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The Role of Regulations in the Fertilizer Sector of Pakistan

Mubarik Ali
Pakistan Strategy Support Program

Faryal Ahmed
Pakistan Strategy Support Program

Hira Channa
Pakistan Strategy Support Program

Stephen P. Davies
Pakistan Strategy Support Program/ International Food Policy Research Institute

The regulatory and institutional setup in fertilizer processing, distribution, marketing, and utilization has resulted in a scenario where the input has failed to reach its full potential in terms of use on crops and has threatened the long term sustainability of the sector. Urea production has historically been subsidized massively by the government, a subsidy which is becoming increasingly difficult to maintain in terms of the fiscal cost and the availability of domestic natural gas. The subsidy on urea production has promoted its imbalanced use and undermined other important soil inputs like phosphorus, potash, and micronutrients. Meanwhile the yield response of urea has tapered off and its' per hectare use is fast reaching its optimal level. The regulatory framework needs to be re-worked to promote modernization of existing capacity and the use of environmentally friendly fertilizer products. Increasing dependence on imports needs to be considered rather than exhausting the existing gas resources. Fertilizer policy should encompass the broader needs of all stakeholders, rather than just focus on the natural gas requirements of urea producers.

Keywords: Regulation, fertilizer, Pakistan, subsidy, policy, legal framework

JEL codes: Q13, Q18

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1. Introduction

Despite many gains attributed to increased fertilizer use in the crop sector, regulations and institutional set up designed to promote its production and use remained controversial. Successive governments have alternated between subsidizing its production, importation and distribution, withdrawing these subsidies in a piecemeal manner, and reverting back when fertilizer prices escalated. In addition, public sector research and development institutions mainly focused on the promotion of urea without paying much attention on developing new fertilizer products and promoting other soil nutrients such as phosphorus, potash, micronutrients, etc.

As a result of these policies—alongside a host of other market and institutional factors such as, for example, scale efficiencies in fertilizer processing, lack of institutional capacity to introduce new and more efficient fertilizer products and application methods —Pakistan now faces widespread misuse of fertilizer and corresponding resource degradation at the farm level, rigid oligopolies in the fertilizer industry, and untenable fiscal burdens for the government.

There is little empirical analysis on the impact of different regulations in the fertilizer sector especially in Pakistan. Few studies have looked at the role of fertilizer in productivity and resource degradation (Ali and Byerlee 2002; Rashid *et al* 2013), estimated crop supply elasticities with respect to fertilizer prices (Ali 1990), demand elasticities of fertilizer (Quddus, Siddiqi, and Riaz. 2008; Ayub 1975, Leonard 1975, Chaudhry and Javed 1976) and have compared the impact of fertilizer subsidy on consumers and producers surplus with various other policy options (Abedullah and Ali 2001). While these estimates provide a good information on the relationships between fertilizer prices, its use, and farm productivity, and how the benefits of increased productivity are distributed among various stakeholders, they fail to provide an insight on the impacts of various options on macroeconomic parameters for policymakers, such as on output and fertilizer prices, crop production levels, fertilizer and output trade deficit, government revenues, and producers and manufacturers' cost and earnings. Here we used the Economic Displacement Model (EDM) to analyze these impacts so that policy makers can make informed decision in adopting various options.

This paper explores the issues of the fertilizer sector in Pakistan in greater depth by reviewing the state of the fertilizer industry, analyzing fertilizer availability spread in various regions, to different crops, and under microenvironments, elaborating the institutional and regulatory framework, identifying main policy issues, and analyzing the impacts of these options on macroeconomic parameters of the economy. The remainder of this chapter proceeds as follows. Section 2 provides a discussion on brief history of the industry in terms of processing, marketing and regulatory framework. The trends in fertilizer use at the country and regional levels, to various crops, and under microenvironments are analyzed in section followed by ab estimation of the optimal or profit maximizing profit levels are estimated. Section 4 describes how the misuse of fertilizer can deteriorate the resource quality and degrade its productivity. Section 5 reviews the government interventions in fertilizer prices to manage these prices through taxes and subsidies, while section 6 analyses the international competitiveness of fertilizer industry. Section 7 concludes with recommendations aimed at improving the regulatory framework to enhance the performance of Pakistan's fertilizer sector and its contribution to future agricultural productivity growth.

2. The Development of Pakistan's Fertilizer Industry

2.1. Fertilizer Production and Imports

The initial introduction of fertilizer in Pakistan began in the 1950s, primarily through imports. Nitrogenous[1] chemical fertilizers were introduced through this channel in 1952, followed by phosphorus in 1959 and potassium in 1967 (NFDC 2014). But Pakistan initially perceived that its reserves of natural gas were large—an input to the Haber-Bosch process used to form ammonia, a key ingredient in nitrogen fertilizers such as urea—conferred a comparative advantage in the production of fertilizer. Beginning in the late 1950s and early 1960s, the government pursued an import-substituting industrialization policy and strategic manufacturing investments to build a domestic fertilizer industry. These included both joint ventures with foreign companies such as Pak-American Fertilizers (now Agritech, which was established in 1958) and Pakarab Fertilizers (established in 1973), as well as the establishment of domestic fertilizer plants, like that of the Fauji Fertilizer Company (FFC), established in 1978.[2] Upon

[1] "Fertilizer products" are a combination of three primary "fertilizer nutrients", which plants need in order to grow: nitrogen (N), phosphorus (P) and potash (K). For example, urea is 46% nitrogen, while DAP comprises 18% nitrogen and 46% phosphorus. Throughout this chapter, we use these terms distinctively.

[2] Company dates retrieved from Agritech 2014, FFC 2014 and PFL 2014.

nationalization of the fertilizer industry in 1973, production for all fertilizer companies was undertaken through the parastatal, the National Fertilizer Corporation (NFC) (Ali et. al., 2015).

By the late 1960s, Pakistan's emerging domestic fertilizer industry build on abundant gas supply allowed the country to simultaneously increase the national supply of fertilizer and reduce the share of fertilizer imports, which drew on valuable foreign exchange reserves. Of course, large quantities of certain fertilizer products that are produced without natural gas (for example, Diammonium Phosphate (DAP) and Potassium (K) compounds) still had to be imported, but domestic production capacity for both nitrogen and phosphate fertilizers nonetheless continued to increase (Figure 1). The fertilizer use gained momentum since 1970 when farmers began adopting high-yielding modern wheat and rice varieties in Pakistan's irrigated areas substantiated with the government promotion through subsidies and research support.

These policies led to the development of a sizeable fertilizer industry in Pakistan. The value of fertilizer sales (estimated at domestic retail prices) was estimated at US$3.74 billion in 2014, up from just US$554 million in 1971 (both values in nominal terms). Approximately 76 percent of fertilizer consumed in Pakistan is produced domestically, with domestic production supplying 83 percent of nitrogen, 51 percent of phosphorus, and 47 percent of potassium consumed nationally. Growth of domestic fertilizer production has been consistently higher than the growth of consumption for all nutrients since 1971, keeping import growth relatively low. For nitrogen, the production growth rate (6.15%) was greater than the offtake growth rate (5.54%), thereby keeping the import growth at 3.40% from 1971 to 2014. although trends in phosphorus and potash production and offtake were less dramatic (Ali et. al., 2015).

Total domestic installed capacity of all types of fertilizer production in Pakistan is currently estimated at 10.0 million metric tons, 69 percent of which is for urea and 31 percent for DAP and potash (the fertilizer product with the active nutrient, potassium). In recent years, the industry was operating below capacity, at approximately 75 percent of capacity in 2013-14. During this year, urea production suffered the most, with operating capacity estimated at 78 percent, while DAP production was running at almost full capacity (Table 1). Had there been no underutilization of capacity, installed capacity for production of urea would have been sufficient to meet domestic demand. However, DAP would remain short even with full utilization of its installed capacity by about 50 percent.

The production capacity and marketing power in fertilizer industry in Pakistan is concentrated in relatively few firms. The two big players, Fauji Fertilizers Company (FFC) (Gorth Machi), and Engro Fertilizer Ltd. (EFL) hold more than two third of total installed urea capacity (Figure 2). The estimated Herfindahl-Hirschman Index of industry concentration for urea manufacturing in Pakistan is 3741 indicating that the industry is highly concentrated.[3] The Competition Commission of Pakistan (CCP) has also arrived on similar conclusions.

With respect to DAP, the situation is slightly different. The Fauji fertilizer, Bin Qasim (FFBL) is also the only producer of DAP in the country, with about 54 percent of its demand met by that domestic producer, and with the rest being imported by a large number of smaller firms. As such, there is likely greater competition in the market for DAP, and domestic DAP prices tend to be closely linked to the international price of DAP. But with this comes greater exposure to international price volatility and currency risk.

There is some evidence suggesting anti-competitive behavior in Pakistan's fertilizer industry. The firms benefit from the government's largess described above and have invested heavily in securing and maintaining their market power. In 2012, the Competition Commission of Pakistan (CCP) fined FFC and DHCL for approximately PKR 6 billion for employing coalition tactics in an effort to manipulate the fertilizer market. Meanwhile, the returns on equity in Pakistan's fertilizer industry fall well beyond international comparators, suggesting the possibility of anti-competitive behavior that rewards investors. In Pakistan, the return on equity (taken as an average for the years 2004-08) for the fertilizer industry was 33 percent, compared to 9 percent in China and 16 percent in India (CCP 2010).

2.2. Marketing

Initially, fertilizer was distributed through the agriculture extension wing of the provincial agriculture departments. There was no independent marketing system for agricultural inputs until the formation of the West Pakistan Agricultural Development Corporation (WPADC) in 1961 (Hussain 2011, Hassan and Pradhan 1998). However, WPADC was abolished in 1972, when this responsibility was transferred to the provincial governments. Later, fertilizer

[3] The Herfindahl-Hirschman Index (HHI) is calculated as the sum of the squared market share of each firm in the industry (Hannah and Kay, 1977). The HHI approaches zero when a market consists of a large number of firms of relatively equal size, and increases both as the number of firms in the market decreases and as the disparity in size between those firms increases. Thus it takes into account the relative size and distribution of the firms in a market.

marketing was the responsibility of the National Fertilizer Marketing Limited (NFML), a parastatal established in 1976 that carried the responsibility for distributing the entirety of domestic production from NFC companies as well as all imports of fertilizer. After privatization of all manufacturing units of NFC, NFML's role has become restricted to the distribution of imported urea. Currently, domestically produced supply is marketed by private sector processing companies through their registered dealers' networks (Ali et. al. 2015).

Typically, fertilizer manufacturers supply products to dealers with a recommended maximum price, which is inclusive of the dealer's profit margin. Dealers procure fertilizer stocks—usually on a cash basis, but sometimes against a bank guarantee—and sell the product through their sales agent networks at prices that are determined by the supply and demand situation. The existence of a competitive market is, however, subject to government intervention, sometimes ad-hoc in nature and sometimes more structural. For example, during periods of short supply, according to interviewed dealers, the historical practice has been for the District Coordination Officer (DCO) call upon a meeting of all the fertilizer dealers in a district to agree upon a price, even though deviations from this set price became the norm. More broadly, regulators have almost never been able to smooth out the supply or keep prices at reasonable levels whenever shortages have occurred—even despite the authority vested in regulators—mainly due to mismanagement of imports controlled by NFML (Nadeem Tariq, pers. comm).

2.3. Regulations, Policies, and Institutions

The growth of fertilizer production and use in Pakistan gave rise to a series of policies designed regulation in the industry. First and foremost, from 1954 until the present, the government maintained control of the supply and allocation of natural gas to the fertilizer industry. The Provincial Essential Commodity Act (PECA), initially promulgated in 1971 and amended in 1973, placed fertilizer production and marketing under the direct regulatory purview of the federal government. At the provincial level, the Punjab Fertilizer (Control) Order of 1973 further strengthens the power of federal regulators by rendering provincial management of fertilizer subservient to PECA. Specifically, laws formulated and executed under PECA provide almost complete powers to the Controller[4] in the management of prices, imports and even the size of

[4] For the management of prices, the controller is at the provincial agriculture department. For imports, the Commerce Ministry through NFML has the responsibility.

daily fertilizer transactions. Other policies that have been deployed over the past 40 years include subsidies on fertilizer importation and distribution, and sales tax exemptions on farmers' fertilizers purchases.

The introduction of these policies, alongside the growth of fertilizer production and use, also led to the establishment of several key organizations aimed at promoting fertilizer use. Fertilizer research and development (R&D) was initially undertaken by the Directorate of Soil Fertility in the Research Wing of the Agriculture Department of the Government of West Pakistan, which was converted into provincially separate soil fertility research institutes in each province in 1971. Issues pertaining to economic policy, for example, concerning production, imports, pricing, subsidies, and regulations, were addressed by the National Fertilizer Development Centre (NFDC), which was established in 1977 by the Federal Planning and Development Division.

At the farm level, the Extension Wing of the Agriculture Department of the Government of West Pakistan was responsible for conveying recommendations for fertilizer use to farmers. Credit for fertilizer purchases was made available to farmers through a variety of formal and informal sources. Initially, the primary formal source of credit was the Agricultural Development Bank of Pakistan (ADBP) now known as the Zarai Taraqiati Bank (ZTBL), established in 1961 to provide affordable financial services to rural Pakistan. Commercial banks such as Habib Bank, Askari Bank, and Punjab Bank began providing agricultural credit at market rates beginning in 1972 (MNFAL 2007c).

The rapid expansion of Pakistan's fertilizer production capacity—alongside increases in fertilizer imports, and the growth of the policy, market and institutional infrastructure required to promote fertilizer use—led to significant yield gains in wheat and rice during the 1960s and 1970s, and also introduced new challenges to Pakistan's agricultural sector. First, relatively smaller subsidies for nutrients other than nitrogen led to a long-term pattern of unbalanced fertilizer use. Second, the regulators' strong hand over the fertilizer industry, as set forth in PECA, placed significant discretionary powers in the hands of regulators and made entry into the fertilizer industry difficult for those without strong political affiliations. Third, the public sector's extensive investment in the formation and management of Pakistan's fertilizer industry—from the pricing and allocation of natural gas to the distribution of fertilizers to farmers—created interest groups that made more market-oriented reforms difficult.

Another dimension of this problem has been the absence of new product testing and promotion until the first decade of 2000s. During the initial years of fertilizer introduction, provincial extension services played a major role in promoting fertilizer based on recommendations made by SFRI for every crop. However, the emphasis of these demonstrations remained focused on the expansion of fertilizer use, meaning that few products or application methods were either tested or promoted. Meanwhile, SFRI had little success in formulating and disseminating new fertilizer recommendations—either general or site-specific—based on their R&D activities. These limitations in the research and extension system have exacerbated trends toward unbalanced use and resource degradation.

In recent decades, Pakistan's fertilizer industry has undergone several changes aimed at addressing several of these issues. After the gradual privatization of NFC's manufacturing units over the period 1996 to 2005, NFML's role has become restricted to the distribution of imported urea. In the 2013-14 rabi season, even this role was reduced further when the government transferred the responsibility for the distribution of urea imports to domestic manufacturers. But subsidies are still central to the production and distribution of fertilizer, with the Ministry of Industry and Production deciding on the production subsidy by controlling the supply of gas to manufacturers, and the NFML deciding on the amount of fertilizer to be imported and the distribution subsidy to be applied.

In sum, the development of Pakistan's fertilizer industry has been both a success story and a source of difficulty for farmers, industrialists, and policymakers alike. The success story was driven by a number of key factors: a major technological shift initially in rice and wheat cultivation during the Green Revolution and later in cotton, sugarcane and maize; Pakistan's perceived abundant endowment of natural gas at the time; and the willingness of policymakers and investors to build a domestic fertilizer industry from the ground up. But difficulties in sustaining this success have emerged in the form of unbalanced fertilizer use, poor management practices, poor allocation of public resources for R&D, and non-competitive industrial practices. We examine these elements in the sections that follow.

3. Fertilizer Use

To provide a better sense of how farmers actually use fertilizer in Pakistan, this section examines fertilizer application rates at country, cropping region, and crop region levels.

Data in this section are drawn from three sources. First, data on fertilizer use across agro-ecological zones and provinces, at an aggregated level, was obtained from the NFDC.[5] Second, data on yield response and soil nutrient contents are drawn from SFRI, collected from laboratories present at district levels in every province.[6] Third, household data are drawn from the first round of the Pakistan Rural Household Panel Survey (RHPS) conducted in 2012 (IFPRI/IDS 2014). RHPS data on fertilizer use, yields, and related variables are specifically drawn from a sub-sample of 942 agricultural households across three provinces surveyed in November 2012 under RHPS Round 1.5.

According to NFDC data, total fertilizer offtake increased over fourteen fold between 1970 and 2014 in Pakistan. The 3-year average per hectare N use increased from 20 kg over 1970-73 to 133 kg during 2011-14, while phosphate fertilizer increased from 2 kg to 33 kg per hectare in the corresponding period. The total soil nutrient application increased from 17 kg per hectare in 1970-71 to 180 kg per hectare in 2013-14 (Appendix 1). The latest application rate is higher to that of India (141 kg/ha), but less than that in neighboring Indian Punjab (229 kg/ha).[7] The highest increase in per hectare fertilizer use was recorded in 2009-10 when the output-fertilizer price ratio jumped to a record level (Ali et. al., 2015).

3.1. Crop-level Availability

Average per ha availability of fertilizer by major crops was estimated by dividing fertilizer off take by crops with crop acreage every year. The fertilizer nutrient off take as estimated from secondary offtake data varied among crops (Figure 3). The highest use was for sugarcane and lately on cotton. Rice and maize have received the lowest application, and the

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[5] All fertilizer traders in the country registered with the extension department are obliged to provide daily sale, price, and stock information to the Extension Wing of the provincial agriculture departments. The NFDC collects this information from them and from importers and companies directly to verify this data. Daily prices of fertilizer products are collected from the Pakistan Bureau of Statistics. We used annual values for our analysis.

[6] These laboratories are engaged in research and development activities to increase agricultural production by improving plant nutrition management, together with a better use of other production factors. The Field Wings of SFRIs carry out experimentation on farmers' fields every year for various crops and cultivars to evaluate optimum nutrient requirements and provide general and site specific fertilizer recommendations.

[7] One reason of this low average use compared to Indian Punjab is that a larger area in Pakistani Punjab is barani in northern and Southern Punjab, where fertilizer use is significantly lower than national average due to lack of water.

use for these crops has in fact decreased overtime since 1999. The highest fluctuation in per ha fertilizer use was observed in sugarcane mainly because of its cyclical production and price fluctuation behavior. Despite relative low per ha application of fertilizer on wheat, it consumes over 50% of the total fertilizer off take in the country because of the largest acreage under the crop. The big consumption for wheat which has a very rigid planting time in November puts huge pressure on fertilizer industry. The huge demand of fertilizer in a short period in combination with the ill-planning of public sector managed import often create seasonal shortage, especially in the rabi season. A surprising increase in per hectare fertilizer use in cotton without corresponding increase in its yield clearly indicates inefficiency. Despite only 14% share in cropped area, cotton now consumes 25% of the total fertilizer offtake in the country.

3.2. Regional Variation

Per ha fertilizer nutrient use by cropping region was also estimated from the district-level fertilizer off take using the definition given in (See Ali, et. al., 2015 for the districts included in each region). Surprisingly, fertilizer consumption in Pakistan's province of Punjab, home of about 60% agriculture in Pakistan, exhibited both the lowest level of nutrient use and the slowed growth rate between 1990-91 and 2011-12 (Table 2). The highest levels of nutrient use were found in Sindh and the highest rate of growth was found in Baluchistan, which is the home of only 7% agriculture. Fertilizer use in barani areas in the northern and southern Punjab and KPK are significantly lower than the national average, although the rate of increase in KPK barani areas has been significantly higher than the national average. The highest growth in fertilizer use is observed in the Baluchistan horticulture region followed by the wheat-cotton region of Sind, and lowest growth is observed in wheat-cotton region of the Punjab.

3.3. Fertilizer Use under Micro Environments

Overall, there was no significant difference in fertilizer nutrient applications across different soil types. Normally, lower levels of fertilizer nutrients were applied on poor land, and the highest use was on most the fertile lands (Table 3). This is contrary to the higher recommended fertilizer doses for less fertile lands. However, this may be because those farming on poor lands have greater cash and credit constraints.

3.4. Optimum and Actual Levels of Fertilizer Use

Optimal (profit-maximizing) values of fertilizer can be calculated using the response functions estimated from the SFRI data collected under experimental conditions and farm levels data collected by RHPS using farm-level fertilizer and commodity prices during 2011-2012 (the results of the yield response function both at the farmers field and experiment station are reported in Ali et. al., 2015). The optimal or profit maximizing level of fertilizer is where the marginal value of the input is equal to the unit cost of the input or marginal value-cost ratio (MVCR) is equal to one.

From SFRI data, the estimated optimum values of nitrogen for wheat and cotton are respectively 183.5 and 209.0 kg per hectare, more than 50 and 30 percent higher than the average reported use of 119 and 123 kg per hectare. The difference indicates a potential of fertilizer use if all socioeconomic and institutional constraints at the farm-levels is removed. For rice the optimal value of nitrogen, 132.8 kg per hectare, is fairly close to the average of 123. However, it is important to note that the optimal value of nitrogen for wheat in barani conditions (not reported in the table) is much lower, around 108 kg per hectare (SFRI 2013a). This reflects the sensitivity of yield response to fertilizer with timely and sufficient availability of water.

Using the elasticity from the yield response function estimated from the RHPS farmers' field data, the MVCR ratio for the nitrogen applied to wheat is one at around 126 kg/ha when subsidy is included. This is almost equal to the actual level of 119 kg/ha under farmers' own set of resource-quality and socioeconomic constraints. This is lower than SFRI's recommended value of 183 kg/ha, estimated based on experiments undertaken in controlled research environments. The optimum level of fertilizer use drops significantly to 100 kg per ha or 16% when fertilizer price without subsidy was employed in the calculation[8] (Table 4). Using the production elasticity of 0.2, this drop will bring 3.2% reduction in wheat production, which will cost farmers about PKR18.5 billion through lower sales.

[8] We assume here that the subsidy given on fertilizer processing (calculated in a later section) is completely passed on to the farmers, and reduction in subsidy on one kg of fertilizer will increase its price with equal amount. These assumptions will be tested in a following section.

4. Fertilizer Use Inefficiencies

Next, we explore the issue of inefficiency in fertilizer use. The negative implications of the misuse of fertilizer on long term sustainability of agricultural production have been pointed out by many researchers (Rashid et .al 2013; Sankaram and Rao 2002; Bumb and Baanante 1996). The process through which it happens is explained in Rashid et al, 2013 borrowed from United nation Environment Program. The misuse of fertilizer can result in environmental damage, soil degradation, increased deforestation and depletion of the natural resource base. Fertilizer use produces the most efficient results when fertilizer-responsive varieties are used, it's most dissolvable form is placed nearest to the root-zone of the plant in the right proportion and at the appropriate time, land is precisely prepared, and other inputs like water are available and applied in a timely manner. While general and site-specific recommendations for fertilizer use along these lines are available in Pakistan, few farmers pay much attention to them. The reasons for this are complex and range from exogenous constraints such as the unavailability of surface irrigation or rainfall, to more internal constraints such as unavailability of cash and labor, or the effort and drudgery associated with adhering precisely to recommended practices.

That said, fertilizer regulatory framework and institutions in Pakistan have tended to overlook the promotion of fertilizer practices that can improve its efficiency. For example, fertilizer subsidies have been primarily allocated to the promotion of urea despite the fact that use is quickly reaching its optimal level (as data suggests) while other nutrients—namely phosphorus and potassium—are both underutilized by farmers and overlooked by the subsidy policy. Meanwhile, extension agents tend to place limited emphasis on educating farmers on practices that can improve fertilizer-use efficiency such as timeliness of application, application methods, and appropriate combinations of different fertilizers.

The balanced use of fertilizer is very important in improving its efficiency. Haerdter and Fairhurst (2003) show that the recovery of N increases 16% within a traditional NP fertilization program to 76% in a balanced NPK application. Also, the recovery of P improves with balanced fertilization, namely from 1% using NP to 13% with NPK, and the recovery of K increases from 22% with a nitrogen potassium application to 61% with NPK fertilization. In Pakistan, the recommended ratio of N:P is 1:0.5 (NFDC 2014), while the optimal level for K is to be determined, as its use in the country is very small. However, the average use of P and the N:P proportion is far from optimal (Appendix 1). In fact the ratio of N:P has dropped from its peak of 1:0.37 in 2006-07 to 1: 0.20 in 2011-12. The ratio of N:K reached to its peak at 1:0.036 in 1985-86 but then gradually decreased to 1:0.007 in 2013-14. The unbalanced use of fertilizer, which deteriorates the release of all nutrients, including those used in abundance, has not only serious implications for nutrient-use efficiency and agricultural productivity but also for the environmental sustainability (Ali et al. 2014) and quality of produce.

Fertilizer use efficiency (defined as fertilizer nutrient use (in kg) divided by yield (in 100 kg per hectare) has declined in Pakistan for both wheat and cotton, as more fertilizer per unit of yield has been required over time (Figure 4). Possible explanations include increasing resource degradation, such as salinity, water logging, or decreases in organic matter and other nutrient contents in the soil, which we will discuss further below. In very few cases, since the Green Revolution, have technological changes such as the introduction of a new, more fertilizer-responsive variety or a change in soil and water management practices helped to address this problem.[9]

Production of 100 kg of wheat in 1980-81 required 4 kg of fertilizer nutrient, but by 2014, the same amount of wheat production required 7.9 kg of fertilizer nutrient. Similar trend is observed in cotton, although fertilizer-use efficiency in rice has remained largely unchanged.

As a result of declining fertilizer and water partial productivities, initially growth in total factor productivity (TFP) slowed down and later stagnated. Pakistan's TFP growth has gone from being amongst the best in the world in the 1980s to the lowest among such Asian comparators as China, India, and Sri Lanka (Ahmed and Gautam 2013).

Failure to use fertilizer appropriately can lead not only to inefficiencies at the farm-level, but also cause resource degradation at a wider scale (Ahmed and Gautam 2013; Ali and Byerlee 2002). Both over and underutilization of fertilizer and poor management of resources have not only damaged the environment but also soil resources (Conway and Pretty 1991; Bumb and Baanante 1996; NRC 1989). Research from other parts of the world has found that imbalance of Urea with P and K has resulted in excessive soil mining which caused yield stagnation.

[9] An exception is the introduction of a new Basmati rice variety which was introduced in 1996 after an increasing trend in fertilizer requirements were observed. This new variety led to a one-time jump in nutrient-use efficiency in rice, indicating the importance of continuous introduction of new varieties to maintain fertilizer-use efficiency (Ali and Flinn 1989).

(Concepcion 2007). In developed countries, applications of fertilizer nutrients have led to environmental contamination of water supplies and soils (Gruhn, Goletti, and Yudelman 2000). In Pakistan, the absence of farming practices that adjust nutrient applications to land resources has resulted in over-mining of several essential soil micronutrients such as phosphorus, iron, zinc, and potassium. The underutilization of micronutrients and reduction in the application of farm manure has decreased organic matter content to threateningly low levels (Figure 5).

5. Pricing Behavior and Government Interventions

5.1. Relative prices

This section examines the relative prices of fertilizer compared to major outputs, the extent of government interventions in the fertilizer industry, and the international and regional competitiveness to show the costs of these interventions.

Fertilizer prices—in real terms and relative to output prices—have evolved in Pakistan as follows. The grain output prices (weighted average of wheat and rice) increased more than the N price, implying that one unit of N purchases more grain in 2014 than in 1976. Similar decrease in real fertilizer prices is observed in other Asian countries like India, Bangladesh, and Indonesia, but the decline is lowest in Pakistan (Rashid et al 2013).

However, the opposite was true for P (Figure 6). In terms of input-output prices, farmers did not lose overtime and their profitability did not shrink due to increased nitrogen prices. However, the decline in fertilizer-use efficiency in Pakistan, as discussed earlier, does have detrimental effect on the profitability of fertilizer use.

5.2. Fertilizer policy

Fertilizer Policy of 2001 is built around the provision of a gas subsidy on the manufacturing of urea. It states:

> *"It is the intent of this policy to provide investors in new fertilizer plants in Pakistan a gas price that enables them to compete in the domestic market with fertilizer exporters of the Middle East so that indigenous production is able to support the agricultural sector's requirement by fulfilling fertilizer demand"*

Clearly, the policy encourages import substitution to meet demand from indigenous sources. Differential and low rates of gas were offered to new plants to encourage investment, which is currently being availed by Engro and Fatima Fertilizer. More importantly, the fertilizer policy ignores the distribution, demand and utilization sides, particularly of farmers and traders interests. Thus, the policy fails to offer incentives to enhance efficiency in fertilizer distribution and application, and encourage more efficient new products.

5.3. Fertilizer subsidies

5.3.1. Gas Subsidy

Public subsidies to the production and distribution of fertilizer have evolved overtime. The most significant subsidy comes through the provision of natural gas to urea producers. Approximately 16 percent of total gas consumed in the country was used by the fertilizer industry (HDIP 2013). The government subsidizes fertilizer manufacturing through a dual gas price policy: one price exists for the fuelstock applicable to the general use of gas, while another, which is far lower than the market price although closer to the Middle East price, is for gas used in fertilizer manufacturing. The subsidy is made available to all urea producers, although issues with access to gas for smaller producers do exist.[10]

In Pakistan, during the 2005-14 period, the feedstock prices were lower than the Middle East prices for three non-consecutive years and vice versa were true for the remaining five years. On average, the Pakistani and Middle Eastern prices are insignificantly different. On the contrary, these prices are substantially lower than the U.S. gas prices, which can be seen as proxy for international prices (Appendix 2). The fuelstock prices are comparable with that in other sectors of the Pakistani economy, except for energy sector where the prices are lower. Thus fuelstock prices can be taken as an opportunity cost for the feedstock gas.

We estimated the production subsidy on fertilizer manufacturing by taking the firm-level difference in fuelstock and feedstock prices and multiplying it with the respective amount of gas used in each firm. The total value of production subsidy during 2013-14 is estimated as PKR 48 billion. It has gradually increased from PKR 2.11 billion in 1995-96. While the prices

[10] The approval of plant installment from the Production Ministry was linked to the gas that could be supplied. Some smaller firms (with the exception of FFC, Fatima Fertilizer, EFL and AgriTech) complained about facing 35-50 days of gas shortage in a year. No schedule of gas supply was provided, which deterred companies from making operational plans. This had increased their fixed and operational costs (Mr. Nadeem Tariq on August 15, 2013).

of fuel stock increased by over seven times, the growth in feedstock price was less than three times during the period. The difference in fuel and feed stock prices grew by more than 15 times and this multiplied by 1.4 times increase in feed gas consumption has resulted in over 22 times increase in gas subsidy over the period (Table 5).

There were clearly two upward shifts in the production subsidy trend shown in Table 5, one in 2002, when it jumped by 4 times and the other in 2008, when it increased by 1.7 times. The later jump overlapped with the start of the ongoing crisis of gas shortage in the country. Some shortage of gas to the expanded fertilizer sector, in terms of its availability in 2014 at the level of 2007, is apparent from the gas supply data to the industry in Table 5. However, more severe shortage was observed in cement industry where it declined about 39% and in power sector where 4% less gas was supplied since 2006. However, the effect of the gas shortage in the country on the fertilizer industry is obvious from its underutilized capacity.[11]

was sourced until 2010 (after which prices were constant irrespective of the gas field) and on the installation date of the plant. The largest beneficiary of the subsidy was Fauji Fertilizer, which received a subsidy of PKR 29 billion in 2011-12 (Table 6).

5.3.2. Distribution Subsidy

In addition to domestic production subsidies, the government subsidizes the importation and distribution of fertilizers in an attempt to maintain the domestic prices at a reasonable level. NFML intervenes in the market when the difference in domestic and international prices becomes significant and domestic supply falls short of demand, and does so by importing higher-priced fertilizer and selling it at the lower domestic price (NFML 2013). Normally, this intervention is limited to imported urea, but for the first time ever in 2007-09, the government intervened in the DAP market through a subsidy on imported DAP.[12] Beginning in 2014, the government allowed the private sector to import urea and sell it at the domestic price, while the NFML covers the price difference including transportation and handling charges.[13] Either way, NFML's intervention in the market is costly for the government (Table 7).

[11] Capacity expanded due to new plants of Engro in 2010 and capacity enhancement of FFC in 2009.
[12] The government has also announced the subsidy on DAP sales for 2014-15, however, as of now no clear distribution mechanism for the subsidy has been defined. (Khan 2014)
[13] However, the SOPs for the mechanism have not been developed yet.

The total production and distribution subsidy in fertilizer sector during 2013-14 amounts to PKR 53 billion (Appendix 3), which is about 20% of the existing fertilizer price in PKR per tonnes, 0.2% of the GDP and 4.6% of the annual development expenditure of the country.[14] The fertilizer subsidy is approximately 7 times[15] of R&D expenditure in the agriculture sector during 2013-14, the latest year when such expenditure data are available.

In order to conduct a further analysis of the benefits of the subsidy to the farmers, we utilize the data discussed above to compare what international price would have been if the production subsidy was removed from the international prices with the actual domestic retail price. The rationale behind this analysis is that if the domestic price was higher than the international price sans the subsidy, it might be more effective to subsidize imports rather than domestic production.

5.4. Taxes

5.4.1. General Sales Tax

The government also intervenes in the fertilizer market through its tax policies. In 2001, the Federal Government exempted urea from the general sales tax (GST), but withdrew the exemption in 2011, along with the taxes on other agricultural inputs that had been exempted. This government charges the tax at the factory gate and the manufacturers pass it on to the farmers at the retail level through sale agents. If all such proceeds are honestly submitted, we estimate the total GST revenue (offtake of urea and DAP multiplied by their respective price and the tax rate) from urea and DAP at approximately PKR 50 billion during 2013-14. It looks that government treasury has even out its loss in revenue on production subsidy with GST collections, although it is unfair to farmers because, as discussed in the next section, little production subsidy is passed on farmers while they pay 100% GST.

5.4.2. Gas Input Development Cess (GIDC)

Government tried to impose 20% GIDC on all gas consumers, other than domestic consumers, in 2013. However, Peshawar High Court struck down the cess in 2014 and the decision of PHC was maintained by the Supreme Court of Pakistan (SCP) in its decision on 22nd August 2014

[14] Estimated at annual development budget of PKR 1159 billion, and GDP of 26001 billion (Economic Survey of Pakistan 2013014)
[15] 8 billion PKR

(Supreme Court of Pakistan 2014). In response, Government of Pakistan issued an ordinance in October 2014 to impose GIDC since 2011 to overcome legal lacuna in the earlier bill. The industry again went to the court and got the decision in their favor. In any case, even if the GIDC is implemented, it will bring the fuelstock prices closer to international prices, while the difference between fuelstock and feedstock prices will continue.

6. Competitiveness and Profit of the Industry

6.1. International competitiveness

Given the extent of subsidies found in Pakistan's fertilizer industry, it is worth asking whether the industry is actually competitive in the international market for fertilizer. One way to evaluate the competitiveness of Pakistan's fertilizer sector is to compare international and domestic prices both with and without subsidies. Although the government provides a distribution subsidy on imported urea, we assume that such subsidies stabilize the domestic price but leave them unchanged. Thus direct comparison of domestic prices without the production subsidy and international prices provides an indication of competitiveness in the domestic fertilizer sector.

The domestic price of urea (with the gas subsidy) remained higher than the FOB international prices until 2004 with the trend reversing afterwards (Figure 7). Until 2004, fertilizer import required subsidies because the local prices were not high enough to cover the shipment, loading/unloading, and in-country transport costs. During 2005-13 the domestic prices were lower and mostly the difference in the two was large enough to cover port and other handling charges thus creating opportunity for export especially to the neighboring countries for which transportation costs may be lower. This opportunity is unlikely to be explored in the presence of subsidy so long as domestic demand remains unmet. Until then, exports will exist primarily through informal smuggling channels to Afghanistan.[16] Additionally, export of subsidized fertilizer is just like financing the importing country farmers.

The trend once again reversed during 2013-14 when domestic prices became higher than the international prices despite gas subsidy on manufacturing indicating that the sector has once

[16] The incentive to smuggle urea to India does not exist because of India's higher subsidy rates: India's retail nitrogen prices with subsidy remained far lower than those in Pakistan throughout the period 1995-2012.

again become uncompetitive with respect to the international market.[17] Again domestic prices are not allowed to rise enough to cover the freight, import, and in country distribution charges so that imports remained blocked.

So what happens when we make the same comparisons without the gas subsidies? To examine this, we adjust the domestic price of urea to account for the gas subsidy by adding the per-unit subsidy to the price. Our analysis indicates that the domestic, unsubsidized, price of urea remained higher than the international price during 1996-2004, but afterwards during 2005-11 it became almost equal to the international price, except for two years 2007-09 when international prices reached their peak. During 2011-14, the trend reversed again and domestic prices became higher than the international prices. This suggests that during 1996-2004 and during the last three years, removal of gas subsidy would have made urea producers uncompetitive in the international market.[18] During the last twenty years, fertilizer manufacturing sector without subsidies was competitive with the international market for only six years.

When fertilizer prices are compared between India and Pakistan keeping subsidy intact in both countries, Indian prices were far lower than Pakistani prices, suggesting higher subsidy at the retail level in India (Figure 8).

The domestic phosphate prices followed the international price trend as the former remained higher than the later with the difference almost equivalent to transport and shipping cost, except during the peak international price period when government provided subsidy on phosphate fertilizer (Figure 9). However, this trend has changed since 2010, when domestic prices are much higher international prices and the gap has increased overtime. This may indicate increased price manipulation on the part of DAP manufacturers and importers.

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[17] The encouraging fact of this price setting was the shocks absorption in international fertilizer prices during 2007 and 2008 without any panic in the domestic market.

[18] Our analysis shows that Pakistan is not competitive with international market, while the CCP (2010) and IRG (2011) studies concluded the reverse. The conclusion in both of these studies is based on 2008 and 2009 international and local price situation, while our conclusion is based on the period 1995-2012. In our study, the normalized prices, after adding back the subsidy in domestic prices, are also lower than international price during 2007, 2008 and 2009.

6.2. Who benefits from Production Subsidies

How much of the production subsidies are passed on varies from year to year depending upon the difference between local and FOB prices (both with subsidy and GST). To make both the prices comparable, we added subsidy and GST in international prices (Table 8).

The positive values indicate the years in which local prices remained higher than the international prices after accounting for the subsidy and GST in the later indicating that the manufacturers fail to transfer all the subsidies to farmers, and the vice versa is true for the years with negative values. The values are especially negative for the years 2007 and 2008 when international prices were extremely high.

The difference is positive for the last year, 2013-14, suggesting that the industry got more in terms of subsidy than it returned. Just in 2013-14, the difference in prices multiplied by the production level was over Rs.46 billion. It implies that fertilizer prices during the year would have been 21% cheaper than the existing market prices had all the subsidies manufacturer received on feed gas would have been passed on to farmers. Summing up all values in the last column of Table 8 over the period of 1995-2014 gives us a positive value of PKR 49 billion, the money fertilizer industry owes to the farmers.

To see the cost of the fertilizer subsidy policy to the society, we made both the domestic and international markets free of any subsidy. But we took the retail, instead of wholesale domestic prices, CIF rather than FOB international prices, added the unit cost of the sum of production and distribution subsidies in domestic retail prices which was calculated as total subsidy divided by total fertilizer offtake not just domestic production. However, we maintain GST on both domestic and international prices and add distribution charges into the international prices (Figure 10).

Again for the last year, the domestic price remains higher than the international price, both are as defined in this section. Only for two years, the domestic prices are significantly lower than the international prices. Adding up the difference between the domestic prices and international prices (as defined in this section) over the whole period gave us a positive cost of subsidy of PKR 49 billion. This implies that we allow the fertilizer sector to consume 16% of our very scarce resource, gas, and in return did not get any benefit over the long-run. If entire fertilizer would have been imported during the whole period without any subsidy on the domestic fertilizer, the nation would have saved 16% of the gas as well as PKR 49 billion given away in subsidies, including the cost of the fertilizer price hike during 2009 and 2010. The domestic fertilizer prices would not have been significantly different than already was the case except for the two years when fertilizer prices were extraordinary high. It has been shown that the transferring gas saved from fertilizer sector to energy sector would have far reaching positive implication on the poverty in rural areas.

6.3. Industry Profit

One logical question emerging from the above discussion is "How have the industry's profit behaved since the increase in gas subsidy in 2008, which has been accompanied by insufficient gas supply to the industry". In order to analyze this further we utilize profit and loss statements (from industry annual reports) which decompose net sales from fertilizer into various cost items during for the period 2003-2012.[19]

The results depicted in Figure 11 indicate that since 2008, the share of raw material costs increased from 19% to 38% of total costs. However, this has been accompanied by an increase in the profit margin from 23% in 2003 to 30% in 2013, with a peak of 42% in 2011 (Table 9). However, it is not clear if this increase in industry profit percentage is due to improvement in the efficiency of the industry depicted by the decrease in sales costs or due to shortage of gas which resulted in a sharp increase in prices as both phenomena happened simultaneously since 2008. More analysis is needed to detach the effect of these phenomena on industry profit.. This will be done in one of the following sections.

Additionally to gain perspective on these figures we compare the profitability of these two main players in Pakistan's fertilizer market with those of companies in the region. Table 10 from the competition report indicates that the Return on Equity during the same time (2004-2008) for these two firms was much higher, estimated at approximately at 38%[20] and has grown much higher since.

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[19] . We completed the series only for FFC and FFBL, which cover over 50% of fertilizer industry. The consistent overtime data for the fertilizers Engro-firms another big player in the industry, were not available.

[20] The CCP estimated ROE for the Pakistani fertilizer industry at 33%, slightly different from our estimates of 38% across the same period because it included all firms in the sector while ours included just FFC & FFBL.

A possible explanation at least with reference to India is that gas prices for feedstock are provided at a relatively higher rate to Indian firms and the large chunk of the subsidy is provided at the retail level in the form of a price ceiling.

7. Policy Recommendations and Conclusions

Historically, Pakistan has offered a favorable setting for growth in fertilizer uptake and increased agricultural production. The rich alluvial soils, an extensive canal irrigation system supplemented by tube wells, and the historically rapid adoption of fertilizer-responsive wheat and rice varieties have created conditions to generate rapid increases in fertilizer demand beginning in the mid-1960s. On the supply side, Pakistan's perceived large natural endowment of gas aided in the rapid construction of a domestic fertilizer industry, because, at that time, policy makers thought sufficient gas existed. That perception has proved to be false as evidenced by the serious shortage of gas in the country and gas fields used in fertilizer processing will exhaust in about 14 years in 2029 (IRG 2011).

However, the general policy emphasis on building domestic production capacity and promoting urea use among farmers occurred at the expense of more balanced use of other nutrients, such as phosphate and potassium, resulting in a long-term trend of declining fertilizer-use efficiency and growing resource degradation. Meanwhile, policies to encourage the industry have resulted in a high concentration of capacity in the hands of a small number of manufacturers and evidence of anti-competitive behavior is emerging (CCP 2010). Despite policies to encourage the industry and government's effort to control price shocks through subsidies, the price of phosphorus remains highly dependent on price fluctuations in international markets due to Pakistan's high dependence on imported DAP.

Pakistan's fertilizer industry, valued at an estimated PKR 3.74 billion in 2013-14, has been operating at approximately 75 percent of capacity in recent years, despite subsidies on both production and distribution. Adding these two sources together, the total subsidy burden comes to about PKR 53 billion, or 14 percent of the fertilizer market value in 2013-14. The subsidies are highly skewed toward urea, while other nutrients remain subject to international price trends.

Various policies, regulations, and organizations oversee the pricing, quality, promotion, manufacturing, importation, and distribution of fertilizer in Pakistan. The elaborate marketing rules provided sweeping and discretionary powers to controllers (extension wings of provincial agricultural department), which, according to the regulations themselves, included stopping or limiting sales, sealing stocks and fixing prices, among others. Such powers, along with the control of the gas supply and prices, limited entry into fertilizer processing and marketing, inducing an oligopolistic cartel (CCP 2010, and our analysis).

The NFDC brings various stakeholders together for issue resolution and policy formulation. However, less attention appears to be given to policies that promote a balanced use of fertilizer and environmentally friendly products and efficient application methods. The provincial soil fertility research institutes do a good job in analyzing farmers' soil and water samples to evaluate the nutrient and productivity status of their lands, and thus to advise them in adjusting nutrient application according to site-specificity. However, plot level data collected by PSSP suggested that this had almost no impact, as we found that farmers did not adjust fertilizer use enough to be consistent with the SFRI recommendations, as such using urea and phosphate fertilizers in a 2:1 ratio, or applying more fertilizer on poor and saline soils.

Basic changes in the philosophy and direction in fertilizer processing, marketing and use are required to exploit the full potential of the industry without damaging the environment and to safeguard the sustainability of agricultural resources. Hence, we make a series of recommendations in the next paragraphs.

With respect to fertilizer manufacturing, the policy emphasis should move away from expansion based on subsidies to full utilization and modernization of existing capacity, thereby improving efficiency and preparing the industry for an era with fewer subsidies and more international competition. Our findings also suggest that the production subsidy on gas should be removed because it will not harm farmers or consumers to a great extent if free import of urea is allowed and combined with other policy options. It will also prepare the industry for an era of sever gas shortage from within the country, going to happen in any case within the next 15 years, thus enabling it to substitute domestic gas with imported LNG.

While it is tempting to leave this adjustment process to the market, by lifting all subsidies and allowing unrestrained imports, the lack of infrastructure needed to deliver natural gas, both domestically and from imports, may make this unlikely to work in the medium term. (It may however, be an ultimate goal). Thus, the sector should be closely guarded with anti-trust laws, and approaches to distributing gas in ways closer to market outcomes, such as diverting more to efficient firms, need to be considered. As it is unlikely that pure market outcomes can be effective in the near term, a broad fertilizer policy should be considered to address issues of *all* stakeholders. A Fertilizer Board consisting of a broad group of stakeholders could help monitor the performance of the fertilizer sector, including pricing, import strategies, and other provisions of the policy.

The redesign of incentives for the industry needs to reflect several dimensions in the outlook for world and domestic fertilizer and natural gas markets. We compared domestic fertilizer prices without subsidies to that of international prices and found the former higher than the latter in most of the year, suggesting that the fertilizer industry did not have much option to sell its product in international markets. Also, a key issue here is the outlook for natural gas, which may disappear locally, and so questions to be examined carefully are whether Pakistan can continue to run its fertilizer plants with imported gas, or whether importing fertilizer directly makes more sense. Given the limited natural gas, it seems unlikely for Pakistan to become an exporter, even though the CCP analysis makes some suggestions along these lines.

On the fertilizer marketing side, the policy focus should change from controlling the fertilizer markets, the existing norms, to freeing the market which will improve marketing efficiency. Firstly, laws need to be rationalized and regulators should only be allowed to interfere within clear parameters of market failure. Secondly, anti-trust laws should be enforced in marketing at district levels as well, and standards for animal manure, micronutrients, PGPR, etc. should be developed and strictly enforced.

In terms of fertilizer promotion among farmers, our results clearly showed that future policy and investment emphasis should be on improving fertilizer-use efficiency rather than promoting higher per hectare use of fertilizer. This will require assessments of the capacity of agricultural extension and soil fertility labs to provide more advanced consulting to farmers. For example, can there be computer based models developed to synchronize fertilizer use with resource quality in line with the plot-specific needs? These could give efficient fertilizer application methods such as placement, fertigation, or machinery that would be standardized for local conditions. Other ways to enhance efficiency, which can be examined for their economic value, include more efficient fertilizer materials, such as PGPR, slow release fertilizer, animal and chicken manure, and micronutrients and more efficient crop varieties, especially for barani areas.

Finally, issues of inventory management, fertilizer stocks, and the relationship of the domestic industry to the international market should be considered in further research. Analyses of reasons that intermittent shortages of fertilizer occur would be valuable, and causes might be due to poor import planning or allocation issues of public sector supplies at the local level. Questions that might also be considered include the costs and usefulness of fertilizer stocks (perhaps held in the private sector but paid for by the government) to help counter sudden international shocks in fertilizer prices, strategic trade negotiation to minimize fertilizer subsidies jointly with India rather than entering in fertilizer-subsidy war with India, which is not beneficial to either country.

In summary, there is opportunity to strengthen the fertilizer industry in Pakistan and, in turn, strengthen the prospects for sustainable agricultural production with continued productivity growth. However, the policy and investments required moving the entire fertilizer sector—manufacturers, dealers, farmers, policymakers, and the civil service—in the right direction are challenging.

Bibliography

Abedullah, A., and M. Ali. 2001. “Wheat self-sufficiency in different policy scenarios and their likely impact on producers, consumers, and public exchequer.” *The Pakistan Development Review*, 203-224.

Agritech. 2014. Our Company. Accessed July 25. http://www.pafl.com.pk/our-company.

Ahmed, A. S., and M. Gautam. 2013. *Increasing agricultural productivity.* Pakistan Policy Note 6. Washington DC: World Bank.

Alhashim, I. J., 2013. *Policies Effects of Wheat Production on Groundwater Usage in Saudi Arabia*. Colorado State University, Fort Collins, Colorado.

Ali, M. 1990. “The Price Response of Major Crops in Pakistan: An Application of the Simultaneous Equation Model.” *The Pakistan Development Review*, 305-325.

Ali, M., Ahmed, F., Channa, H., Davies, S., 2014. *Pakistan's Fertilizer Sector: Structure, Policies, Performance and Impacts.* Working Paper, Pakistan Strategy Support Program, International Food Policy Research Institute, Washington, DC. (forthcoming)

Ali, M., and D. Byerlee. 2002. “Productivity Growth and Resource Degradation in Pakistan's Punjab. A Decomposition Analysis.” *Economic Development and Cultural Change* 50 (4): 839-863.

Ali, M., and J. C. Flinn. 1989. “Profit Efficiency among Basmati Rice Producers in Pakistan Punjab.” *American Journal of Agricultural Economics* 71(2): 303-310.

ASTI-PARC (Agricultural Science and Technology Indicators and Pakistan Agricultural Research Council). 2012. Country Note July 2012. Islamabad and Washington DC.

Ayub, M., M. Nadeem, M. Sharar, and N. Mahmood. 2002. “Response of maize (Zea mays L.) fodder to different levels of nitrogen and phosphorus.” *Asian J. Plant Sci* 1(4): 352-355.

Ayub, M., A. Tanveer, M. A. Choudhry, M. Amin, and G. Murtaza. 1999. “Growth and yield response of mungbean (Vigna radiata L.) cultivars to varying levels of nitrogen.” *Pak. J. Biol. Sci* 2(4): 1380-1387.

Ayub M. A. 1975. “An Econometric Study of the Demand for Fertilizers in Pakistan.” *The Pakistan Development Review*, 135-141.

Bumb, B., and C. Baanaate. 1996. *The role of fertilizer in sustaining food security and protecting the environment in 2020.* 2020 Vision Discussion Paper 17. Washington, DC: International Food Policy Research Institute.

Byerlee, D., and Siddiq, A. 1994. “Has the Green Revolution been sustained? The quantitative impact of the seed-fertilizer revolution in Pakistan revisited.” *World Development* 22(9): 1345-1361.

CCP (Competition Commission of Pakistan). 2010. *Competition Assessment Study of the fertilizer sector in Pakistan.* Islamabad: Competition Commission of Pakistan, World Bank.

Chaudhary, M. I., J. J. Adu-Gyamfi, H. Saneoka, N. T. Nguyen, R. Suwa, S. Kanai, H. A. El-Shemy, et al. 2008. “The effect of phosphorus deficiency on nutrient uptake, nitrogen fixation and photosynthetic rate in mashbean, mungbean and soybean." *Acta Physiologiae Plantarum* 30(4): 537-544.

Chaudhry, M. G., and M. A. Javed. 1976. "Demand for Nitrogenous Fertilizers and Fertilizer Price Policy in Pakistan." *The Pakistan Development Review*, 1-7

Conway, G. R., and J. N. Pretty. 1991. *Unwelcome harvest: Agriculture and pollution*. London: Earthscan Publications Ltd.

Concepcion, R. N. 2007. *Sustainable Fertilization Management of Croplands: The Philippines Scenario.* Bangkok: Food and Agriculture Organisation. http://www.fao.org/docrep/010/ag120e/AG120E16.htm

Din, M. S., and H. S. Jafry. 2007. *Pakistan Fertilizer Sector Review*. Karachi: IGI Securities.

DoP (Department of Fertilizer). 2012. *Indian Fertilizer Scenario 2012.*New Delhi: Department of Fertilizer, Ministry of Chemicals and Fertilizers, Government of India.

FAO (Food and Agriculture Organization of the United Nations). 2014. Food Balance / Food Balance Sheets. Accessed July 25. http://faostat3.fao.org/faostat-gateway/go/to/browse/FB/FBS/E.

FFC (Fauji Fertilizer Company Limited). 2014. About Us. Accessed July 25. http://www.ffc.com.pk/company-profile.aspx

Gruhn P., F. Goletti and M. Yudelman, M. 2000. *Integrated Nutrient Management, Soil Fertility, and Sustainable Agriculture: Current Issues and Future Challenges.* Food, Agriculture, and the Environment Discussion Paper 32. Washington, DC: International Food Policy Research Institute.

Haefele, S., M. Wopereis, M. Ndiaye, S. Barro, and M. O. Isselmou. 2003. "Internal Nutrient Efficiencies, Fertilizer Recovery Rates and Indigenous Nutrient Supply of Irrigated Lowland Rice in Sahelian West Africa." *Field Crops Research* 80(1): 19-32.

Hannah, L., and J. A. Kay. 1977. *Concentration in Modern Industry: Theory, Measurement and the UK Experience.* London: Macmillan.

Harrington, D. and R. Dubman. 2008. Equilibrium Displacement Mathematical Programming Models: Methodology and a Model of the U.S. Agricultural Sector, Technical Bulletin No. (TB-1918) 61 pp, Economic Research Service, United States Department of Agriculture, February 2008.

HDIP (Hydrocarbon Development Institute of Pakistan). 2013. *Pakistan Energy Yearbook 2012.* Islamabad: Hydrocarbon Development Institute of Pakistan, Ministry of Petroleum and Natural Resources, Government of Pakistan.

Hudson, D., and D. Ethridge. 2009. *The Pakistani cotton industry: impacts of policy changes.* Lubbock: Texas Tech University.

Hussain, A. 2011. Seed Industry in Pakistan. Paper presented at World Bank Roundtable Discussion on Agriculture and Water, Islamabad, Pakistan, March 10–11.

International Food Policy Research Institute (IFPRI), and Innovative Development Solutions (IDS). 2014. Pakistan Rural Household Panel Survey (RHPS), 2012. Washington, DC:

International Food Policy Research Institute (IFPRI). http://dx.doi.org/10.7910/DVN/28558.

IRG (International Resource Group) (2011). Pakistan Integrated Energy Model (Pak-IEM) (Final Report Volum II, Policy Analyses Report) prepared for Asian Development Bank and Ministry of Planning and Development, Government of Pakistan, ADB TA-4982 PAK.

Kaneda, H. 1969. "Economic implications of the "Green Revolution" and the strategy of agricultural development in West Pakistan." *The Pakistan Development Review*, 111-143.

Khan S. A. 2014. *DAP sales plunge on subsidy issue.* Dawn, July 12.

Li, S., Yaoqi Z., Denis N., John D. W., Yeifei Z., and Xian X., 2014. "Fertilizer Industry Subsidies in China: Who Are the Beneficiaries?" *China Agricultural Economic Review* 6(3).

Leonard, P. L. *A note on the demand for fertilizer in West Pakistan.* 1969 The Pakistan Development Review : 419-425.

Mahmood-ul-Hassan, M., A. Rashid, and M. S. Akhtar. 1993. "Phosphorus requirement of corn and sunflower grown on calcareous soils of Pakistan." *Communications in Soil Science & Plant Analysis* 24(13-14): 1529-1541.

MNFAL (Ministry of Food, Agriculture and Livestock). 2007a. *Agricultural Statistics of Pakistan Volume IV (1981-1990).* Islamabad: Ministry of Food, Agriculture and Livestock, Government of Pakistan.

MNFAL (Ministry of Food, Agriculture and Livestock). 2007b. *Agricultural Statistics of Pakistan Volume V (1991-2000).* Islamabad: Ministry of Food, Agriculture and Livestock, Government of Pakistan.

MNFAL (Ministry of Food, Agriculture and Livestock). 2007c. *Agricultural Statistics of Pakistan Volume III (1971-1980).* Islamabad: Ministry of Food, Agriculture and Livestock, Government of Pakistan.

MNFSR (Ministry of National Food Security and Research). 2013. *Agricultural Statistics of Pakistan 2011-2012.* Islamabad: Ministry of National Food Security and Research, Government of Pakistan.

Mounter, S., G. Griffith, R. Piggott, R. Fleming, and X. Zhao. 2008. An Equilibrium Displacement Model of the Australian Sheep and Wool Industries, Economic Research Report No. 38, NSW Department of Primary Industries, Sheep Cooperative Research Center, University of New England, Armidale.

Muth, R. F., 1964. T"he Derived Demand Curve for a Productive Factor and the Industry Supply Curve." *Oxford Economic Papers*, 221-234.

Nazli, H., S. H. Haider, and A. Tariq. 2012. *Supply and demand for cereals in Pakistan, 2010-2030.* IFPRI Discussion paper 01222. Washington, DC: International Food Policy Research Institute.

NFDC (National Fertilizer Development Centre). 1998. *Pakistan Fertilizer Related Statistics*. Islamabad: National Fertilizer Development Centre, Planning Commission, Government of Pakistan.

NFDC (National Fertilizer Development Centre). 2002. *Pakistan Fertilizer Related Statistics.* Islamabad: National Fertilizer Development Centre, Planning Commission, Government of Pakistan.

NFDC (National Fertilizer Development Centre). 2008. *Pakistan Fertilizer Related Statistics.* Islamabad: National Fertilizer Development Centre, Planning Commission, Government of Pakistan.

NFDC (National Fertilizer Development Centre). 2014. Statistics. Accessed June 20. www.nfdc.gov.pk/stat.html.

NRC (National Research Council). 1989. *Alternative agriculture.* Washington, DC: National Academy Press.

PFL (Pakarab Fetilizers Limited). 2014. Company Overview. Accessed July 25. http://www.fatima-group.com/pakarabfertilizers/companyoverview.php

Piggott, R. R., 1992. "Some Old Truths Revisited." *Australian Journal of Agricultural and Resource Economics* 36 (2), 117-140.

Piggott, R. R., N. E. Piggott, and V. E. Wright 1995. "Approximating farm-level returns to incremental advertising expenditure: Methods and an application to the Australian meat industry." *American Journal of Agricultural Economics* 77(3): 497-511.

PPI (Pakistan Press International). 2012. *Gas shortage: Fertiliser manufacturers claim losses of nearly Rs5b*. The Express Tribune, November 21.

Pritchett, J. G., S. P. Davies, R. Fathelrahman, A. Davies. 2010. Welfare Impacts of Rural to Urban Water Transfers: An Equilibrium Displacement Approach. In 2010 Annual Meeting, Agricultural and Applied Economics Association, Denver, Colorado, July 25-27.

Quddus , M. A., M. W. Siddiqi, and M. M. Riaz. 2008. "The demand for Nitrogen, Phosphorus and Potash Fertilizer Nutrients in Pakistan." *Pakistan Economic and Social* Review 46 (2): 101-116

Rashid, S., P. A. Dorosh, M. Malek, and S. Lemma. 2013. "Modern input promotion in sub-Saharan Africa: insights from Asian green revolution." *Agricultural Economics* 44: 705–721.

Sankaram A. and P. Rao. 2002. "Perspectives of Soil Fertility management with a focus on fertilizer use for crop productivity." *Current Science* 82(7): 797-807.

Shafi, M., J. Bakht, M. T. Jan, Z. Shah. 2007. "Soil C and N dynamics and maize yield as affected by cropping systems and residue management in North-western Pakistan.*" Soil and Tillage Research* 94(2): 520-529.

SFRI (Soil Fertility Research Institute). 2013a. *Fertilizer Response Curve Studies.* Lahore: Soil Fertility Research Institute, Punjab Agriculture Department, Government of Pakistan.

SFRI (Soil Fertility Research Institute). 2013b. *Nutrient Depletion over time.* Lahore: Soil Fertility Research Institute, Punjab Agriculture Department, Government of Pakistan.

SSD-PARC (Social Sciences Division-Pakistan Agricultural Research Council). 1980. Agro ecological region of Pakistan, 1-58.

Sumner, D. A. and M. K. Wohlengat. 1985. “Effects of an Increase in the Federal Excise Tax on Cigarettes.” *American Journal of Agricultural Economics* 67 (2): 235-242.

Sumner, D.A. (2005): Boxed In: Conflicts Between U.S. Farm Policies and WTO Obligations. Trade Policy Analysis No. 32. Washington, D. C.: CATO Institute.

Ul Hassan, M., and P. Pradhan. 1998. Coordinated services for irrigated agriculture in Pakistan. Proceedings of the IWMI National Workshop, Lahore, Pakistan, October 29-30.

und Anwendung, M. 1999. “Utilising Equilibrium-Displacement Models to Evaluate the Market Effects of Countryside Stewardship Policies: Method and Application.” *Die Bodenkultur* 143(50): 2.

Wohlgenant, M. K. 1993. “Distribution of Gains from Research and Promotion in Multi-Stage Production Systems: The Case of the U.S. Beef and Pork Industries.” *American Journal of Agricultural Economics* 75: 642–651

Zuberi, H. A. 1989. “Production function, institutional credit and agricultural development in Pakistan.” *The Pakistan Development Review*, 43-55.

Table 1: Operating capacity of selected firms by type of fertilizer (%), 2013-14

Firm	Urea	DAP	NPK	NP	CAN	Phosphate Fertilizer	Total
Fauji Fertilizers*	116.6	-	-	-	-	-	116.6
Engro	80.3	-	40.0	87.5	-	-	77.8
Fatima	71.4	-	-	101.7	124.4	-	95.5
Pak Arab	5.8	-	-	23.1	28.2	-	22.7
Agri Tech	31.7	-	-	-	-	-	31.7
Dawood Hercules	9.7	-	-	-	-	-	9.7
Fauji Fertilizers	38.1	102.8	-	-	-	-	73.7
Others	-	-	-	-	-	21.0	21.0
Total	78.0	102.8	40.0	63.8	76.3	21.0	75.3

Source: Authors' calculation based on MNFSR (2013).

Table 2: Fertilizer use by cropping region (kg/ha), 1990-91 to 2011-12

Cropping region	1990-91	1995-96	2000-01	2005-06	2010-11	2011-12	Annual growth rate (%)
Pakistan	**89**	**111**	**135**	**169**	**166**	**165**	**2.98**
Punjab	**90.7**	**114.9**	**107.4**	**150.7**	**158.7**	**157.4**	**2.66**
Barani	19.6	22.4	23.2	30.3	58.5	36.1	2.93
Mixed crop	70.0	103.1	94.1	134.2	136.52	137.2	3.26
Wheat-cotton	137.7	175.2	148.9	209.4	213.5	210.0	2.03
Wheat-rice	70.4	90.9	83.7	134.7	160.7	157.1	3.90
Wheat/gram-mungbean	67.9	66.7	80.4	107.2	112.2	115.4	2.56
Sindh	**88.0**	**134.7**	**154.9**	**208.8**	**246.9**	**296.5**	**5.96**
Mixed crops	136.3	123.0	151.3	179.1	154.6	325.8	4.24
Wheat-cotton	60.4	161.6	182.6	233.6	365.1	363.9	8.93
Wheat-rice	100.4	107.1	121.8	201.5	167.6	185.0	2.95
Khyber Pakhtunkhwa	**59.4**	**70.0**	**90.1**	**161.1**	**156.2**	**172.7**	**5.21**
Barani	16.8	20.1	24.9	129.4	110.9	69.2	6.99
Mixed crops	72.0	88.3	108.6	169.7	166.6	199.3	4.97
Baluchistan	**28.7**	**31.9**	**65.0**	**299.5**	**148.2**	**215.2**	**10.06**
Wheat-cotton	31.6	22.4	40.8	1496.8	65.4	109.2	6.09
Horticulture	26.8	43.1	100.5	325.44	256.0	352.6	13.06

Source: Authors' calculations based on NFDC (2008), NFDC (2002) and NFDC (1998)

Notes: All districts having a common major Kharif season (May-October) crop in a province, like cotton, rice, or gram-mungbean are merged into separate cropping regions. For example, the wheat-cotton region implies that the region is dominated by the cotton crop in the kharif season. The district where no crop dominates in kharif is called a mixed cropping region. Moreover, all districts where 85% of the area depends on rain for irrigation in a province are categorized as barani regions. In Baluchistan, horticulture regions consist of districts where horticulture cultivation in the valleys dominates. The data for 2010-11 and 2011-12 were collected from NFDC headquarters in Islamabad.

Table 3: Fertilizer use (kg/ha) in microenvironments, 2012

Type	N	P	K	Overall	Share of farmers (%)
Fertilizer nutrient use	120.94	38.24	0.54	159.72	87.00
	(1326)	(972)	(9)	(1326)	
Soil type					
Sandy and sandy loam	117.56	37.12	0.37	155.05	89.73
	(437)	(322)	(3)	(437)	
Loam	121.48	38.56	1.01	161.06	90.25
	(426)	(318)	(5)	(426)	
Clay and clay loam	126.30	39.34	0.27	165.90	96.46
	(463)	(334)	(1)	(463)	
Land quality					
Highly fertile	127.44	39.42	1.14	168.00	93.12
	(230)	(172)	(2.)	(230)	
Moderate fertile	121.66	38.47	0.43	160.55	91.92
	(1069)	(788)	(7)	(1069)	
Poor/very poor fertile	77.70	23.83	0.00	101.54	93.10
	(27)	(14)	(0)	(27)	
Farm size					
Less than 12 acres	122.84	37.37	0.56	160.77	92.92
	(1155)	(824)	(7)	(1155)	
More than 12 acres	114.91	44.44	0.46	159.80	61.07*
	(171)	(150)	(2)	(171)	

Source: Authors' estimates based on IFPRI/IDS (2014)

Note: The categories are based on the definitions used in IFPRI/IDS (2014)

*This low number is due to a high number of missing observations for this category. Parentheses represent frequencies of plots in each category.

Table 4: Marginal value-cost ratio at different levels of fertilizer use with and without subsidy in wheat production in Pakistan during 2011-12

Nitrogen level (kg/h)	MP (Kg of wheat/kg of fertilizer)	MP*PR (PKR/Kg of fertilizer)	Cost of nitrogen with subsidy (PKR/kg)	Subsidy on nitrogen (PKR/kg)	Cost of nitrogen without subsidy (PKR/kg)	MVCR (with subsidy)	MVCR (without subsidy)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
70	6.0	137.3	74.7	18.1	92.8	1.8	1.5
100	4.5	103.8	74.7	18.1	92.8	1.4	1.1
120	3.5	81.4	74.7	18.1	92.8	1.1	0.9
126	3.2	74.7	74.7	18.1	92.8	1.0	0.8

MP = Marginal productivity of fertilizer in column (2) derived from the estimated production function by taking its first derivative and evaluating it at the mean value of all other inputs, where PR is the price of output in (3).
VCR = Value cost ratio in column (7) and (8) are estimated as value of marginal productivity in column (3) divided by per unit cost of fertilizer with subsidy in column (4) and without subsidy in column (6), respectively.

Table 5: Trends in Production Subsidy during 1995-2014

Year	Gas Prices (Rs/mcf) Feed stock	Fuel-Stock	Difference in Price	Gas consumed (billion mcf)	Total production Subsidy* (Billion PKR)
1995-96	44.2	67.6	23.4	90.2	2.11
1996-97	47.7	77.7	29.9	90.0	2.69
1997-98	52.7	77.7	25	88.2	2.20
1998-99	49.5	80	30.5	100.6	3.07
1999-00	56.9	88.1	31.2	105.7	3.30
2000-01	63.9	117.2	53.2	106.0	5.64
2001-02	70.8	95.6	24.7	110.0	2.72
2002-03	76.1	170.4	94.4	112.8	10.64
2003-04	79.6	175.7	96.1	116.1	11.16
2004-05	61.2	185.7	124.5	119.9	14.93
2005-06	110.8	229.2	118.4	124.2	14.71
2006-07	124.7	256.7	132.0	122.8	16.20
2007-08	124.7	256.6	132.0	128.1	16.90
2008-09	120.3	341.2	220.9	129.6	28.63
2009-10	132.3	360.4	228.1	140.5	32.05
2010-11	138.7	375.2	236.5	140.7	33.29
2011-12	161.8	492.4	330.6	135.0	44.62
2012-13	116.3	460.0	343.7	116.7	41.37
2013-14	123.4	488.2	364.8	128.3	48.04

Source: Authors' estimates based on HDIP (2013)

*The production subsidy on fertilizer is calculated as the difference between fertilizer feedstock and fuel-stock prices per million British thermal units (mmbtu), multiplied by the amount of feedstock gas used by each firm and then aggregated for the sector. The conversion from MMCFT to MMBTU was done at the rate of 1 MMCFT=950 MMBTU for SSGCL and SNGPL and at the rate of 1 MMCFT=750 MMBTU for Mari Gas. Gas consumption figures for the sector were obtained from HDIP (2013), NFDC(1998), NFDC(2008), NFDC(2014),

The subsidy to each firm depended upon the gas field from which their gas

Table 6: Subsidy on fertilizer manufacturing through natural gas pricing, 2013-14

Fertilizer firm	Prices (PKR/MMBTU)		Gas consumption[1]	Subsidy[2]
	Fuel Stock	**Feed stock**	**Billion MBTU**	**(Million PKR)**
SSGCL				
Fauji Fertilizer-Bin Qasim	488.23	123.41	12325	4497
SNGPL				
Pak Arab	488.23	123.41	3034	1107
Dawood Hercules	488.23	123.41	1446	527
Pak American	488.23	123.41	3367	1228
Engro Chemicals ENVEN	488.23	73.17	3729	1548
Mari Gas Limited				
Engro Chemicals	488.23	123.41	28931	10554
FFC	488.23	123.41	55044	20081
Fatima Fertilizer	488.23	73.17	20468	8495
Total			128344	48038

Source: Authors' calculation based on NFDC (2014)
Notes: The consumption of gas to each firm was reported after adjusting for the difference in pressure of each field. For the procedure to estimate production subsidy on fertilizer, see footnote in Table 5.

Table 7: Subsidy on fertilizer distribution (Billion PKR)

Year	Subsidy on Imported Urea (Billion PKR)	Imports of Urea (000 tonnes)	Subsidy on other P & K Fertilizer (Billion PKR)	Total distribution Subsidy
2004-05	1.85	307	-	1.85
2005-06	4.54	825	-	4.54
2006-07	2.05	281	13.7	15.75
2007-08	2.74	181	17.4	20.14
2008-09	17.23	905	26.50	43.73
2009-10	12.87	1524	0.50	13.37
2010-11	8.41	694	0	8.41
2011-12	9.55	1075	-	9.55
2012-13	10.50	833	-	10.50
2013-14	4.53	1200	-	4.53

Source: Authors' calculation based on NFDC (2014).
Note: Subsidy figures for urea are calculated as import quantity multiplied by the difference between the international and domestic prices. The international is taken as the CIF price($ 30 freight charges) and is inclusive of GST. The figures for 2011--14 are collected from NFDC in Islamabad.
The subsidy for P and K is taken from NFDC (2008, 2014).

Table 8: Subsidy not passed onto farmers

Year	International prices of urea (FOB, inclusive GST) $/ton	Subsidy ($/ton)	International prices (FOB, inclusive GST minus Subsidy)	Domestic Prices of urea including GST & subsidy ($/ton)	Subsidy not passed ($/ton)	Total Urea produced (000 tonnes)	Subsidy not passed on (Billion PKR)
1995-96	208.2	21.38	186.819	169.80	-17.016	3681	-2.10
1996-97	171.6	23.62	147.981	173.87	25.894	3655	3.69
1997-98	105	17.66	87.340	159.27	71.935	3610	11.22
1998-99	79.35	21.03	58.325	147.89	89.569	3903	16.36
1999-00	84.9	17.98	66.922	125.17	58.245	4434	13.37
2000-01	110.2	41.05	69.152	124.23	55.083	4465	14.37
2001-02	99.35	55.38	43.974	128.28	84.311	4639	24.03
2002-03	115.5	58.03	57.468	140.51	83.046	4766	23.15
2003-04	153.15	46.87	106.284	146.25	39.961	4940	11.37
2004-05	226.95	46.73	180.220	156.37	-23.846	5159	-7.36
2005-06	231.6	45.65	185.948	169.74	-16.209	5383	-5.22
2006-07	264.4	90.19	174.211	173.83	-0.382	5276	-0.12
2007-08	399.15	62.57	336.579	187.38	-149.19	5463	-50.98
2008-09	404.1	68.67	335.432	191.60	-143.84	5504	-62.15
2009-10	263.1	117.02	146.078	192.36	46.281	5802	22.50
2010-11	356.2	83.29	272.914	244.44	-28.474	5743	-13.98
2011-12	459.75	94.21	365.538	389.18	23.644	5524	11.53
2012-13	450.333	86.89	363.447	350.41	-13.035	4909	-6.21
2013-14	367.965	82.94	285.030	361.68	76.654	5735	45.72

Source: NFDC (2014)

Table 9: Cost structure and profit (%) in fertilizer industry (FFBL & FFC) during 2003-13

Cost item/profit	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fuel & Power	12	10	10	11	11	10	10	10	7	7	7
Distribution cost	9	8	9	9	9	8	7	7	6	7	7
Raw material cost	19	29	28	28	30	71	32	35	32	40	38
Other cost of sale	37	27	28	30	23	-17	24	18	13	14	17
Operating Margin with subsidy	23	26	25	23	28	28	27	29	42	31	30
Operating margins less subsidy	-4.5	-1.3	-0.2	-0.5	1.4	1.2	1.5	7.2	19.5	Na*	Na*
Operating margins less 50% subsidy	9.2	12.2	12.4	11.1	14.6	14.5	14.1	18.2	30.8	Na*	Na*
Return on Equity (%)	25	30	36	39	44	41	53	63	92	66	66

Source: Authors' estimates based on data collected from company annual reports (FFBL 2005, 2006, 2008, 2010, 2012, 2014); (FFC 2004, 2006, 2008, 2010, 2012, 2014).
Notes: *Data for subsidy not available for the years 2012 and 2013

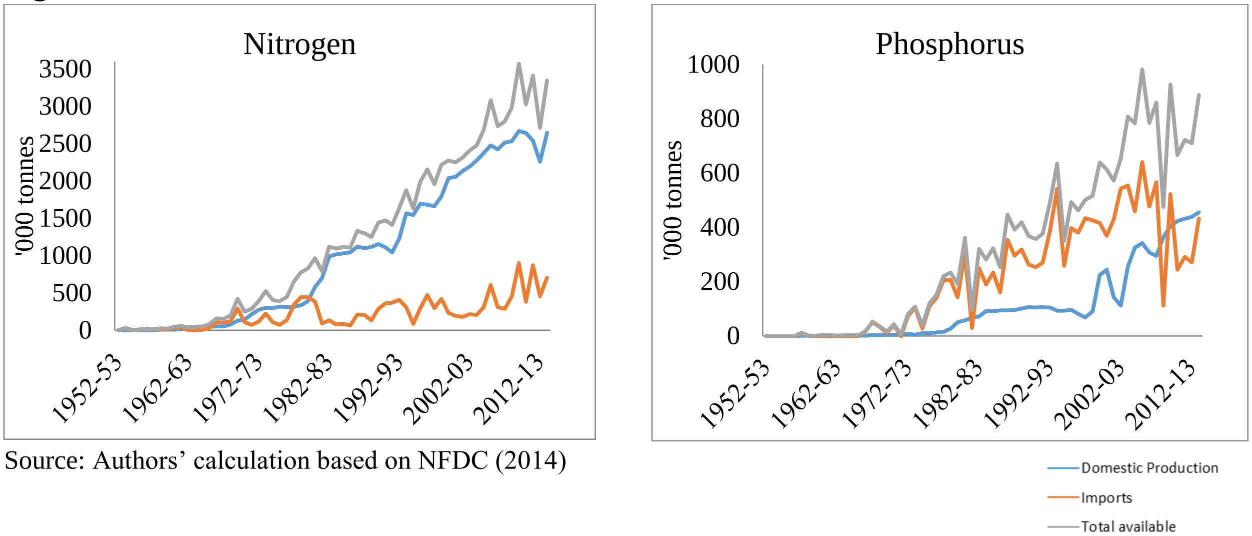
Table 10: Profitability Comparisons

Region	**Average ROE Margin**
SAFCO	30%
MENA	31%
China	9%
India	16%
Pakistan	33%

Source: CCP (2010)

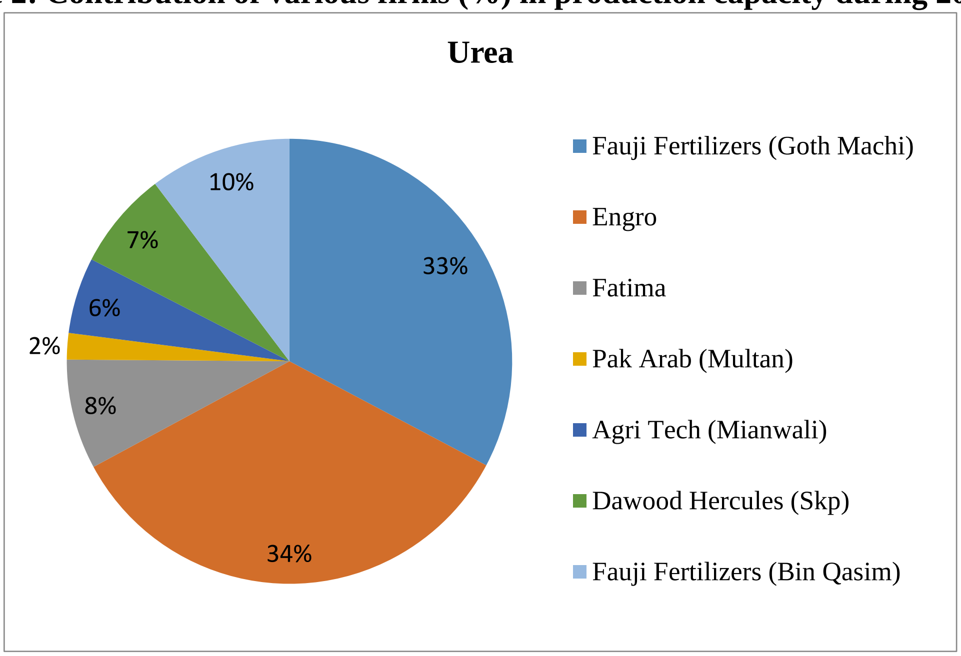
Notes: We converted all nitrogen into Urea. We convert the domestic available nitrogen to urea by dividing all nitrogen tonnes by 0.46. Annual average exchange rates were used to convert values in US$ into PKR. Four year average has been taken for the year 2004-2008

Figure 1: Historical Trend in Production, 1952/53-2013/14



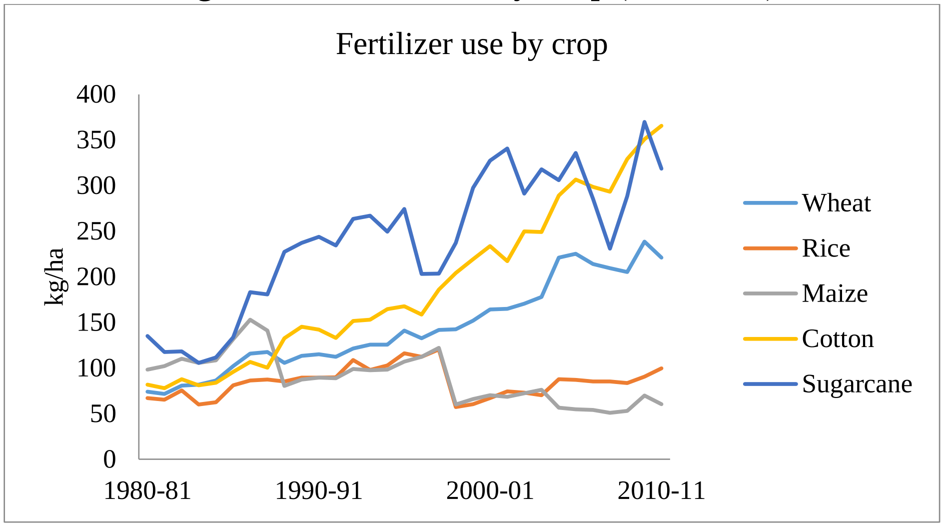
Source: Authors' calculation based on NFDC (2014)

Figure 2: Contribution of various firms (%) in production capacity during 2013-14.



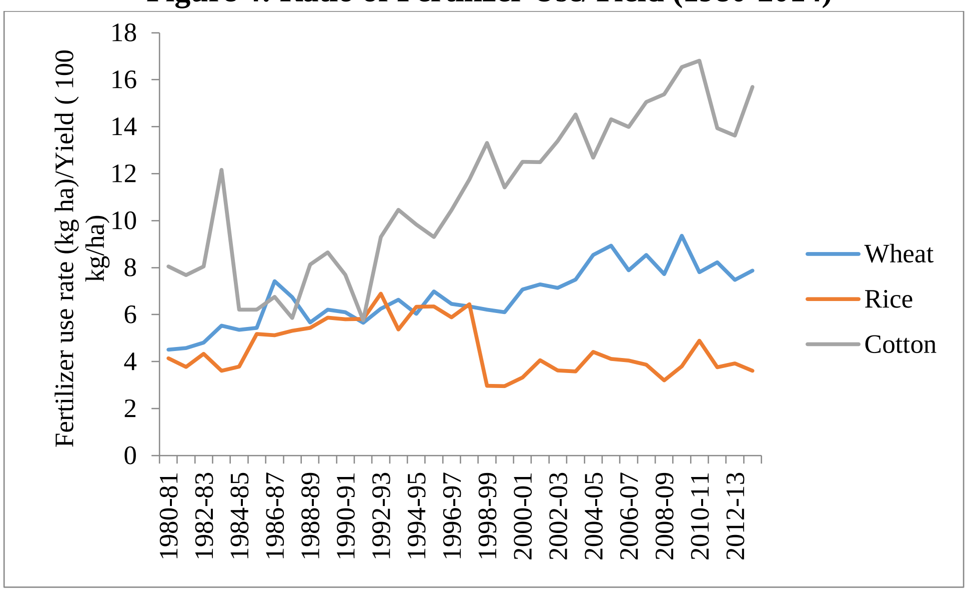
Source: Authors' calculation based on MNFSR (2013)
Notes: FFBL is a subsidiary of FFC, both are controlled by the Fauji Foundation

Figure 3: Fertilizer Use by Crop (1980-2011)



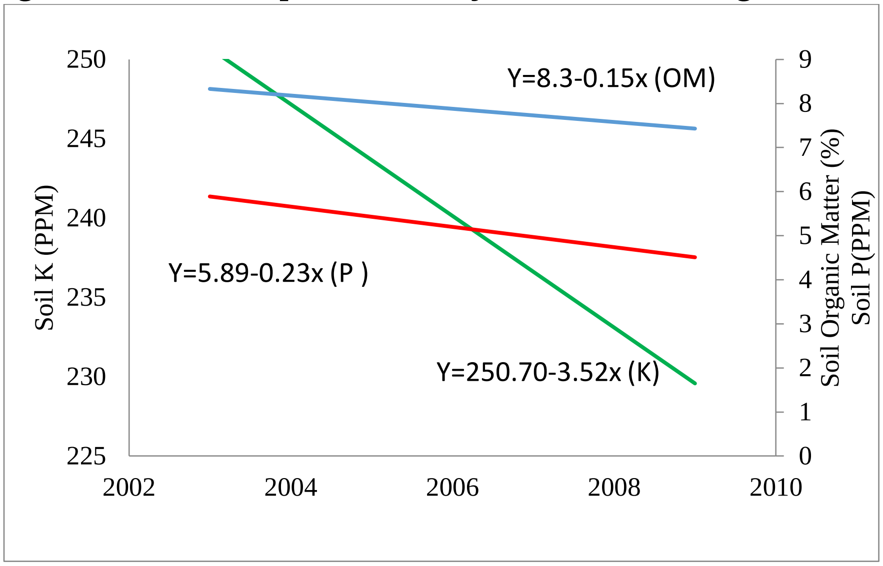
Source: NFDC (2014)

Figure 4: Ratio of Fertilizer Use/Yield (1980-2014)



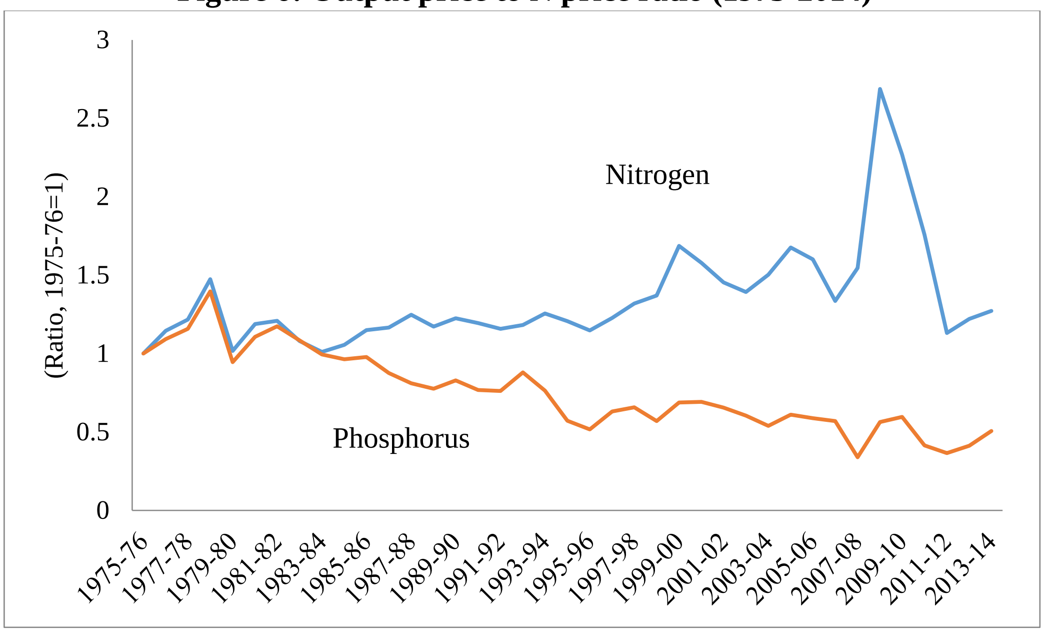
Source: Authors' calculation based on NFDC (2014), MNFSR (2013), MNFAL (2007a) and MNFAL (2007b)

Figure 5: Nutrient depletion in Punjab, Pakistan during 2003-2009



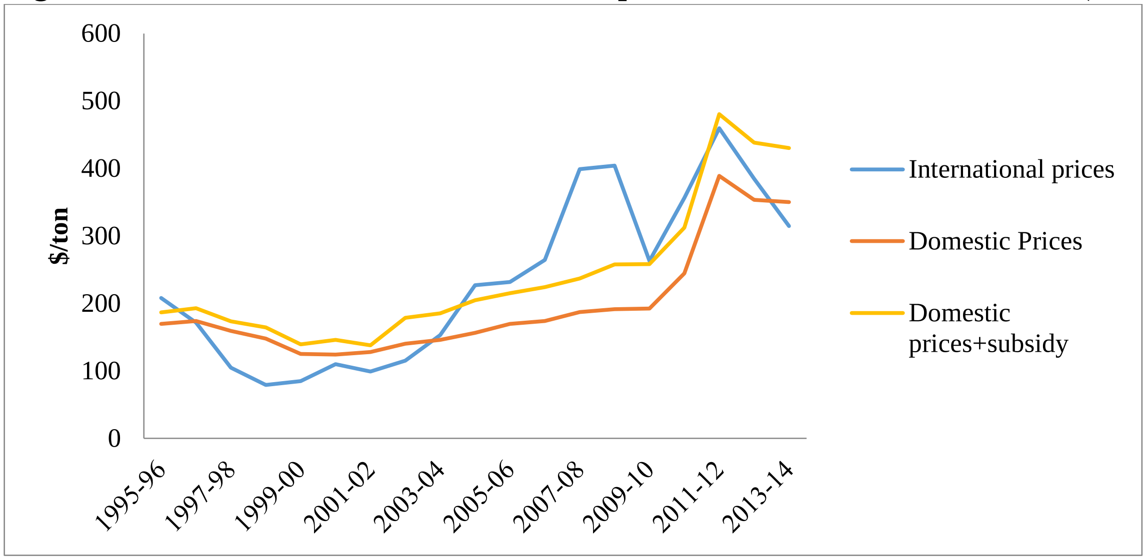
Source: SFRI (2013b)

Figure 6: Output price to N price ratio (1975-2014)



Source: Authors' estimates from NFDC (2014), MNFSR (2013), MNFAL (2007a), MNFAL (2007b) and MNFAL (2007c)

Figure 7: International verses domestic urea prices with and without subsidies (1995-2014)

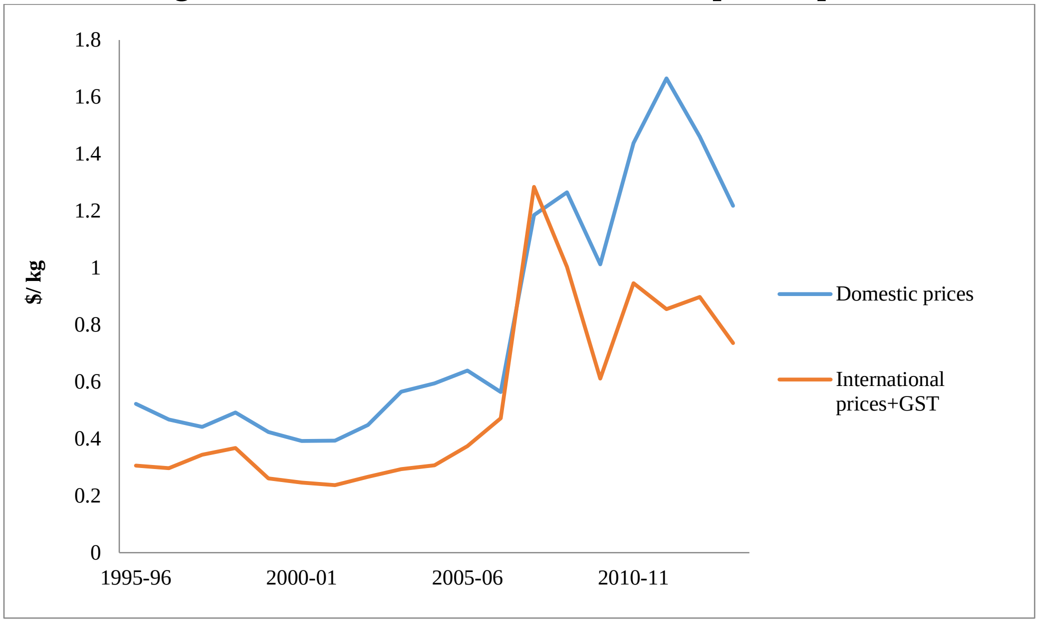


Source: Authors' estimates based on NFDC (2014)

Figure 8: Comparison of Indian and Pakistani Prices of urea with subsidies (2003-2014)

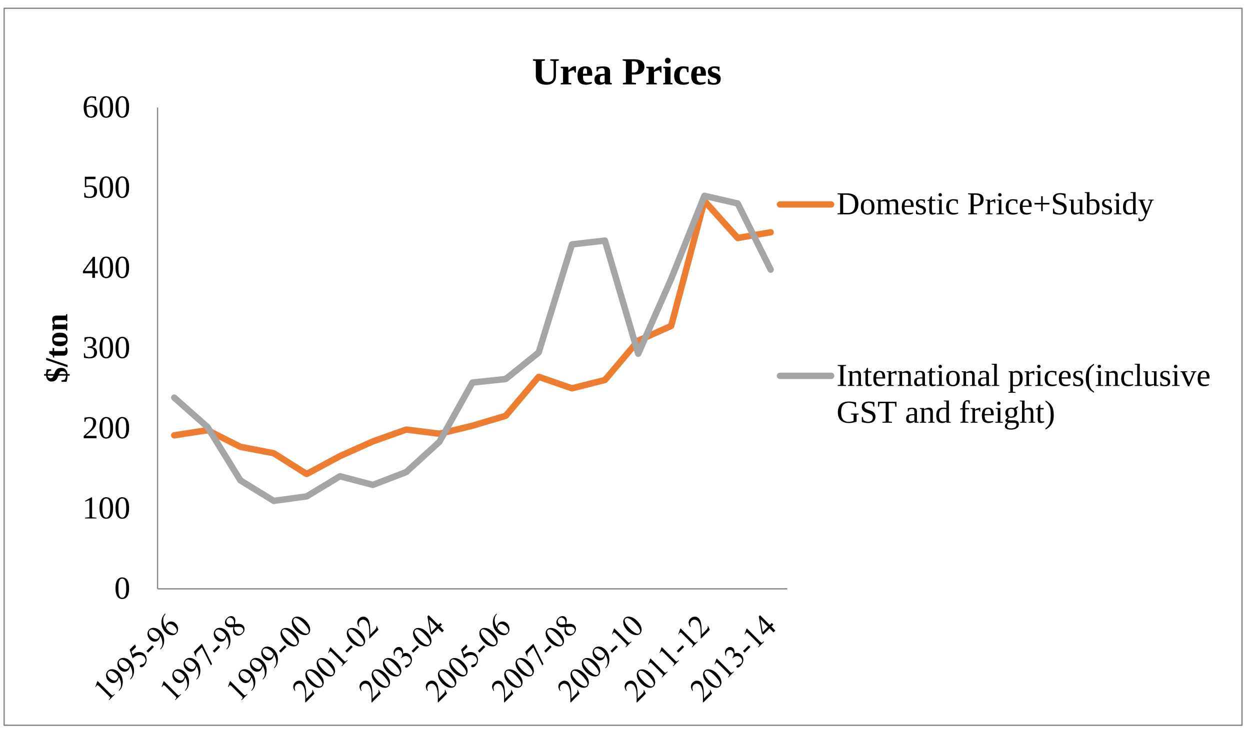
Source: Authors' estimates based on NFDC (2014), DoP (2012), and HDIP (2013).

Figure 9: International vs. Domestic Phosphorus prices



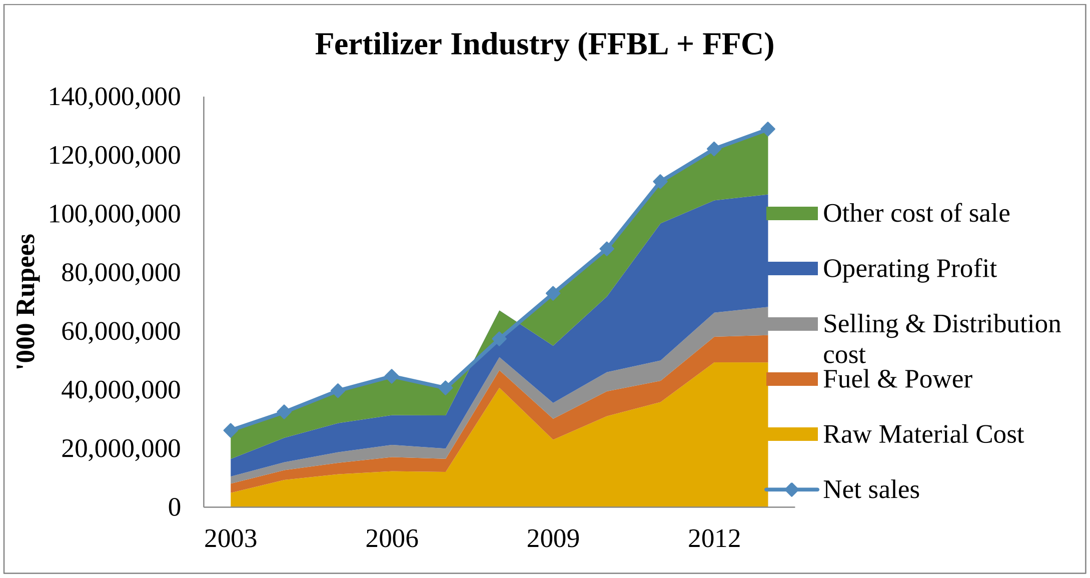
Source: Authors' estimates based on NFDC (2014) and HDIP (2013).

Figure 10: Year to Year Cost of Fertilizer Policies to Farmers During 1996-2013



Source: Authors' estimates based on NFDC (2014)

Figure 11: Trend in cost and profit structure of fertilizer industry (FFBL & FFC) during 2003-13



Source: Authors' estimates based on data collected from company annual reports (FFBL 2005, 2006, 2008, 2010, 2012, 2014); (FFC 2004, 2006, 2008, 2010, 2012, 2014).

Appendix 1: Fertilizer use rate (kg/hectare) (1970-2014)

Fiscal Year	N	Moving average	P	Moving average	K	Moving average	Total	Moving average	P/N	K/N
1970-71	15		1.83	-	0.07		17		0.12	0.005
1971-72	21		2.24	-	0.04		23		0.11	0.002
1972-73	23	20	2.88	2	0.08	0	26	22	0.13	0.003
1973-74	19	21	3.18	3	0.15	0	22	24	0.17	0.008
1974-75	21	21	3.49	3	0.12	0	25	24	0.17	0.006
1975-76	25	22	5.75	4	0.16	0	30	26	0.23	0.006
1976-77	28	25	6.47	5	0.12	0	35	30	0.23	0.004
1977-78	30	28	8.45	7	0.32	0	39	35	0.28	0.011
1978-79	35	31	9.73	8	0.39	0	46	40	0.28	0.011
1979-80	42	36	11.85	10	0.5	0	54	46	0.28	0.012
1980-81	44	40	11.81	11	0.5	0	56	52	0.27	0.011
1981-82	43	43	11.67	12	1.13	1	56	55	0.27	0.026
1982-83	47	45	13	12	1	1	62	58	0.28	0.021
1983-84	46	45	13	13	1	1	60	59	0.28	0.022
1984-85	47	47	15	14	1	1	63	62	0.32	0.021
1985-86	56	50	17	15	2	1	75	66	0.3	0.036
1986-87	64	56	20	17	2	2	85	74	0.31	0.031
1987-88	66	62	20	19	2	2	88	83	0.3	0.03
1988-89	61	64	18	19	1	2	80	84	0.3	0.016
1989-90	69	65	18	19	2	2	89	86	0.26	0.029
1990-91	69	66	18	18	2	2	89	86	0.26	0.029
1991-92	69	69	19	18	1	2	88	89	0.28	0.014
1992-93	77	72	23	20	1	1	101	93	0.3	0.013
1993-94	76	74	21	21	1	1	98	96	0.28	0.013
1994-95	79	77	19	21	1	1	99	99	0.24	0.013
1995-96	88	81	22	21	1	1	111	103	0.25	0.011
1996-97	87	85	18	20	0.4	1	105	105	0.21	0.005
1997-98	91	89	24	21	1	1	116	111	0.26	0.011
1998-99	91	90	20	21	1	1	112	111	0.22	0.011
1999-00	97	93	26	23	1	1	124	117	0.27	0.01
2000-01	103	97	31	26	1	1	135	124	0.3	0.01
2001-02	104	101	28	28	1	1	133	131	0.27	0.01
2002-03	106	104	29	29	1	1	136	135	0.27	0.009
2003-04	116	109	31	29	1	1	147	139	0.27	0.009
2004-05	122	115	38	33	1	1	161	148	0.31	0.008
2005-06	130	123	38	36	1	1	169	159	0.29	0.008
2006-07	115	122	42	39	2	1	159	163	0.37	0.017
2007-08	125	123	27	36	1.2	1	153	160	0.22	0.01
2008-09	128.2	123	28	32	1.1	1	157	156	0.22	0.009
2009-10	146.1	133	36	30	1	1	183	164	0.25	0.007
2010-11	132.4	136	32	32	1.4	1	166	169	0.24	0.011
2011-12	137	139	27	32	0.9	1	165	171	0.2	0.007
2012-13	122	130	32	30	0.9	1	155	162	0.26	0.007
2013-14	140	133	39	33	1	1	180	167	0.28	0.007

Source: NFDC (2014)

Appendix 2: Feedstock gas prices ($/mmbtu) for fertilizer manufacturers in Pakistan, the Middle East, and the USA

Year	Pakistan	Middle East	Henry Hub, USA
2004-05	1.0	1.1	6.3
2005-06	1.9	1.4	8.9
2006-07	2.1	1.3	6.9
2007-08	2.0	1.7	8.3
2008-09	1.5	2.7	5.9
2009-10	1.6	1.1	4.3
2010-11	1.6	1.4	4.2
2011-12	1.8	1.9	3.2
2012-13	1.2	2.0	3.8
2013-14	1.2	2.1	4.3
Average	1.6	1.7	5.6

Source: Data retrieved from HDIP (2014), EIA (2014) & HC Securities & Investment (2010)

Appendix 3: Total Subsidy to the Fertilizer Industry (Million USD)

Year	Production Subsidy	Distribution Subsidy	Total Subsidy
2004-05	222.9	30.88	253.78
2005-06	219.3	75.79	295.09
2006-07	239.7	259.83	499.53
2007-08	243.5	321.95	565.45
2008-09	326.1	557.05	883.15
2009-10	339.7	159.50	499.20
2010-11	343.7	98.38	442.08
2011-12	410.9	108.11	519.01
2012-13	366.8	108.22	475.02
2013-14	397.2	43.54	440.74

Source: Authors' calculation based on HDIP (2014) & NFDC (2014)

Appendix 4: Acronyms

ADBP	
ASTI	Agricultural Development Bank of Pakistan
CAN	Calcium Ammonium Nitrate
CCP	Competition Commission of Pakistan
DAP	Diammonium Phosphate
DCO	District Coordination Officer
DHCL	Dawood Hercules Corporation Limited
ECP	Engro Corporation Pakistan
ECPL	Exxon Chemical Pakistan Limited
EDM	Equilibrium Displacement Model
EFL	Engro Fertilizer Limited
FAO	Food and Agricultural Organization of the United Nation
FF	Fauji Foundation
FFBL	Fauji Fertilizer Bin Qasim Limited
FFC	Fauji Fertilizer Company Limited
FJFC	FFC-Jordan Fertilizer Company
FOB	Free on Board
GAMS	General Algebraic Modeling System
GIDC	Gas Input Development Charges
GST	General Sales Tax
HDIP	Hydrocarbon Development Institute of Pakistan
IDS	Innovative Development Strategies
IFPRI	International Food Policy Research Institute
IMWI	International Water Management Institute
JPMC	Jordan Phosphate Mines Co.
K	Potash
KPK	Khyber Pakhtunkhwa
MMBTU	Million British Thermal Units
MMCFD	Million Cubic Feet per Day
MMCFT	Million Cubic Feet
MNFAL	Ministry of Food, Agriculture and Livestock
MNFSR	Ministry of National Food Security and Research
MP	Marginal Product
MVCR	Marginal Value-Cost Ratio
N	Nitrogen
NFC	National Fertilizer Corporation of Pakistan
NFDC	National Fertilizer Development Centre
NMFL	National Fertilizer Marketing Limited
NP	Nitro Phosphate
NPK	Nitrogen Phosphorous Potassium
NRC	National Research Council
PECA	Provincial Essential Commodity Act
P	Phosphorous
PFL	Pakarab Fertilizers Limited
PGPR	Plant Growth Promoting Rhizobacteria
PKR	Pakistani Rupee (PKR 102=1 US$)

PPL	Pakistan Press International
PSFL	Pak Saudi Fertilizer Limited
PSSP	Pakistan Strategy Support Program
RHPS	Pakistan Rural Household Panel Survey
R&D	Research and Development
SCP	Supreme Court of Pakistan
SFRI	Soil Fertility Research Insitute
SNGPL	Sui Northern Gas Pipelines Limited
SSGCL	Sui Southern Gas Company Limited
TFP	Total factor productivity
WPADC	West Pakistan Agricultural Development Corporation
WTO	World Trade Organisation
ZTBL	Zarai Taraqiati Bank Limited