Percentages of Progressive Farmer Yields**
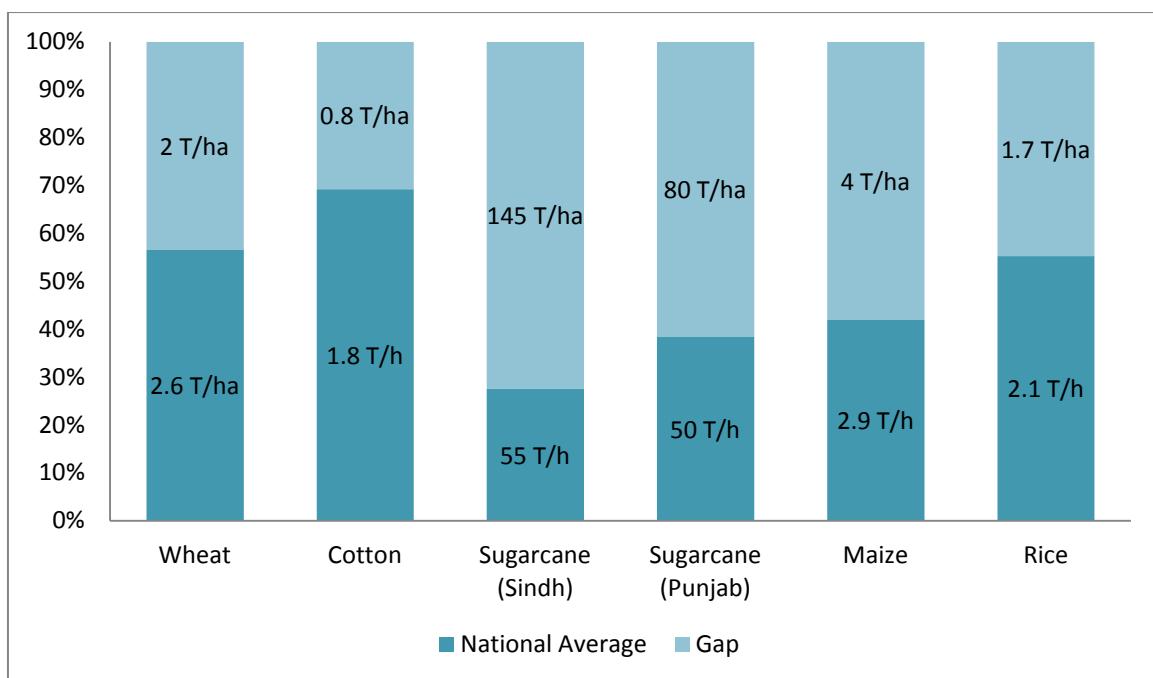
Note: Numbers on bars indicate yield for crop for national average and for difference from Progressive Farmer yields in T/ha.
Source: Planning Commission (2009)

Figure 6	**Composition of Total Agricultural Production**
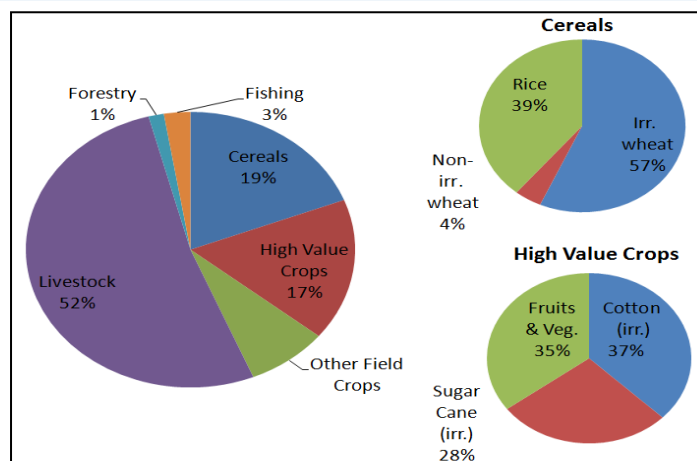
Note: Irr=Irrigated, *Source: IFPRI (2012)*

40.   In light of Pakistan's high population growth, robust agricultural growth has to be maintained to also generate sufficient rural employment. Table 2 shows how agricultural GDP growth has decelerated, while overall GDP growth rate has accelerated since the 1990s. At the same time, the GDP growth rates per worker have declined, severely in the case of agricultural GDP. In the 1990s, the average annual agricultural GDP per worker was 2.67 percent, but had fallen to 0.28 percent in the 2000-08 period. There are thus pressures on the rural labor market that are being exacerbated by the sluggish agricultural sector growth.

Table 2	Average Annual GDP Growth and Agricultural GDP Growth Rates per Worker (%)			
	Mean		Standard Deviation	
	1990-99	2000-08	1990-99	2000-08
Real GDP growth rate	3.92	4.76	2.02	2.19
Ag-GDP growth rate	4.37	3.17	5.04	3.05
GDP Growth Rate per worker	1.24	1.09	2.94	1.50
Ag-GDP growth rate per worker	2.67	0.28	7.71	5.19

Source: Authors' estimates from World Bank (2011a)

41.   Pakistan's value added in agriculture has almost doubled in real terms over the past two decades, going from USD 11.6 billion (constant 2000 dollars) in 1990 to USD 23.1 billion in 2009. It had sluggish growth in the 1990s and early part of the decade, but the growth rate has picked up since 2004-05. In 1990s, the average annual growth rate of the value added from agriculture was 4.37 percent per year, but fell to 3.17 percent per year in the 2000 to 2008 period. Given that the overall economy was growing in real terms by more than 4.76 percent a year on average over this latter period, the contribution of agricultural sector to the overall economy has been declining. For example, in 1990s, value added from agriculture accounted for about 26 percent of GDP. In the 2000s this share had dropped to 21.2 percent (World Bank, 2011a).

42.   Livestock and major crops[8] like wheat, basmati and IRRI rice, cotton, and sugarcane, account for more than 85 percent of agricultural GDP. In 2010, livestock contributed to 53 percent of agricultural GDP, and 11 percent of total GDP, while major crops contributed 33 percent to the sectoral GDP and 7 percent to the total GDP, as can be seen in Table 3 (IFPRI, 2012; World Bank, 2007). Since 2005-06, the shares of livestock and minor crops in total agricultural output have grown, while the share of major crops has shrunk. At the same time, the growth of real value added for major and minor crops, as well as livestock, has also slowed down. In 1990s, the average annual growth rates of real value added for major and minor crops were 2.7 and 4.8 percent per year, respectively. However, the growth rates declined to 1.3 percent per year for minor crops, while staying about the same for major crops. The growth rate of real value added in livestock decline, from 7.0 percent per year to 4.8 percent per year.

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[8] Major crops include wheat, basmati and IRRI rice, gram, sugarcane, cotton, and tobacco (IFPRI, 2012).

Table 3	Composition of Agricultural GDP in Pakistan					
	Share of Total GDP (%)		Share of Agricultural GDP (%)		Real Value Added Growth Rate (%)	
	2005-06	2010	2005-06	2010	1990-00	2000-10
Major Crops	7.6	7.0	35.2	32.8	2.7	2.8
Minor Crops	2.7	2.4	12.3	11.1	4.8	1.3
Livestock	10.7	11.4	49.6	53.2	7.0	4.8
Fishing	0.3	0.4	1.3	1.8	2.7	5.2
Forestry	0.3	0.3	1.6	1.2	-3.0	-6.8
Total Agriculture	21.6	21.5	100	100	4.4	3. 4

Source: IFPRI (2012) and World Bank (2007a) estimated from Pakistan Economic Survey FY 2006 and FY 2010

43.   The relative sizes of the fishing and forestry subsectors have remained almost the same over time, even though their real value growth rates have been declining. The growth rate of real value added from forestry continued to shrink from -3.0 percent a year in the 1990-00 period to -6.8 percent per year in the 2000-10 period. The growth rate of value added from fishing grew slightly, from an average of 2.7 percent per year in the 1990s to 5.2 percent per year in the past decade.

44.   The production growth rates of several major crops have been declining over the past decade. The production growth rates of rice, sugarcane, tobacco, and wheat were higher in the 1990s than in the 2000s (Table 4). In case of sugarcane, the average annual growth has become negative in the past decade. Rice is an exception, with a rising average annual growth rate over the past two decades. This has been driven almost completely by improvements in its yield. Rice yields have grown at a much faster rate in the 2000s relative to the 1990s, while the harvested area has been shrinking.

45.   The case of wheat, one of the most important crops for domestic consumption illustrates some key features of current trends in crop production. Wheat production has been increasing, but at a decreasing rate since 1990s. When the average annual yield growth and area expansion rates for the crop are examined, it can be seen that the rate of area of expansion has been increasing from 0.86 percent per year in the 1990s to 0.98 percent per year in the past decade. The slowdown in production growth can thus be traced back to yield, where the growth rate has slowed from 2.84 percent per year to 1.75 percent per year.

| Table 4	Production Growth Rates of Select Major Crops								
	Production			Yield			Area		
	2010 Value ('000 tonnes)	Avg. Growth Rate, 1990-2000 (%)	Avg. Growth Rate, 2000-2010 (%)	2010 Value (tonnes/ha)	Avg. Growth Rate, 1990-2000 (%)	Avg. Growth Rate, 2000-2010 (%)	2010 Value ('000 ha)	Avg. Growth Rate, 1990-2000 (%)	Avg. Growth Rate, 2000-2010 (%)
Maize	3,341.0	3.18	7.44	3.6	2.28	7.38	939.0	0.84	-0.12
Rice	7,235.0	4.26	0.55	3.1	2.81	0.19	2,365.0	1.21	-0.11
Sugarcane	49,372.9	2.66	-0.13	52.4	0.96	0.95	942.8	1.50	-1.21
Tobacco	119.3	4.12	1.44	2.1	1.09	1.11	55.8	2.92	0.22
Wheat	23,310.8	3.76	2.85	2.6	2.84	1.75	9,131.6	0.86	0.98

Source: Estimates from FAOSTAT data

46.   Pakistan's agricultural output growth rate has been decelerating, and is reflected in its declining TFP growth rate. Pakistan's agriculture did exceptionally well in the 1980s with an average annual output growth rate of 4.8 percent, making it a global leader in agricultural growth (Figure 7). However, the agricultural output growth rate has shrunk to a more modest 3.34 percent in the past decade. The decline in growth is driven by more complex changes in input use and TFP.

47.   Decomposition of growth and relative shares of inputs and TFP provide insight into the sources of growth. The sources of growth have shifted significantly. In the 1980s, TFP growth was the prime driver, while in the 1990s and 2000s, TFP has progressively slowed down and growth has been increasingly driven by input use (fertilizer, labor, livestock and machinery) and irrigation.

48.   In earlier decades, Pakistan's TFP growth was responsible for substantial shares of the output growth (Figure 8). For example, in the 1960s, 1980s, and 1990s TFP accounted for 44 percent, 67 percent, and 37 percent, respectively, of the output growth. In contrast, TFP accounts for less than a fifth of the growth.[9] Relative to other countries, agricultural TFP growth since the 1990s has been very slow (Figure 9).

| Figure 7 | Average Annual Agricultural Output Growth Rate in Pakistan, 1961-2009 (%) |
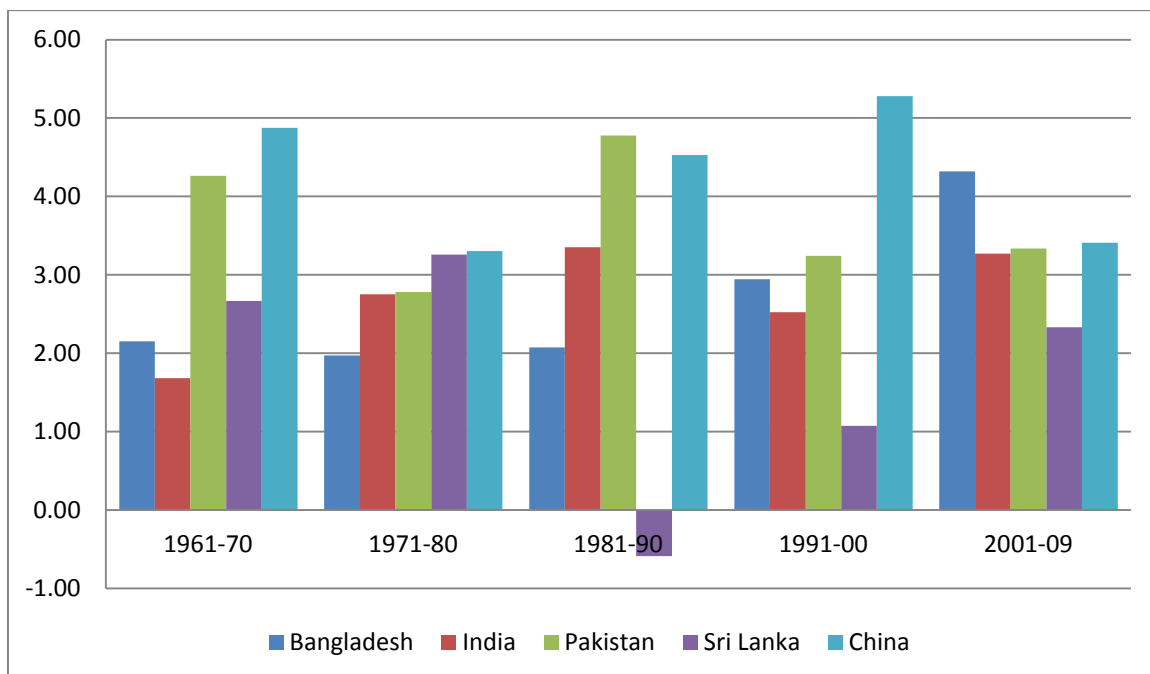
Source: Fuglie (2012)

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[9] It is important to note that growth in agricultural TFP was higher in Pakistan than China till the mid-1990s, and grew at almost the same pace as Brazil—two of the outstanding long-term performers globally. Since the mid-1990s, however, TFP for Pakistan has been flat while the comparators (including the high performing East Asia countries like Thailand, Vietnam and Indonesia) have performed markedly better.

Table 5	Average Annual Output, Input and TFP Growth Rates (%) for Agriculture in Pakistan					
	Output Growth		Input Growth		TFP Growth	
	2001-05	2006-09	2001-05	2006-09	2001-05	2006-09
Bangladesh	3.6	4.8	1.6	0.5	1.9	4.2
India	2.2	3.5	1.1	1.2	1.1	2.4
Pakistan	2.8	3.3	2.6	2.2	0.2	1.1
Sri Lanka	1.5	2.8	0.9	1.1	0.6	1.8
China	3.2	3.5	0.8	0.5	2.4	3.0
Indonesia	4.7	4.7	1.3	1.5	3.4	3.2
Thailand	2.8	2.8	0.5	0.4	2.3	2.4

Source: Fuglie (2012)

Figure 8	Decomposition of Output Growth in Agricultural Sector by Land, Input Intensity & TFP%
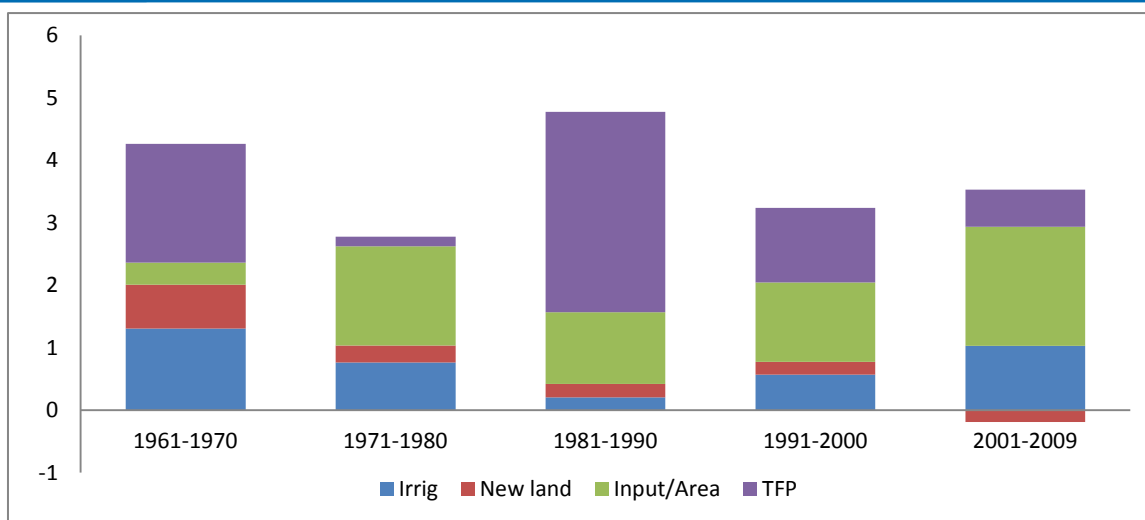
Note: Land Quality Adjusted
Source: Fuglie (2012)

Figure 9	Average Annual TFP Growth Rates for Agriculture in Pakistan, 1961–2009

Note: Land Quality Adjusted
Source: Fuglie (2012)

49.   Even though growth in non-land inputs in agriculture has been rising, the changes in use vary by specific input. Figure 10 reveals that fertilizer, livestock, and machinery use, all grew faster in the past decade than they did in the 1990s. This is concurrent with lower use of labor and land, since less land and labor are needed due to the adoption of labor augmenting technologies (e.g. m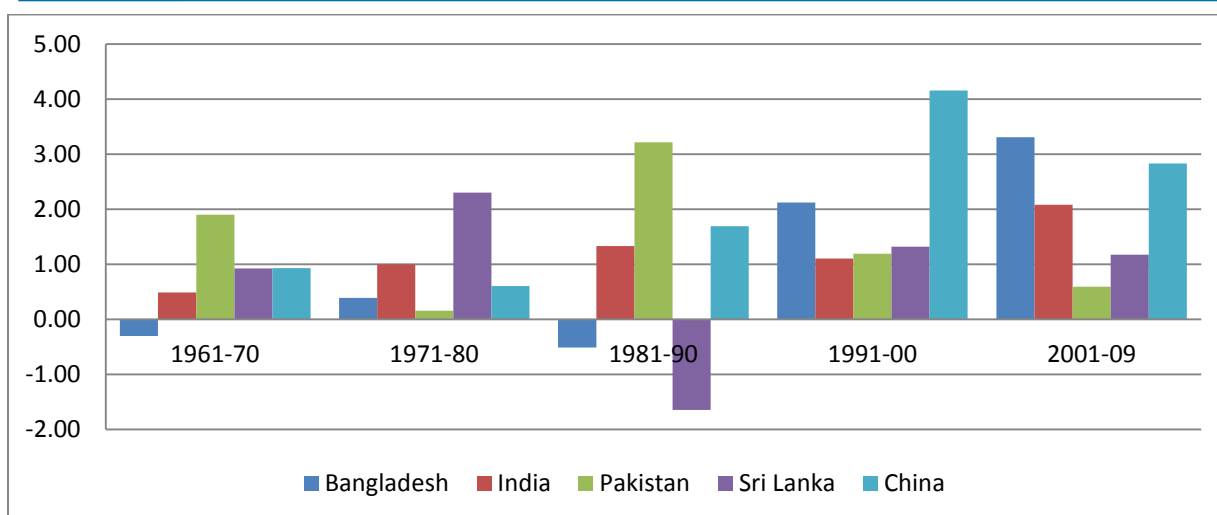echanization and draft animals) and fertilizers which can enhance yields substantially when used under the right conditions, like sufficient irrigation (FAO, 2012). Total cropped area grew at an average annual rate of 0.72 percent per year in the 1991-2000 period with this growth rate rising to 0.83 percent per year in the 2001-2009 period[10]. This acceleration in the cropped area expansion rate is reflected in the greater use of land as an input in the two time periods.

| Figure 10 | Average Annual Growth Rates of Inputs in the Agricultural Sector |
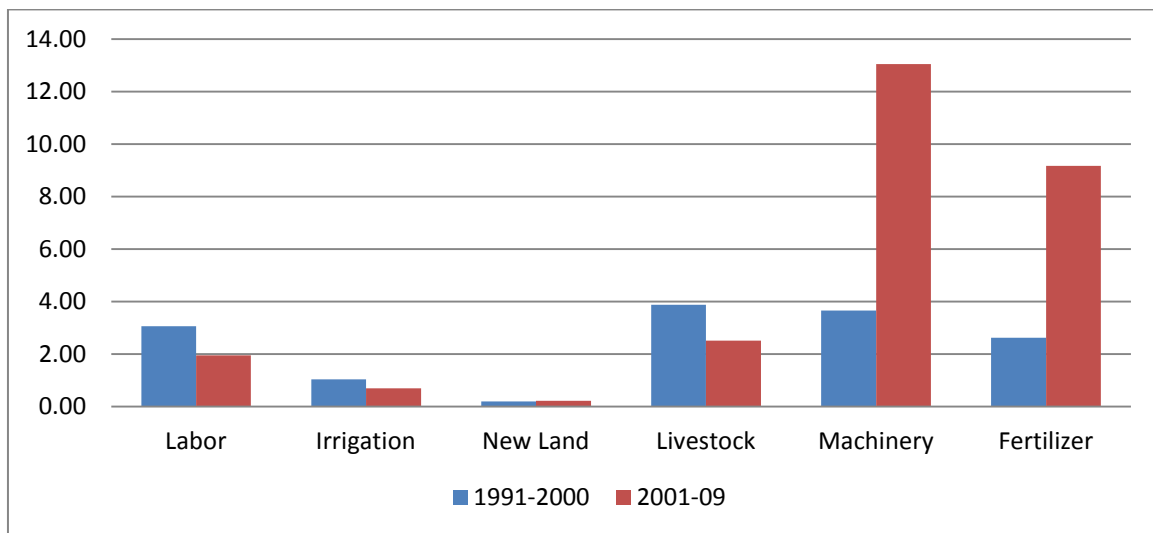
Source: Fuglie (2012)

50.   A critical factor in improving the yields of these crops is water availability and the performance of the irrigation system. About 95 percent of Pakistan's arable land is currently irrigated, up from 64 percent in 1960 and 72 percent in 1980, following decades of rapid expansion of irrigation. Given the arid/semi-arid conditions, access to water is absolutely essential to agricultural production. Irrigation expansion has thus been central to improving yields, as illustrated by Figure 11, which describes how the area equipped for irrigation has steadily grown, as a share of cropland and as a share of harvested area. What can be seen is that the irrigated area-cropland ratio was previously lower than the irrigated area-harvested area ratio. Over time, these two ratios have converged, highlighting the growing importance of irrigation in successful harvests. However, supply constraints and inefficiencies within the irrigation system threaten the continuing contributions of irrigation to crop production, with the threats expected to increase under climate change. Between 1990 and 2009, there was virtually no growth in harvested area or cropland[11].

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[10] Authors' estimates from FAOSTAT cropped area data.
[11] Based on Fuglie (2012) data, the average annual growth rate was 0.7 percent in cropland, and 0.3 percent in harvested area.

| Figure 11 | Irrigated Area as a Share of Cropland and Harvested Area |
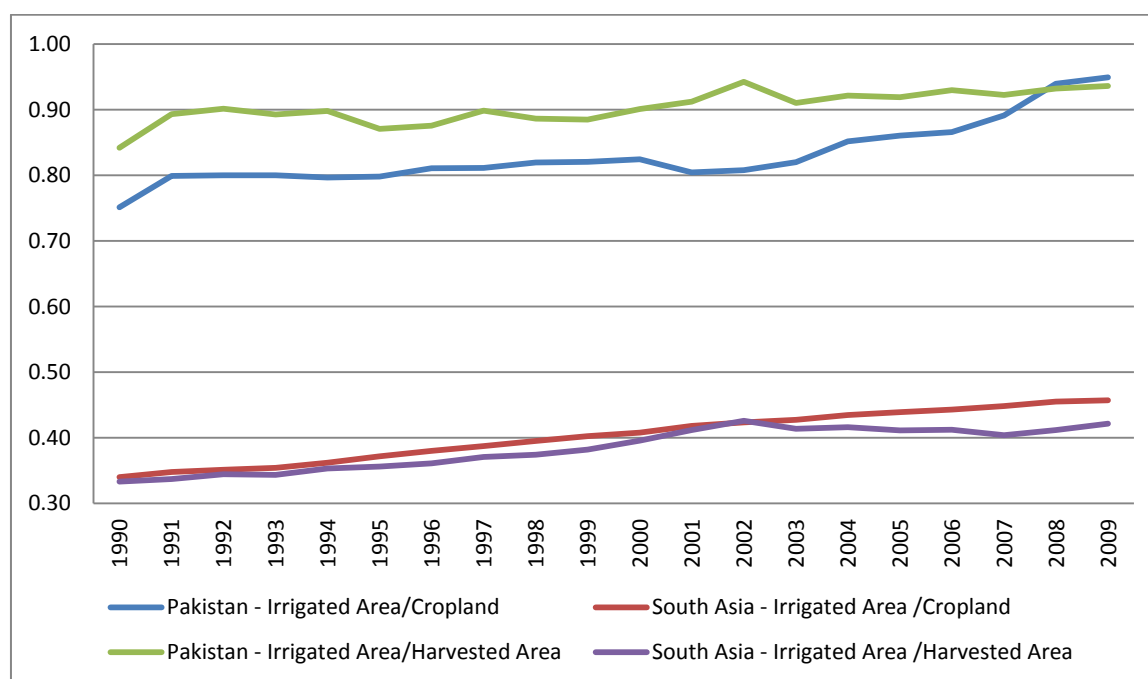
Note: Irrigated area is the area equipped for irrigation; area harvested is the total area harvested for all crops, both temporary and permanent; cropland is arable land and land in permanent crops; the values for South Asia are determined by aggregating data for Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.
Source: Authors' estimates from Fuglie (2012)

51.   The case of wheat in Punjab can illustrate some of the key factors, such as irrigation use, affecting yield growth. Punjab is responsible for almost 63 percent of Pakistan's agricultural output (IPP, 2012). Murgai et al. (2001) and Ali and Byerlee (2002) examine the TFP in crop agriculture from 1966 to 1994 in Punjab, and find that overall output growth in the sector was over 3 percent annually for nearly three decades, with TFP growth of 1.26 percent per year (Table 6). However, land productivity growth rates had declined since the Green Revolution while the labor productivity growth rate had risen due to the adoption of labor augmenting technologies (e.g. tractors).

52.   There is substantial variation in productivity growth by wheat production system with much of the TFP declines attributed to resource degradation. Ali and Byerlee (2002) also found that TFP growth had been strong in wheat-cotton and wheat-mung bean production systems, and negative in wheat-rice system. The study suggests that the negative TFP growth in wheat-rice system was due to degradation in soil and water quality throughout the province and there is evidence that some of this depletion is related to the use of inputs considered to be important components of modern high-productivity agricultural practices. On average, this deterioration in resource quality lowered annual productivity growth by 0.53 percent in the province. Thus TFP growth could have been much higher in the absence of resource degradation.

Table 6	Average Annual Growth Rates in Factor Productivities in Punjab, 1966-1994 (%)						
Production System	Time Period	Partial Factor Productivity			Total Factor Productivity for Crop Sub-Sector		
		Water	Land	Labor	Output	Input	TFP
Wheat-Mixed	1966-1994	-1.9	2.09	n.a.	2.29	1.42	0.87
	Green Revolution	-3.08	2.54	-5.09	3.35	4.46	1.12
	Intensification Period	-1.5	3.51	1.67	2.25	0.75	1.5
	Post-Green Revolution	-0.9	0.02	2.66	1.87	1.4	0.46
Wheat-Rice	1966-1994	-3.03	0.89	1.03	1.79	2.3	-0.5
	Green Revolution	-7.31	0.76	-2.11	3.44	5.88	-2.43
	Intensification Period	-3.65	0.88	0.8	1.24	1.84	-0.6
	Post-Green Revolution	0.14	1.85	3.01	2.04	1.17	0.88
Wheat-Cotton	1966-1994	-0.25	2.98	3.44	3.65	2.08	1.57
	Green Revolution	-4.99	3.18	-1.81	3.66	3.96	-0.3
	Intensification Period	0.1	2.32	3.48	3.55	1.77	1.79
	Post-Green Revolution	1.96	2.9	4.3	2.7	0.92	1.77
Wheat-Mungbean	1966-1994	-3.49	1.89	3.08	3.68	2.36	1.32
	Green Revolution	-7.85	4.36	0.95	6.79	4.55	2.24
	Intensification Period	-2.81	-1.26	0.7	1.31	2.02	-0.7
	Post-Green Revolution	-0.48	3.68	7.7	4.8	1.56	3.24
All	1966-1994	-1.41	2.43	2.51	3.23	1.97	1.26
	Green Revolution	-5.14	2.75	-2.85	4	4.49	-0.49
	Intensification Period	-1.29	2.22	2.33	2.77	1.5	1.27
	Post-Green Revolution	0.61	1.96	4.14	2.85	1.25	1.6

Note: Green Revolution 1966-1974; Intensification Period 1975-1984; Post-Green Revolution 1985-1994
Source: Adapted from Ali and Byerlee (2002)

53.   Input intensities jumped substantially during and after the Green Revolution, when modern varieties were adopted (Ali and Byerlee, 2002; Murgai et al. 2001). For example, fertilizer use jumped from an average of 14.1 kg/ha during the Green Revolution to an average of 86.1 kg/ha in the post-Green Revolution period. Pesticide use also increased rapidly, especially for cotton in the post-Green Revolution period. Water supply and availability greatly improved through investment (largely private) in tube wells, especially during the Green Revolution and intensification periods. However, water productivity is negative because of inefficient use of irrigation water, partially due to subsidies on canal water prices, and fixed electricity rates on tube wells (Farquee, 1995).

54.   While labor productivity generally grew in the 1966-94 period, it shrank during the Green Revolution (1966-74). The technologies being adopted increased average labor use for crops from 85 person-days/ha in the Green Revolution period to 99 person-days/ha in the intensification period (Ali and Byerlee, 2003; Murgai et al., 2001). Eventually, the additional labor demand together with non-farm demands, raised wages and induced mechanization, which then led to a decline in labor use and a rapid improvement in labor productivity.

55.   There are a range of other factors that have also contributed to the sluggish TFP growth rate for wheat in Punjab. These include severe droughts and reduced effectiveness of agricultural research and extension. Increasingly frequent power disruptions are also major constraints to Punjab's agricultural production (IPP, 2012).

56.   Climate change is anticipated to put additional stress on agricultural production, with the impacts varying by region and crop. Yu et al. (2012) consider a range of climate change scenarios[12] to estimate impacts on the economy. Production impacts in the crop sub-sector vary by crop and region. Crop production declines are greatest in Sindh, where it declines by 10 percent on average. In the most extreme case, Sindh's crop production shrinks by 36 percent. In contrast, Punjab's crop production shrinks by only 5 percent in the worst case scenario. In terms of crops being affected, the IRRI rice and sugarcane production experience the largest declines, with about 6 percent decline on average. If the monthly hydrograph shifts forward by a month—April inflows becoming March inflows—then the negative impacts are exacerbated.

57.   Most of the negative real income effects of climate change in Punjab and Sindh are expected to be on households outside of the agriculture sector, since those households will be facing higher food prices without any corresponding increase in income that agricultural households would experiences. GDP, agriculture GDP and household income are estimated to decrease by 1.1 percent, 5.1 percent, and 2 percent respectively. GDP, agriculture GDP and household income are estimated to decrease by 2.7 percent, 12 percent, and 5.3 percent, respectively in the most extreme climate future. Percent declines in agricultural production are smaller than the percent increases in prices, leading to a positive change in farm income. Households that do not depend on farm-income as their primary source of income, however, will have to pay more for food, and will thus see their real incomes decline.

58.   Sufficiently high crop yield improvements can be the best way to adapt to climate change. Yu et al. (2012) estimate[13] that if crop yields were to improve by 20 percent, then GDP, agricultural GDP, and household incomes would rise by 2.6 percent, 11.6 percent, and 3.4 percent, respectively, more than compensating for the effects of climate change. Furthermore, the 20 percent yield improvement is a realistic goal, given that wheat and rice yields improved by 1-2 percent per year over the 1989-99 period. Even after a 20 percent improvement in wheat and rice yields, there would still be a substantial yield gap between the average achieved yield and what is currently achievable in the best case scenario (as illustrated by Figure 5).

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[12] The study considered 70 different possible climate scenarios which were characterized by river inflows varying from 10 percent to 90 percent exceedance probability and temperature changes ranging from 1°C to 4.5°C.
[13] Yu et al. (2012) use the CGE economic simulation model of IFPRI (2012), described earlier, to examine the effects of three different counterfactual adaptation policies—improving crop yields, improving the efficiency of the irrigation system, and building new dams.

Key Issues and Challenges

59.   Spurring inclusive growth in the agriculture sector will thus require improvements in productivity, and this section discusses some of the major policy and technical barriers to the necessary improvements. It starts with a description of some of the areas of improvement in agricultural research, development, and extension. It then moves on to a discussion of the institutional and technical inefficiencies of the water management and irrigation system. Finally, it reviews the range of policies that distort agricultural output and input markets, and discourage diversification.

Technology

60.   As discussed earlier, there is substantial room for improvement in Pakistan's crop yields. The national average yields of major crops like wheat and rice are currently only about 55 percent of Progressive Farmer yields, which represent the highest achievable yields in Pakistan (Figure 5). These yield gaps are even greater for some commercial crops like sugarcane in Sindh. Despite the large potential for improvement, yield growth has been steadily declining over the years. For example, rice yields grew at an average annual rate of 5.24 percent in the 1960s and 3.16 percent in the 1990s, whereas they have only been growing at 1.68 percent per year this past decade[14]. A similar pattern can be seen in the case of wheat, which had average annual yield growth of 2.92 percent in the 1960s and 1.99 percent in the 1990s. This growth rate is now only 1.1 percent per year.

61.   Much of the high historical growth in yields can be attributed to major scientific breakthroughs in technology, as during the Green Revolution, resulting from investments in agricultural research undertaken by the national agricultural research system. Agricultural R&D in Pakistan has historically been led by the public sector, and has proven to be a good investment. But this research has also been biased towards technologies focused on the use of modern inputs, while ignoring public goods such as integrated crop management, sustainable production systems, efficient input use, and the balancing of external input use and internal nutrient sources. About half of the public research expenditure is on crops, followed by a quarter on natural resources, about 14 percent on livestock and fisheries, and about 9 percent on social sciences (World Bank, 2011d).

62.   The historical review of Ahmad and Nagy (2001) shows Pakistan's public agricultural research system has been successful—estimated internal rates of return from investments in agricultural research have ranged from 57 percent to 65 percent, with most of the returns coming from Green Revolution research. Following a period of nationalization of large and medium sized private agribusiness firms in the mid-1970s, there was a slow process of denationalization and deregulation of these entities. Investment in private agricultural research and development was thus severely curtailed for a long time, with only recent outreach to the private sector through programs like the Science and Technology for Development program.

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[14]Authors' estimates using FAOSTAT data.

63.   However, there are severe technical capacity constraints to the current agricultural research system. According to ASTI data, public investment in agricultural research has been on the decline. It is currently about 0.21 percent of agricultural GDP and ranks at the bottom of agricultural R&D spending as a share of agricultural GDP in the region (Figure 12). The Planning Commission (2009) notes that persistent funding constraints may have contributed to limited technology advancements even in major cultivars. Only 15 percent of agricultural research staff trained holds PhDs, which is low relative to the educational attainment of researchers in the rest of South Asia (Beintema et al. 2007). Qualified research staff is discouraged from public research agencies due to institutional disincentives such as limited promotion opportunities and low salaries.

| Figure 12 | Agricultural R&D Spending as a Share of Agricultural GDP in South Asia |
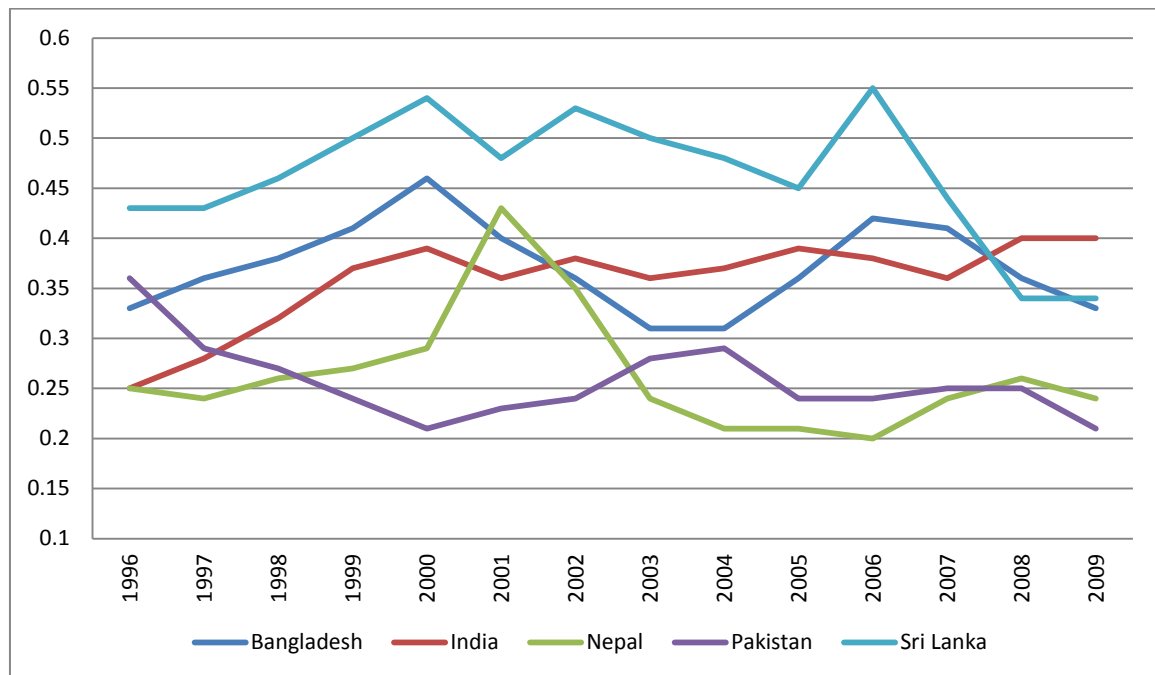
Source: ASTI (2012)

64.   The technical capacity constraints are compounded by inefficiencies generated by the institutional environment. Beintema et al. (2007) identified a total of 111 agencies involved in agricultural R&D, employing more than 3,600 researchers and spending nearly Rs. 2.4 billion (constant 2000 Rupees). Of these, 37 were federal agencies, 98 were provincial agencies, and 13 were private sector entities. The Pakistan Agricultural Research Council (PARC) coordinates the activities of a large network of public national and provincial agricultural research bodies, institutes and experimental stations. PARC does not conduct agricultural research itself, though the National Agricultural Research Center (NARC) is under its administration. With the passing of the 18th Amendment to the Constitution[15] in 2010, the public agricultural system has been devolving from the federal to the provincial level, creating new opportunities for re-energized public agricultural research. By moving the research agenda to the provincial and local levels, research can have a greater focus on the needs of local farmers and environmental conditions.

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[15] The 18th Amendment switched the government from a semi-presidential system to a parliamentary republic.

65.   Diversification is also influenced by changes in technology affecting the relative profitability and risk, among other factors[16] (Pingali and Rosegrant, 1995). The analysis of diversification in India from Joshi et al. (2003) illustrates these factors to be in play. Aside from the essential improvements in markets and roads, the study found that there were complex interactions between technological improvements and technology absorption of different commodities. For example, they found that greater adoption of technology for cereals was related to less diversification in favor of high value commodities. Similarly, diversification towards horticulture and livestock production, relatively more profitable products than cereals, was greater in areas that benefited less from the Green Revolution, such as rain-fed areas. These rain-fed areas were found to diversify into non-cereals away from cereals, and were found to be growing faster than regions specializing in cereals. This growth also had distributional implications since high-value commodities were grown more by small holder farms.

66.   Agricultural extension services need to be developed in parallel to R&D for greater uptake of relevant information to target groups. Extension services have suffered from weak linkages to agricultural research institutions, reflected in low technical capacity of the services (World Bank, 2011d). Administrative devolution has further weakened these services, with greater budgetary pressures and unclear linkages to the bureaucracy.

67.   The focus of extension services needs to expand even as it improves targeting. Historically, the extension services have focused on disseminating technology to farmers. However, there is a range of additional information that may be helpful to the farmer, such as advice on quality standards in production and marketing, which is currently not being provided. There is also a disproportionate uptake of extension services by larger farms relative to small and medium sized farms. Focusing on the case of sugarcane technologies, Abbas et al. (2003) found that information on varieties was taken up by 73 percent of large farms, relative to 64 percent of small farms. This discrepancy is even greater when advice on sowing methods and fertilizer application were considered. 73 percent of large farms adopted sowing methods from extension services, compared to about 40 percent of small and medium sized farms. Given that increasing small holder productivity is critical to enhancing agricultural production, agricultural extension will need to expand on improving adoption among this group.

Inefficient Water Use and Water Resource Management

68.   Pakistan's irrigated land as a proportion of cropland is the highest in South Asia, with about 95 percent of arable land being equipped for irrigation (Figure 13). Pakistan has been able to accelerate the rate of expansion of areas under irrigation, from an average annual rate of 1.24 percent in the 1960s to 1.44 percent in the 2000s (Figure 14). Pakistan has an irrigation potential of 21.3 million ha of land, of which 19.3 million ha is equipped for irrigation: 35.9 percent is for surface water, 21.4 percent for groundwater, and 41.3 percent for a mix of surface and groundwater sources (FAO, 2010). The Indus Basin Irrigation System (IBIS) supports this irrigation system, with about 106 million-acre-feet (MAF) of water flows diverted from the river system to canals.

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[16] These other factors include changes per capita income and urbanization, improvements in infrastructure, and changes in factor endowments

Figure 13	Ratio of the Area Equipped for Irrigation to Cropland Area
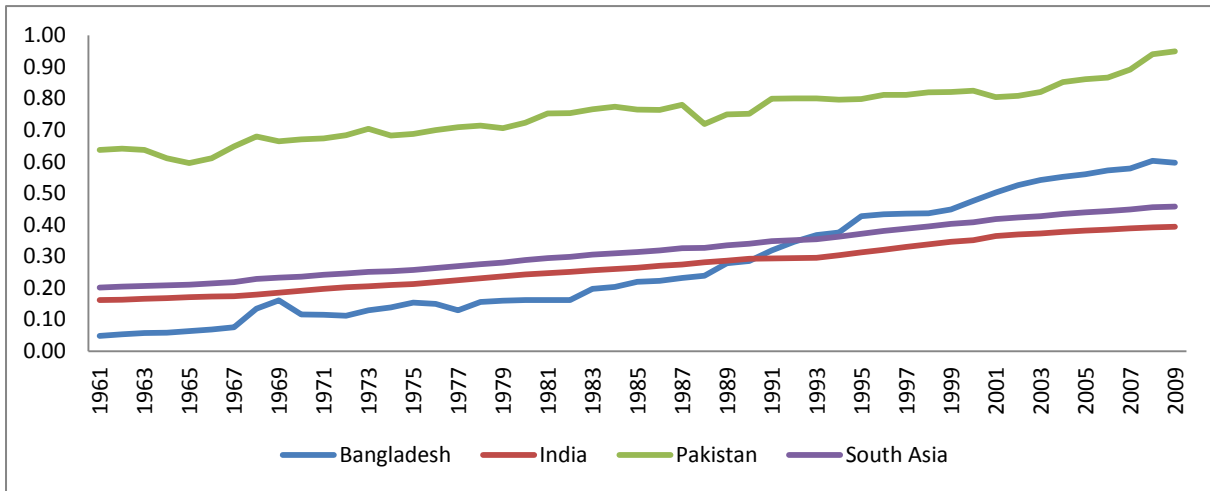
Note: Cropland is the FAO arable land and land in permanent crops; the values for South Asia are determined by aggregating data for Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.
Source: Authors' estimates from Fuglie (2012)

Figure 14	Average Annual Growth Rates of Irrigated Area and Cropland
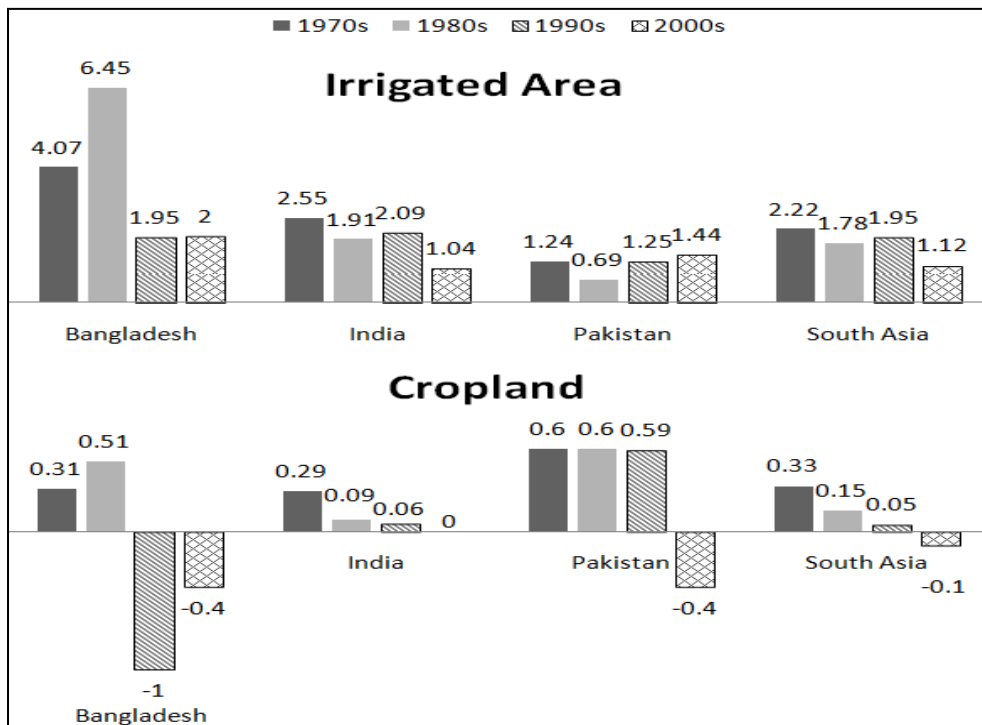
Note: Cropland is the FAO arable land and land in permanent crops; the values for South Asia are determined by aggregating data for Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.
Source: Authors' estimates from Fuglie (2012)

69.   Farmers' access to water however is less than it could be due to major limitations of the water allocation system. At the farm level, access to canal water is determined by physical location along the canal and through the *warabandi* water allocation system of administratively set rotations. Access to canal water then becomes contingent on access to land, and the location of that land. There might not be enough water by the time it gets to

land at the tail end of distributaries or watercourses, especially if upstream farmers illegally access the water (Yu et al., 2012).

70.   Another critical challenge to the irrigation system under the current water management system is that it is financially unsustainable. The canal irrigation management system recovers only a quarter of its annual operating and maintenance costs, with the shortfall expected to increase with rising costs and stagnant *Abiana* (water charges per acre of crops irrigated) (Planning Commission, 2012). The collection rate of assessed *Abiana* is also low—at only 60 percent of assessed values. The overall budget gap is about Rs. 5.4 billion annually, with the system thus being subsidized by the federal government.

71.   The current *Abiana* for different crops might also be distorting farmer decisions. The national average *Abiana* per acre over the 2000-09 period for different crops were between Rs. 126 and 214 for cotton, Rs. 185 and 428 for sugarcane, Rs. 125 and 210 for rice, Rs. 69 to 136 for maize, and Rs. 75 to 131 for wheat, respectively. Comparing the *Abiana* for rice and cotton—two major export crops—it can be seen that their irrigation charges per acre are about the same, even though rice requires 60 percent more water than cotton. These charges may not reflect relative profitability of the two crops, leading to a possible overproduction of rice.

72.   Availability of groundwater has an even higher impact on yields than the availability of canal water, but less than 10 percent of cultivating households owned tube wells in 2001-02. Groundwater markets significantly improve access for small farmers, landless tenants and younger households who often lack the resources (or land and water rights) to install their own tube well (World Bank, 2007). However, water purchasers do not have full access rights to the water, and in times of energy or water scarcity can be denied access. Access to groundwater also depends on the distance to the tube well, in addition to the existence and efficiency of the channels to distribute that water.

73.   Recognizing the importance of a robust and efficient water management system, the Government of Pakistan implemented reforms in the 1990s. As reviewed in World Bank (2011b), these reforms restructured the Public Irrigation Departments (PIDs) to Provincial Irrigation and Drainage Authorities (PIDAs); Area Water Boards (AWBs) to manage main and branch canals; and Farmers' Organizations (FOs) and Water User Associations (WUAs) to manage distributor and minor canals. The goal of these reforms was to enhance water use efficiency, streamline the water resources management, and facilitate participation by users.

74.   These reforms however have not been completely successful, due to problems at both the provincial and local levels. At the provincial level, the devolution of autonomy from the PIDs is incomplete. World Bank (2011b) illustrates by describing the case of Punjab's PID and PIDA, where the Secretary of the PID is also the Managing Director of the PIDA. Another example is from Sindh, where even though the posts of PID's Secretary and PIDA's Managing Director are held by different people, the latter has a direct reporting relationship to the former.

75.   At the local level, the FOs either do not have the resources or the capacity to fulfill their roles. As noted by World Bank (2011b), FOs have no input into the *Abiana* setting process, even though they might be responsible for collecting the charges. FOs also vary widely in regard to their role as charge collectors, since this is a determination made by

management, which in turn, they may or may not have any voice in. The lack of clarity in the role of FOs and their widely varying mandate across local governments has contributed to inefficiencies in *Abiana* collection that are damaging the financial sustainability of the system.

76.   The Planning Commission (2012) recognizes these challenges, and has proposed a series of recommendations. These recommendations include the revision of *Abiana* rates to be economically reasonable (i.e. reflecting the profitability of irrigated crops), reviewing the *Abiana* collection mechanisms, improving service provision, and water trading at the Indus River System Authority (IRSA) level, inter alia. The most important intervention however would be institutional reform of the entire management system to a) complete devolution of authority to the relevant scale; b) clarify the roles and mandates of each authority; c) provide sufficient resources and capacity building to allow devolved authorities to fulfill their mandates. It would be difficult and potentially detrimental to implement specific reforms, such as revision of *Abiana* or introducing water trading, in current dysfunctional institutional environment. Institutional clarity and ownership of reforms are thus key prerequisites to any other intervention.

77.   The irrigation system is highly inefficient as is demonstrated by substantial seepage losses which occur in almost every component of the delivery system. Only 41 MAF of irrigation water reach crops out of the 106 MAF that is in the system, equivalent to about 61 percent of the initial water delivered at the head[17] (Table 7). 25 MAF and 17 MAF are lost in watercourses and in fields, which are the most vulnerable components of the irrigation system. The overall efficiency of the system is about 35 percent, and improving the canal system's efficiency from 35 percent to 50 percent could boost growth substantially. Yu et al. (2012) estimated that GDP and GDP from the agriculture sector would decline by 1.1 percent and 5.1 percent on average, under climate change. An improvement to the canal system's efficiency that saved just an additional 12 MAF would improve GDP by 0.94 percent and agricultural GDP by 4.22 percent, on average, even under climate change.

Table 7	Seepage Losses in Irrigation System		
Location	**Delivery at Head**	**Losses**	
	MAF	**Percentage***	**MAF**
Main and branch canals	106	15	16
Distributaries and Minors	90	8	7
Watercourses	83	30	25
Fields	58	30	17
Crop Use	41		
Total		61**	65

*Note: *Percentage loss estimates are based on losses in MAF for that location and the delivery delivered at location head; **Total percentage loss = 100*(65/106)*
Source: Yu et. al. (2012)

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[17] The 61 percent seepage loss is in the ballpark of seepage losses in surface water irrigation in South Asia. Global Water Partnership (2011) synthesizes discussion that argue that over 49 percent of water passing through surface water irrigation systems is lost through seepage, with another 12 percent lost through evaporation. The synthesis also argues that some of water lost through the seepage is recovered because it recharges groundwater.

78.   Another limitation to water access is at the provincial level due to institutional features such as the 1991 Provincial Water Allocation Accord. Since 1991, water inflows have been apportioned among the provinces by the Indus Water Accord, allocating flows among the provinces based on a 5-year record of pre-Accord historical canal diversions. It assumes average flow of 114.35 MAF of water in the Indus system, and allocates 55.94 MAF to Punjab and 48.76 MAF to Sindh, with remainder going to Balochistan and Khyber Pakhtunkhwa. The Accord accounts for the possibility of surplus water in the system, allocating 37 percent of the surplus to Punjab and Sindh each, with the remainder being distributed to other provinces. The agreement does not, however, have a mechanism to deal with extremely low flow conditions or agreed-upon transfers across provinces (Yu et al., 2012).

79.   Relaxation of the institutional rigidities of the Accord can allow for a more market-based allocation of water leading to aggregate economic benefits. Yu et al. (2012) estimate that by relaxing the allocation constraints of the Accord, an additional 14 MAF of water enters the system, with both Punjab and Sindh experiencing increases in canal diversions with the effects varying by agro-climatic zone. Punjab and Sindh gain Rs. 83 and Rs. 82 billion in revenue, while other provinces collectively lose about Rs. 7 billion.

80.   Relaxing the conditions of the Accord by itself, without complementary policy may lead to outcomes that are not necessarily pro-poor. The complementary policy would need to compensate groups that the Accord relaxation would harm, such as farmers in Baluchistan and Khyber Pakhtunkhwa, or producers of crops that are not irrigated. One possibility would be to collect a part of the gains in Punjab and Sindh through revenue, and then transfer them to affected groups through targeted transfers. Such a policy would need to first identify the magnitude of the gains and losses by group, construct appropriate collection and transfer instruments, and establish a federal body that can regulate this process.

Markets, Trade and Diversification

81.   Pakistan experienced considerable growth in both exports and imports over the past decade. Export receipts grew by 13.9 percent per year during this period, while import payments rose by 12.8 percent per year. Total export receipts changed by USD 33.48 billion, while import payments changed by USD 29.65 billion (IFPRI, 2012). There is a notable concentration of both imports and exports in very few products: wheat and palm oil account for almost half of all agricultural imports, while rice is the largest export item and generates well over half of agricultural export earnings.

82.   Policies and policy reversals introduced in the past five years have steadily eroded the effects of trade liberalization that Pakistan implemented between 1996 and 2003. Pakistan had simplified its tariff structure and state trading monopolies for agricultural products had been abolished. However, exceptions were introduced in 2006, and a number of more important liberalizing reforms in agriculture were reversed, especially in regard to wheat, sugar and fertilizer. The use of SROs (Statutory Regulatory Orders) has also expanded since 2006. SROs and new regulatory duties have been used to provide exemptions to normal tariffs in some cases, while increasing tariffs for others. The resulting trade regime is thus highly discretionary and uncertain, leading to high variable output and input price distortions.

83.   Major crops like wheat, rice, sugar, and cotton are implicitly taxed by various price distortions introduced by policies in most years. Valdes et al. (2012) estimates nominal and effective rates of protection for output of major crops as well as for inputs used in these sectors. Nominal rates of protection (NRP) reflect output price distortions, which is relevant to buyers and consumers. Effective rates of protection (ERP) account for the effects of the trade regime and other policies on costs as well as output price. Tradable inputs have a net subsidy, driven by the subsidy on fertilizer. The subsidy rate on fertilizer is about 35 percent, and overwhelms any taxes on other inputs. It also represents a substantial fiscal cost.

84.   The policy-induced implicit tax on crop production serves to depress production, despite implicit net input subsidies. For example, basmati rice had negative ERPs between 2008 and 2010, when farm income would have been higher by 21 percent to 40 percent under a no-intervention regime. The case of sugar is also similar. The significant increase in the world price of refined sugar increased the parity price, but the increase in the general sales tax applied to sugar offsets higher border prices. The NRP on sugarcane at the farm gate is negative and high—the parity prices are approximately double the observed farm gate price. The wedge driven between the parity price and the farm gate price leads to lower effective production.

85.   Government procurement of wheat is extensive, and involves federal, provincial and district level agencies. The government sets the procurement price with expected procurement targets that the Pakistan Agricultural Storage and Services Corporation (PASSCO) and Provincial Food Departments are responsible for meeting. Provincial governments (mainly Punjab and Sindh) and PASSCO procure about 20 percent of total wheat production each year (Prikhodko and Zrilyi, 2012).

86.   The government maintains high domestic wheat procurement prices. The objective of these high prices is to support farm incomes, and encourage sufficient production for the domestic needs. However, domestic prices can exceed the import price parity levels, as happened in 2009-10, since wheat can only be imported under special circumstances and by specific parties, such as for supply to Afghanistan under the auspices of international humanitarian missions.

87.   Wheat procurement policies have a price stabilizing effect. Valdes et al. (2012) note that in spite of high volatility in border prices, both wholesale and farm gate wheat prices appear relatively stable. It is suggested that federal procurement through PASSCO and Provincial Food Departments are absorbing the price transmission that would otherwise prevail in open markets. Indeed, since the government controls domestic wheat prices and procurement volumes, as well as international wheat trade, there is very little price transmission from world markets to domestic markets.

88.   However, the impact of these procurement policies is negative on the welfare of net buyers (the majority of the landless poor, will be negatively affected)—they are fiscally unsustainable, and can lead to perverse outcomes like subsidized exports.[18] The ERP on wheat has fluctuated from negative to positive values over the past few years. Valdes et al. (2012) explain that this is mainly due to shifts in implicit NRP on the product price, which

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[18] The full distributional impact of different categories of households, in particular the producer-consumer households, needs to be carefully analyzed.

was negative over the three years, but small in 2009-10. The implicit NRP on tradable input costs was negative—implying a subsidy to farmers—and relatively stable compared to that on output price. The negative ERP in 2008-09 accompanied an effective subsidy to consumers, since the cost of imported wheat was greater than the issue price wheat at which the government releases grain to flour mills through its public procurement mechanisms. All procured wheat is bought and then sold to flour millers in the same wheat marketing year, with the government absorbing the costs of procurement, storage, and financing. Millers are able to buy the subsidized wheat at below market prices, and then sell the flour at open market prices, which are the prices faced by consumers.

89.   Reforming Pakistan's wheat procurement is thus a key area for domestic trade policy. The simplest reform would be to reduce the wheat procurement volume. This would reduce the fiscal burden of the subsidy as well as the effective subsidy to wheat producers. Valdes et al. (2012) also argue that reduction of the wheat procurement does not have to jeopardize food security (through price management) objectives. The study argues that rules-based adjustable tariffs that set floor and ceiling prices to follow world prices and social safety net programs can be implemented in parallel to a scale back in wheat procurement. These policies would address the food security concern, while reducing the scope for extreme distortions caused by the procurement policies (e.g. exports of subsidized wheat).

90.   An enabling policy environment can also encourage the growth of high value agriculture (HVA), which can maximize returns to scarce factors of production, like land and water. Higher value agriculture would include crops like oilseeds, fruits, vegetables, and livestock, while low value agriculture would include cereals. Domestic demand for these products will continue to rise rapidly as incomes increase and diets become more diversified if marketing channels function efficiently (World Bank, 2007a).

91.   Pakistan, like the rest of South Asia, has been slowly diversifying towards HVA. As estimated in Joshi et al. (2003), Pakistan's crop sub-sector has diversified between 1991 and 2000. The study estimated the Simpson Index of Diversity, and found that Pakistan's index had risen from 0.56 to 0.57 over the period—a minor increase that is consistent with the average improvement for South Asia, which rose from 0.66 to 0.67. Decomposing the source of Pakistan's diversification, it was found that more than three-quarters of this diversification occurred through utilization of fallow lands, rehabilitation of degraded lands, or increasing cropping intensity. Much of the area expansion also came from deforestation, which may have long run environmental implications. The remainder of the diversification was through crop substitution.

92.   Pakistan's high value agricultural exports are growing rapidly. Currently high value agriculture (HVA) account for less than a quarter of annual export revenue. However, exports of these products are growing rapidly. In 1990, there were virtually no exports of dairy and eggs, or of meat (Hazell et al., 2012). However, in 2011 Pakistan's exports of dairy and eggs were valued at USD 30.1 million (real 2000 dollars), while that of meat and livestock were valued at USD 106 million, as estimated from UN COMTRADE data. The growth of HVA exports has been rapid, with some products like fisheries and fruits, vegetables, and oilseeds experiencing average annual growth rates of 45 percent and 15 percent, respectively, between 2008 and 2011 (Figure 15).

Figure 15	Exports of High-value Agricultural Products from Pakistan
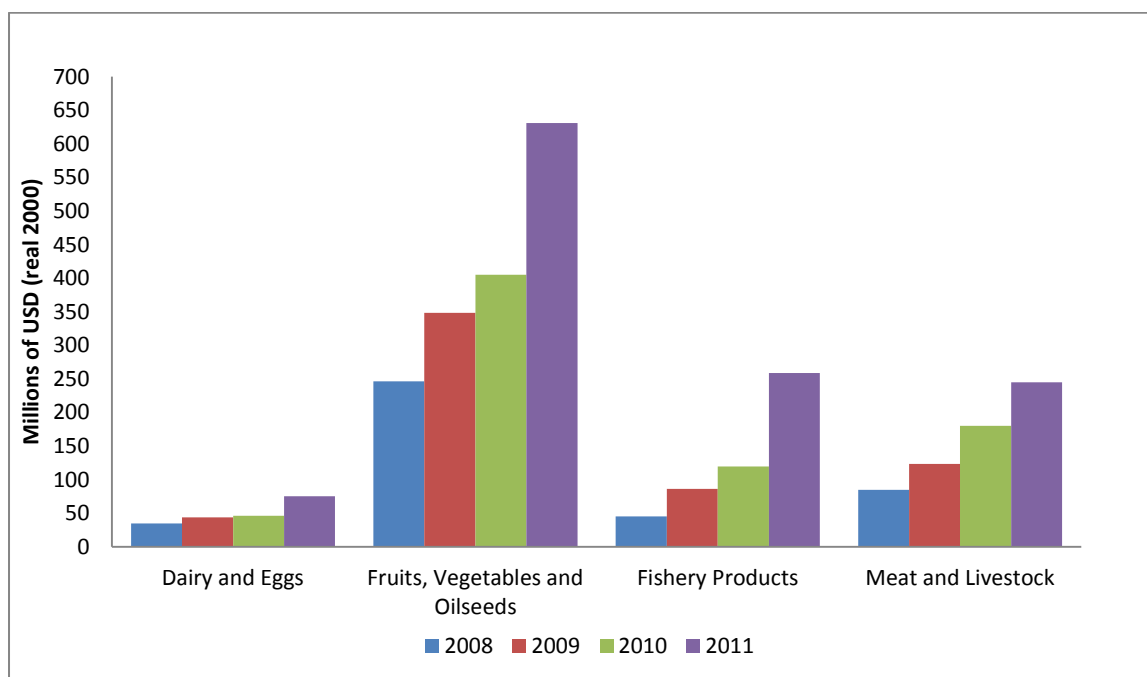
Source: Authors' Calculation from UN COMTRADE

93.   Protection of low value crops may stifle the diversification process. In India, there is a high degree of support to wheat and rice through price support and water subsidies go to these crops, with the result being that diversification away from cereals has been slower in the north-west (Gulati and Pursell, 2007; Hazell et al., 2012). Pakistan's policy environment can be similarly constraining, as illustrated by the wheat procurement policies and the irrigation water charges that favor rice production. Improvement and enforcement of sanitary and phytosanitary (SPS) regulations are also necessary to meet international trade standards. These require establishment of testing facilities, training and capacity building, and active representation in international standard formulating agencies (Hazell et al., 2012; Joshi et al. 2007).

94.   Access to credit has the potential to enhance agricultural productivity, and would help facilitate a shift from cereal-based to high value agriculture by providing the necessary investment. Households with credit constraints had a 23 percent reduction in value of yields (World Bank, 2007a). Access to formal credit markets in rural areas is generally limited to landowners, since land is the most acceptable collateral for loans. World Bank (2007a) reports that only 11 percent of farmers obtained formal sector loans in 2001-02. Access to informal credit markets is more widespread, but approximately 40 percent of rural households are unable to access as much credit as they need at existing interest rates. Khandker and Faruqee (2001) find that farm credit schemes—such as those delivered by the Agricultural Development Bank of Pakistan—tend to have a higher impact on small holder production and welfare.

95.   Weakness in the seed sector constrains the crop sub-sector, including high value crops. In 1997-98, only 10.1 percent of the potential demand for seed for various crops was met. However, the seed sector in Pakistan has undergone several reforms and a national seed policy was developed in 1994. By 2007-08, 16 percent of potential demand was met. Seed for major crops like wheat and cotton saw some substantial improvement. The supply of wheat

seed rose by 126 percent from 78,554 T between 1998 and 2008, while the supply of cotton seed rose by 37 percent from 23,128 T over the same period (Seed Info, 2010).

96.   The private sector has taken the initiative in seed supply for several crops, but there is still a substantial gap between total supplied and potential demand. The private sector supplies more than 69 percent to 84 percent of the seed for wheat, rice, and cotton (Table 8), while imports are responsible for 66 to 88% of total seed supply for less popular crops like maize, vegetables, and potatoes. The public sector only has a substantial role in seed supply for wheat, where it is has an elaborate public procurement program.

Table 8	Seed Supply of for Major Crops in 2010				
Crop	**Seed Supplied (T)**	**Source of Supply (%)**			**Supply to Potential Demand Ratio (%)**
		Public	**Private**	**Import**	
Wheat	177,792	31.2	68.8	0.0	17
Rice	13,868	17.1	71.9	11.0	35
Maize	9,785	2.2	31.4	66.4	33
Vegetables	6,340	4.0	7.7	88.3	115
Potato	8,200	7.2	8.9	84.0	3
Cotton	31,691	15.9	84.1	0.0	49

Source: Adapted from Seed Info (2010)

97.   Reforming the regulatory environment can thus enhance seed supply. Seed registration requirements impose restrictions on seed imports. Given the low domestic supply in the formal markets, farmers often resort to obtaining uncertified seed through informal markets and through retention. Due to the resulting heavy reliance on the informal sector, research and development to enhance seed production is constrained (World Bank, 2011c).

Policy Recommendations

98.   Broad-based agricultural growth can be achieved through narrowing the wide yield gaps and diversifying toward high-value agricultural products. This growth can improve the agricultural incomes of farmers (and especially of smallholders), as well as improve rural incomes more generally, through higher returns on land and labor—the latter benefiting the many rural landless poor. Actions are needed in the areas of agricultural productivity, water use efficiency, and trade and marketing policies to enhance agricultural growth and improve farm incomes (see Policy Matrix below).

99.   Substantial reforms to the national agricultural research system are needed. First, the system requires fundamental institutional reforms to make it more efficient and effective. With efforts underway to develop provincial agricultural research institutions, the roles of the PARC and the NARC need to be adjusted to exploit their comparative advantage of being federal institutions able to facilitate federal funding, intraprovincial knowledge, and capacity building. Second, with the shift in primary activities from federal to provincial levels and from policy coordination to agricultural research, there is a need to reflect these activities in human resource and performance incentives. This may require moving personnel from the center to provincial institutions, or even changing the composition of the staff, to increase the proportion of scientific research staff, for example. Third, these reforms will require additional spending in agricultural R&D, whether for supporting agricultural research in provincial research centers or capacity building of science staff, with the exact composition of the additional spending depending on the nature of the institutional reforms.

100.   These reforms to the R&D architecture, by their nature, would be very wide ranging and require substantial groundwork prior to execution. The first step (of two)—a stocktaking of the current agricultural research system—would need to include a detailed institutional audit that examines the system as a whole and to clearly delineate the roles, functions, and mandates of the public federal and provincial bodies that govern and conduct agricultural research. More broadly, this stocktaking would also need to account for the current roles of (and environment for) private R&D, including those of domestic and multinational agribusinesses. It should then lead to a strategic road map for overhauling the national agricultural research system, with particular emphasis on future budgets, human resources, and capacity building. In keeping with the spirit of the 18th Amendment, this strategic planning would need to have the input and buy-in of provincial and local government institutions and should not be left to just the PARC and the NARC. The second step would be to roll out the appropriate reforms over the next one or two budget cycles

101.   To improve water use efficiency, the most important intervention would be institutional reform of the entire water management system. Given the system's high dysfunction, clarifying the institutional environment would be a prerequisite for any other intervention under consideration, such as revising the *Abiana*. The reforms to the water management system include completely devolving authority to the relevant scale, clarifying the roles and mandates of each authority, and providing sufficient resources and capacity building to allow the devolved authorities to fulfill their mandates.

102.   As with the reforms to the national agricultural research system, reforms to the whole water management system will require action over multiple years and will need to be

carefully considered. Water management systems show wide divergence in budgets, capacity, and extent of devolution from the federal to provincial level. The reforms need to first identify their current state, from public irrigation departments down to the Farmers' Organizations (FOs) and Water User Associations (WUAs), which will help clarify the roles and mandate of each authority and outline a devolution plan for each area where devolution has not occurred (such as the public irrigation and drainage authority still managing public irrigation departments). For entities that require capacity building and management reform (such as FOs), budgets to train and support personnel are needed.

103.   To promote trade and agricultural diversification, the trade regime must be simplified. This will require removing unpredictable and discretionary instruments like the SROs, shifting to a lower set of uniform tariffs, and simplifying the trade regime by removing alternative trade policy instruments like export taxes. These three measures would reduce uncertainty, volatility, and the policy bias against agricultural products like rice and sugar. Valdes et al. (2012) also point out that equalizing tariffs across agricultural products, while necessary, is not sufficient for equal effective protection across products, because protection or support in the input markets could still be substantial, at varying levels. Their study argues that the best approach to reducing the variation in effective protection across outputs is to also reduce the variation in protection of all inputs, including raw materials, capital, and tradable inputs. From a practical perspective, the measures will require a realistic timetable, as well as instruments compliant with the World Trade Organization that may still be able to protect national interests.

104.   To improve domestic trade of agricultural products while protecting food security, distortions in domestic markets of commodities like wheat need to be removed. The simplest set of reforms would be to reduce the wheat procurement volume while designing and implementing complementary social safety net programs. The wheat procurement contraction would reduce the effective subsidy to wheat producers and thus the fiscal burden. If food price stability is important, price bands can be implemented using rules-based adjustable tariffs that set floor and ceiling prices to follow world prices[19]. In parallel, social safety net programs that target food-insecure groups can be established, with clearly defined triggers and graduation requirements.

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[19] Valdes et al. (2012) suggest this approach for wheat and sugar, based on the moving averages of border prices. By keeping the basis of the price band delinked from domestic prices, the policy remains a World Trade Organization–compliant instrument as a variable levy.

POLICY MATRIX

Objective	Short Run Action (<1 year)	Medium/Long Run Action
Improve agricultural productivity	Initiate reform of the national agricultural research system to make it more efficient and effective Develop plan for building scientific research capacity	Carry out reforms of national agricultural research system (clarify mandate, shift personnel from federal to provincial institutions, shift budget, provide appropriate performance incentives) Increase budget for agricultural research Plan and implement long run capacity building program for scientific research capacity
Improve water use efficiency	Identify mechanisms for institutional reform of the management system: • Complete devolution of authority to the relevant scale (including provincial authorities and farmers' organizations) • Clarify the roles and mandates of each authority	Implement institutional reform Provide sufficient federal and provincial resources for transition and capacity building Set up third party watchdog to evaluate state of institutional reform and monitor for rent seeking behavior
Remove protection variability and bias against agricultural exports	Identify timetable for removal of statutory regulator orders, tariff reduction and harmonization, and export barrier removal. Identify WTO compliant instruments that may be appropriate to use instead, e.g. special safeguard mechanisms	Remove statutory regulator orders, reduce and harmonize tariffs, and dismantle export barriers.
Reduce distortions in domestic grains markets while protecting food security	Identify minimum volume of public wheat procurement, accounting (federal and provincial procurement programs). Identify floor and ceiling prices to follow world prices for wheat prices Identify food insecure groups for social protection programs	Implement rules-based adjustable tariffs to maintain designated price bands Develop and roll out social protection programs for food security, with clear triggers and graduation requirements.

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