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The Fertilizer Industry and Philippine Agriculture: Policies, Problems, and Priorities[1]

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ABSTRACT

The fertilizer policy in the country has evolved from pervasive interventionism in the 1970s to today's market-oriented regime. Government has abandoned price policies and subsidies, focusing rather on standard setting, quality regulation, and training. Over the same period, domestic demand for fertilizer has continually increased, though recently, resurgent fertilizer prices have reduced total utilization. Evidence suggests that farmers (at least in the case of rice) are underapplying fertilizer, forfeiting efficiency gains at the margin. On the supply side, imports have in the past few decades emerged as the main source of fertilizer, as domestic production has dwindled. With deregulation, numerous private sector players have taken over its distribution; analysis of the supply chain points to low marketing margins. Integration analysis fails to find systematic arbitrage opportunities between the domestic and world markets. Within the domestic market, however, there remain large disparities in prices across regions. Priorities for research and policy are therefore understanding the behavior of farmers in terms of fertilizer application, and addressing internal price disparities, perhaps by improved transport infrastructure and logistics.

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OVERVIEW

Mineral fertilizer makes a tremendous contribution to the productivity of Philippine agriculture. This paper examines this contribution and the role of fertilizer policies in the development of the fertilizer industry, and outlines a way forward for continuing the development of the industry. The paper focuses on several questions as key policy issues:

Are farmers applying the right amount of fertilizer? Economic theory shows that fertilizer use is optimized when its marginal contribution (in value terms) equals its price. Too much or too little application of fertilizer may raise cost per unit output and erode agriculture's competitiveness.

Is the price of fertilizer too high? The *Philippine Development Plan 2017–2022* (NEDA 2017, p. 252) affirms the need to review market competition in key inputs to production such as fertilizer and seeds. In a competitive market, the price of fertilizer (relative to output) will be brought down to its marginal product; in the presence of market power, price may not be competed down to this benchmark.

Is market structure a factor in keeping fertilizer prices high? Perhaps there are still policies that introduce barriers to entry and related distortions in the fertilizer market.

The paper concludes with a discussion of remaining areas for further research, as well as implications on the country's policies related to fertilizer demand and supply.

EVOLUTION OF FERTILIZER POLICY

During the postwar period, growing fertilizer demand was mostly met by increasing domestic production, supported by incentives and price policies. David and Balisacan (1981) summarize the postwar history of the fertilizer industry up to the 1970s. During the 1950s, the fertilizer industry was regarded as a "new and necessary" industry exempted from taxes and customs duties. Market policies in the form of controls and tariffs on fertilizer imports raised the domestic price of fertilizer. Government also extended subsidies, e.g., distribution of discounted fertilizers to sugar planters' cooperatives.

In 1973, government intensified interventions in the fertilizer industry, first establishing a Fertilizer Industry Authority (FIA) to regulate prices, imports, production, and marketing. Over the next two years, the authority imposed two-tier pricing: with food producers able to access fertilizer at an administered price that was lower than the market price. A supervised credit program was simultaneously launched, which incorporated a fertilizer subsidy. After 1975, the authority continued its price-targeting policy by imposing a quantitative restriction (QR).

In 1977, Presidential Decree (PD) No. 1144 reorganized FIA into the Fertilizer and Pesticide Authority (FPA). The PD assigned FPA a regulatory function over both fertilizers and pesticides to ensure the safety and efficacy of products sold in the market. However, the authority retained the mandate to "determine and set the volume of prices, both wholesale and retail, of fertilizer and fertilizer inputs".

In 1986, government began a series of reforms that allowed a much greater scope for market allocation and pricing. FPA ceded administrative controls (Alcala 2012), abandoned the QR, and the price-setting function (OP 1992). Import duties were also reduced over a series of tariff reduction programs. Currently, applied rates are in the range of 1–3 percent (Table 1). The Agriculture and Fisheries Modernization Act of 1997 furthermore allows duty-free importation by enterprises engaged in agriculture, conditional on direct use by these enterprises, i.e., plantations, aquaculture operators, farmer cooperatives, etc.

Table 1. Tariff rates for fertilizer products, Philippines (2015)

AHTN Code	Item	MFN[b] Rate	FTA Partner Rate[a]
3102.10.00	Urea	1	0
3102.21.00	Ammonium sulphate	3	0
3103.10.10	Superphosphate	1[b]	0
31.04	Potassic fertilizers	1	0
3105.20.00	Blended fertilizers	3	0

AHTN = Association of Southeast Asian Nations (ASEAN) Harmonized Tariff Nomenclature
MFN = most favored nation; FTA = free trade agreement
[a] ASEAN countries plus Australia, China, Japan, Korea, and New Zealand. India is a free trade partner by virtue of the ASEAN India Free Trade Agreement. However, fertilizer imports from that country are levied MFN rates.
[b] For feed grade superphosphate, the tariff rate is 7 percent.
Source: Tariff Commission (2015)

Together with opening the domestic market to foreign competition (thus making fertilizers cheaper), government has retreated from extending fertilizer subsidies. The remaining incentive for the sector is indirect, namely, the exemption of sale and importation from the 12 percent value-added tax.

As mentioned earlier, fertilizers were part of the package of technology promoted under *Masagana 99* based on subsidized credit and inputs. Even without subsidy, mineral fertilizers continued to be a prominent fixture in the country's agricultural programs. After an initial enthusiasm over the new technologies, in the 1980s and 1990s, the government began to promote judicious and scientific use of agri-chemicals under Integrated Pest Management and balanced fertilization and site-specific nutrient management (SSNM). SSNM is defined as the dynamic field-specific management in a particular cropping season to optimize supply and demand according to their variation in time and space (Dobermann and Witt 2004).

Regulations on importation and manufacture are now directed toward maintaining product quality and standards. Imports need not be accompanied by a permit; instead, licensed fertilizer importer-distributors can bring in registered fertilizer products. An import license is good for one year (subject to renewal) and may be obtained within three days of filing. Requirements for a license are as follows:

- Duly accomplished and notarized application form (original copy) with documentary stamps
- Business Name Registration Certificate (Securities and Exchange Commission/Department of Trade and Industry/Cooperative)
- Copy of latest income tax returns and financial statements
- Copy of Distributorship Agreement/Certification with mother company
- List of distributors and dealers per province by region (for importer-distributors)
- Product registration approval of all fertilizer grades to be sold
- Inspection and recommendation by the FPA regional/provincial officer on their area coverage
- Registration of fertilizer warehouse
- Filing and license fee

Registration of fertilizer products is good for three years, and will take not more than 265 days for new products and only 65 days maximum for renewal (FPA 2016). Requirements for registration are:

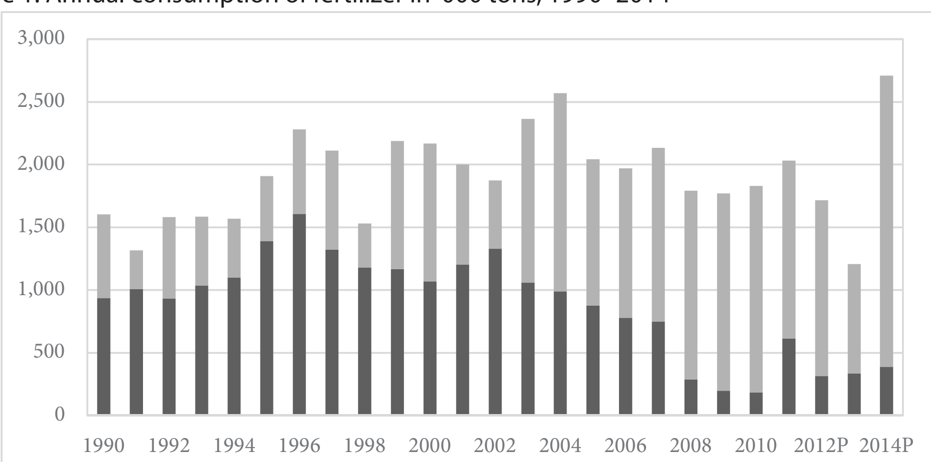
- Schematic diagram/production process
- Sample of the product for confirmatory analysis at any FPA accredited laboratory
- Proposed label or bag
- Certificate of analysis from the source/country of origin
- Brochure/pamphlets of exporting/manufacturing firm or company profile
- Test for pathogens
- Bioefficacy data: test crop
- Experimental Use Permit (if applicable)
- Completeness of data
- Filing and registration fee

DEMAND-SIDE ISSUES

Trends in fertilizer consumption

Consumption has followed an upward trend since 1990, punctuated by occasional sharp declines. Figure 1 presents estimates of fertilizer consumption from 1990 onward using supply and utilization accounts from the Philippine Statistics Authority. Consumption is proxied by net supply, i.e., production plus net imports. Consumption has been on an upward trend since 1990, suffering a major decline in 1998 due to the nationwide drought brought about by El Nino. Note that consumption subsequently recovered to a peak of 2.6 million tons in 2004. Since then, consumption has declined, with another abrupt drop in 2008 when world fertilizer prices soared.

Figure 1. Annual consumption of fertilizer in '000 tons, 1990–2014

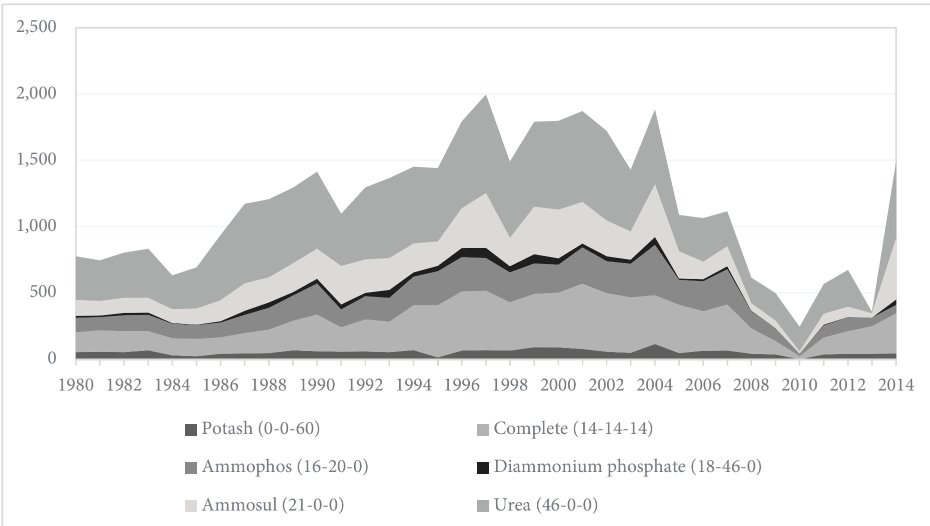


Source: CountrySTAT (Philippine Statistics Authority [PSA] n.d.)

Also noticeable in Figure 1 is the diminishing importance of domestic production in meeting demand. Domestic production accounted for at least 70 percent of consumption in the mid-1990s. However, by 2008–2010, the share of domestic production in consumption had fallen to an average of 12 percent. Domestic production could not keep pace with rising demand, which increasingly shifted to imports to take advantage of reduced trade barriers.

The most popular type of fertilizer in the country is nitrogen fertilizer. The major types of fertilizer in the country are potash (0-0-60), complete NPK (nitrogen, phosphorus, and potassium (14-14-14), ammonium phosphate (16-20-0), diammonium phosphate (18-46-0), ammonium sulfate (21-0-0), and urea (46-0-0). The main type of fertilizer consumed has usually been nitrogen based. Until recently, next in importance are phosphate-based fertilizers (Figure 2). The largest shares in consumption are urea and ammonium sulfate, which account for about half of quantity sold in recent years. The next in rank is complete NPK fertilizer, accounting for one-fifth to a quarter of fertilizers sold by volume.

Figure 2. Utilization of fertilizer by major type in '000 tons, 1980–2012



Source: Fertilizer and Pesticide Authority (2014)

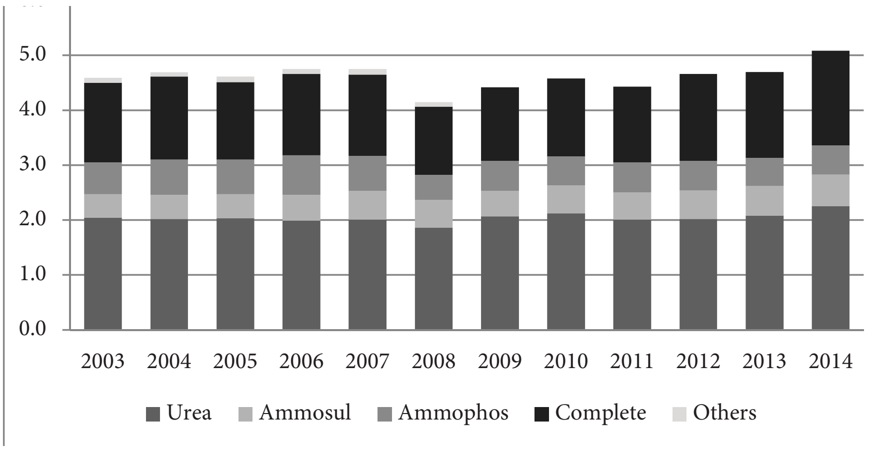
The major users of fertilizer are cereals, followed by fruits and vegetables, and sugarcane. About 60 percent of fertilizer consumption goes to food crops, mainly rice and corn (Mojica-Sevilla 2006). This is consistent with Bunoan-Olegario (2011) who estimates that rice accounts for 38 percent of fertilizer use, followed by maize (21 percent). The next major users are fruits and vegetables, at 19 percent; sugarcane accounts for 7 percent; and other crops, 15 percent.

For both paddy rice and maize, fertilizer application has ranged between 200 and 250 kilograms (kg) per hectare (ha), with paddy rice being slightly higher (Figures 3 and 4). In both, the biggest item is for urea, about 100 kg/ha for either crop. The next biggest category is complex NPK fertilizer, between 70 and 80 kg/ha for paddy rice, and 55–65 kg/ha for maize.

Table 2 reports fertilization rates by major crop, based on actual nutrient applied (instead of fertilizer quantity). By proportion of area harvested, the extent of fertilizer application is widest with rice, followed by sugarcane, maize, palm oil, potato, and tobacco. Highest nitrogen fertilizer rate is found for sugarcane, potato, and cocoa. Sugarcane also exhibits the highest fertilization rate for phosphorus at 55 kg/ha (together with potato); the highest fertilization rate for potassium is rubber, followed by palm oil.

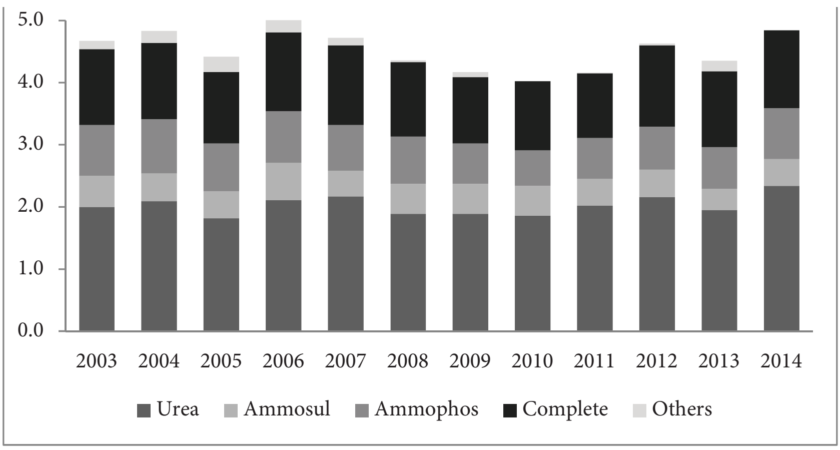
Fertilizers account for a significant but still minor share in production cost (Table 3). The highest shares are observed for several types of fruits and vegetables, and lowest for root crops, with cereals in between (about 10–5 percent share). The high fertilizer costs for fruits and vegetables apparently

Figure 3. Fertilization rate in 50-kilogram bags per hectare for paddy rice, 2003–2012



Source: CountrySTAT (PSA n.d.)

Figure 4. Fertilization rate in 50-kilogram bags per hectare for maize, 2003–2012



Source: CountrySTAT (PSA n.d.)

contradict the data in Table 2. The latter, though, pertains to the average for all vegetables, which includes many categories grown with lower intensity, such as peanut and mungbean (as seen in Table 3).

Impact and efficiency of fertilizer application

Fertilizer, combined with the adoption of modern crop varieties, was a major contributor to growth in agricultural productivity. Prior to the dissemination of IR-8—the prototypical "miracle rice" variety—only 14 percent of farmers applied fertilizer before transplanting and 41 percent after transplanting (Castillo 1975, citing Sumayao 1969). For the same group of farmers, in their fourth season of planting IR-8, 37 percent applied fertilizer before transplanting and 54 percent after. By the 1990s, close to 100 percent of farmers in irrigated areas apply mineral fertilizer (Horstkotte-Wesseler 1999).

Table 2. Extent and rate of fertilizer application, by type of nutrient, 2001

	Extent of Area Harvested (%)	Fertilization Rate (kg/ha)		
		Nitrogen	Phosphorus	Potassium
Rice	85	51	15	11
Sugarcane	80	85	55	30
Maize	80	58	16	10
Palm oil	80	75	25	70
Potato	80	85	55	45
Tobacco	80	75	20	55
Cocoa	50	85	45	45
Fruits	50	75	35	40
Vegetables	50	0.1	0	0
Coffee	40	0	0	0
Rubber	40	25	15	80
Coconut	30	20	15	10
Other crops	30	25	15	10
Groundnut	20	40	30	20
Soya	20	20	30	10

Source: Food and Agriculture Organization (2006)

The advantage of modern over traditional varieties is higher yields, larger yield increases, higher maximum yield fertilizer levels, and higher average productivity of fertilizer. The average maximum yield increase due to fertilizer during the dry season is 3.1 tons/ha in the case of modern varieties, but only 0.7 tons/ha for traditional varieties. The increment is smaller during the wet season, but still substantial (Barker et al. 1985).

Average productivity measured by the ratio of kg of rice per kg fertilizer was higher for modern varieties by 8.9 kg rice/kg fertilizer during the dry season and by 6.2 kg rice/kg fertilizer during the wet season. The coefficient of variation of yield implies that modern variety yields are less variable than traditional variety yields; that is, at any given level of applied fertilizer, there is a higher probability of receiving the expected yield with the modern varieties than with the traditional varieties. Hence, the country's rice output grew by 3.27 million tons over the period 1965–1980. Of this increment, 1.01 million tons or 30 percent could be attributed to increased fertilizer use (Herdt and Capule 1983).

These findings continue to hold in the post-Green Revolution period, i.e., fertilizer continues to contribute significantly to output. A panel data set covering the period 1995–1999 generated an estimate of output elasticity of fertilizer application of 0.11 (Shively and Zelek 2003). Using another panel data set spanning the period 1996–2007, Mariano et al. (2010) estimate the output elasticity of fertilizer for irrigated systems at 0.08.

In the case of rice, fertilizers are still being applied at below profit-maximizing levels. A number of studies indicate that Filipino rice farmers are applying insufficient quantities of fertilizer. In one study by the International Rice Research Institute (IRRI) (conducted in the latter half of the 1990s), farmer's practice is contrasted with SSNM (Gines et al. 2004). SSNM led to a significantly

Table 3. Fertilizer cost as a share in total cost, 2002–2011 (%)

	2002	2004	2006	2008	2010	2011
Cereals						
Maize	13.8	19.1	20.6	29.8	14.8	15.7
Paddy rice	8.3	12.7	13.9	16.1	10.0	11.1
Fruits						
Watermelon	14.4	20.3	22.4	30.6	21.5	25.4
Mango	9.8	14.1	15.8	15.8	20.1	23.6
Pineapple	16.9	24.1	27.6	27.6	21.8	21.3
Root crops						
Cassava	6.0	8.7	9.5	16.2	10.7	11.2
Sweet potato	5.5	8.1	8.8	14.1	8.6	8.6
Vegetables and others						
Tomato	17.1	22.9	25.8	34.2	24.8	27.2
Cabbage	16.0	20.5	21.3	33.0	24.4	24.4
Potato	12.0	15.8	17.8	26.1	22.3	22.1
Eggplant	26.2	18.3	20.1	28.2	21.0	21.3
Cauliflower	13.5	20.5	22.2	29.8	21.7	20.0
Bittermelon	9.5	13.9	15.2	21.4	14.6	18.2
Onion bulb	n.a.	n.a.	16.0	20.4	16.7	14.9
Garlic	n.a.	n.a.	9.7	15.5	9.5	10.1
Stringbeans	5.1	7.7	8.6	13.5	8.5	9.9
Peanut	1.2	1.8	2.0	3.2	1.9	2.3
Mungbean	0.4	0.6	0.6	0.9	0.5	0.6
Coffee	13.7	18.9	20.9	26.1	17.2	20.4

n.a. = not applicable
Source of basic data: CountrySTAT (PSA n.d.)

larger fertilizer cost. In their sample, rates of N were similar in SSNM and farmer practice (about 110 kg/ha), but more P and K were applied in the first year. Average fertilizer cost in SSNM was 45 percent higher than under farmer practice, even as average yields were 11 percent higher. In general, farmer practices tended to remain unbalanced, applying an average of 30 percent less P and 130 percent less K than SSNM.

Pingali et al. (1998) compared the marginal productivity of fertilizer with the ratio of fertilizer to rice prices. In 1985 and 1986, based on farm-level data, the marginal product of 1 kg fertilizer was estimated at 15.3 kg/ha during the wet season, and 8.3 kg/ha during the dry season, evaluated at the sample means (84.2 kg/ha and 133.6 kg/ha during dry and wet seasons, respectively, based on product weight). The marginal product is far above the ratio of fertilizer to paddy rice price, equal to 4.1. Fertilizers are still contributing positively to profitability in rice farming. On the other hand, this implies that fertilizer is being underutilized in Philippine farms. In contrast, for Indonesian farms, the marginal product (2.7 kg paddy/kg fertilizer) is close to but above the input/output price ratio (1.7). Average fertilizer application in the Indonesia sample is 176 kg/ha (product weight) in irrigated areas, whereas in the Philippines, the average fertilizer application (wet and dry seasons) is 109 kg/ha.

Another IRRI study suggests that Filipino rice farmers may be mismanaging nitrogen fertilizer application (Dawe et al. 2007). Data from a rice farmer survey spanning 1988–2002 is contrasted with computed optimal N based on experimental trials. The comparison suggests that farmers tend to overapply N during the wet season and underapply N during the dry season (31–55 kg gap from optimal). For irrigated areas, bridging the gap may result in up to a one-ton yield increment—a substantial increase (compared with the yield of irrigated systems in 2012 of 4.2 tons/ha).

What accounts for this systematic underapplication of fertilizer is not clear. Mataia and Dawe (2007) rule out one possible reason, which is access to credit. Another potential explanation, namely, risk aversion, has been ruled out in Abedullah and Pandey (2004) at least for the case of favorable rainfed environment in the Philippines. Other reasons may be the sheer lack of knowledge of farmers on the techniques of determining correct fertilizer application. Deeper analysis is needed to pinpoint the explanation.

SUPPLY-SIDE AND MARKETING ISSUES

Sources of fertilizer supply

There are few players in domestic fertilizer production. Currently, domestic production of fertilizer is obtained from five firms. The largest is Philippine Phosphate Fertilizer Corporation (PHILPHOS), originally a Philippine government corporation established in 1980 and privatized in 2000. PHILPHOS produces for both the export and domestic market. Fertilizer production is subject to large-scale economies, limiting the number of domestic manufacturers. However, the market as a whole need not be an oligopoly if there is strong competition from imports.

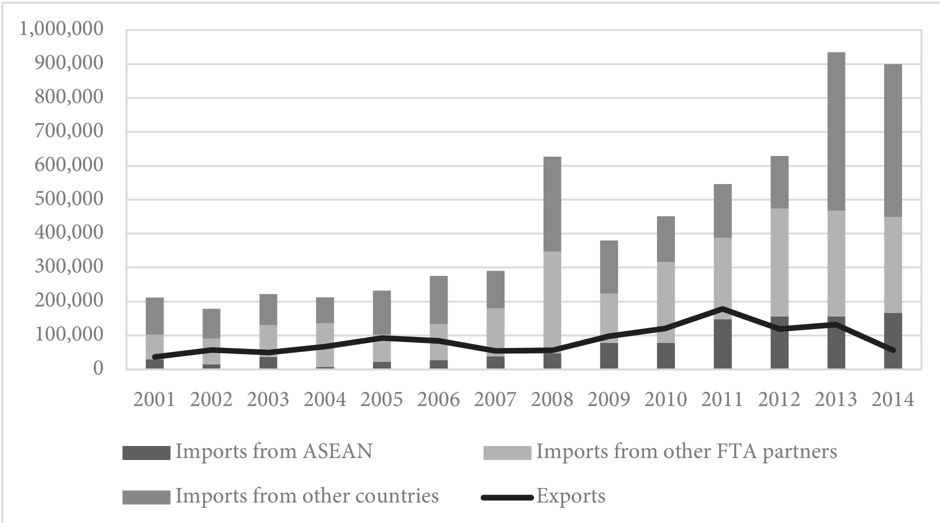
Fertilizer imports by value have been rising. Importation peaked in 2008, declining in 2009 as the domestic market adjusted to the high fertilizer prices. Since then, imports have recovered (Figure 5). Exports are far lower with a much more erratic trend (but a downward direction is observed since 2011). Up to 2011, imports were mostly sourced from the Association of Southeast Asian Nations (ASEAN) and other free trade partners, i.e., China, Japan, Korea, and Australia, for which the import duty is zero. Together with the tariff exemption of agricultural enterprises, imports of fertilizers into the Philippines are effectively duty free. Since 2013, however, imports from other countries have increased rapidly.

The main type of fertilizer imported (by value) is nitrogenous fertilizer (Figure 6), consistent with fertilizer usage patterns shown in Section 3. The Philippines has no domestic source of ammonium, as any domestic natural gas deposits are prioritized for use of the power and fuel industry. Domestic production depends mainly on imported raw materials such as rock phosphate, anhydrous ammonia, sulfuric acid, and other finished fertilizer grades, which are needed in the blending process of fertilizer production (Alcala 2012).

The fertilizer supply chain and market structure

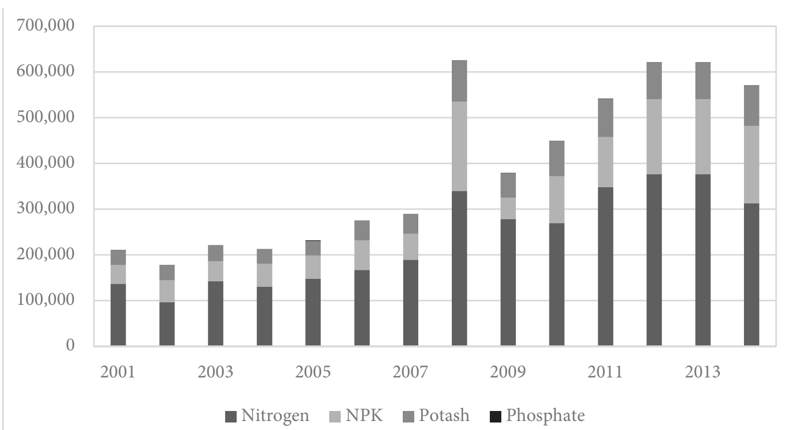
Fertilizer marketing passes through three levels, namely, importers/manufacturers, distributors/ wholesalers, and dealers/retailers (Figure 7). Distributors typically operate in one province and sell to dealers who, in turn, sell to end-users, i.e., farmers. Distributors can also sell directly to farmers or

Figure 5. Imports and exports of fertilizer, 2001–2012 (in USD '000)



ASEAN = Association of Southeast Asian Nations; FTA = free trade agreement
Source: Trademap (International Trade Centre [ITC] n.d.)

Figure 6. Fertilizer imports by product type, 2001–2012 (in USD)

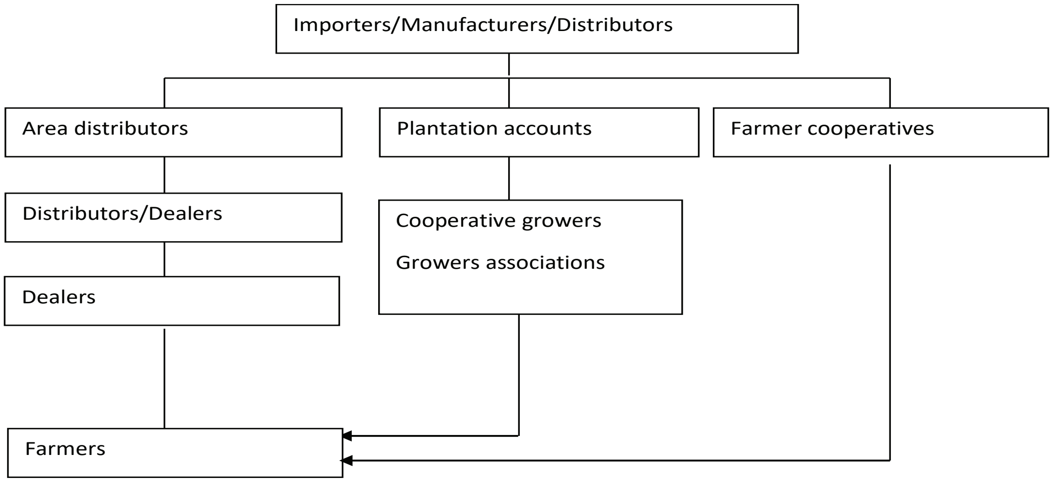


NPK = nitrogen, phosphorus, and potassium
Source: Trademap (ITC n.d.)

large plantations, and may also have a dealer's license. In some areas, there may be area distributors whose operations span multiple provinces and who supply distributors. As discussed earlier, imports can also be done by large plantations and farmer cooperatives.

As of 2012, there were 483 licensed handlers in the fertilizer industry, spanning importation, distribution, repacking, export, and manufacturing. Of these, 150 were listed as importers. Much of importation is done within the region (in 2012, 68% of imports by volume originated from ASEAN countries and China). Eight handlers were also listed as end-users. Many more handlers are farmer cooperatives or associations (e.g., sugar planter organizations) who distribute fertilizer to their

Figure 7. Schematic diagram of key players in the fertilizer market



Source: Bunoan-Olegario (2011)

members. Hence, even if there are entry barriers to fertilizer marketing, these are not so high as to limit the number of players.

Pricing along the supply chain

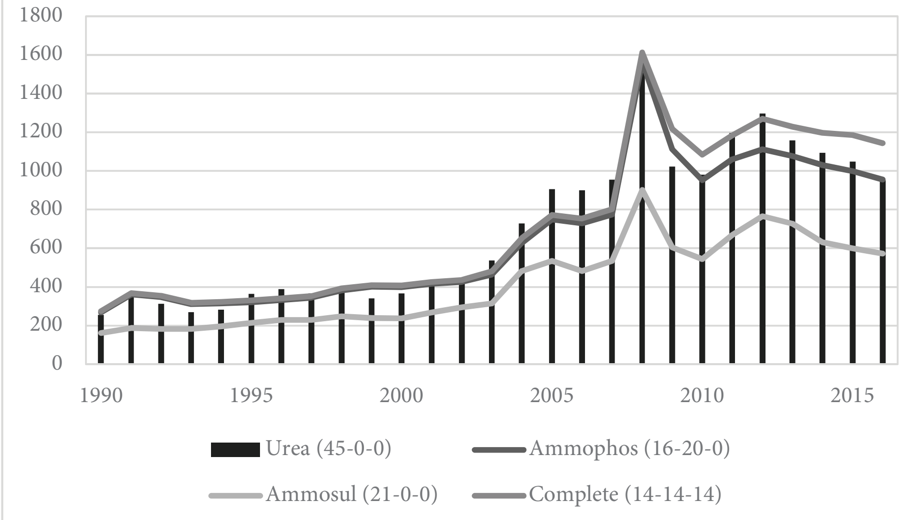
Official data on fertilizer price pertain to retail or dealer's prices. Prices of the four major fertilizer grades were on a relatively gradual upward trend from 1990 onward, accelerating in 2007, and culminating in a price spike in 2008, before receding in 2009 (Figure 8). Thereafter, prices resumed their more gradual upward trend. By 2011, fertilizer prices were much higher than in 2007. This, to a great extent, accounts for lower fertilizer application after 2007. From 2012 onward, though, fertilizer prices have been on a decline, reflecting a softening of petroleum prices.

Figure 9 presents a longer time series (1980–2015), which is only available for urea. The series is presented in both nominal and real terms (at 2010) prices. Prices rose dramatically in the early 1980s. The price of fertilizer in real terms averaged PHP 1,515/bag in 1980–1985, during a period of strong government intervention punctuated by a severe balance-of-payments crisis in 1983–1985. With the economic recovery and shift to a more open regime, real prices of fertilizer fell sharply in 1986, remaining at low levels (with an average of PHP 826/bag in 1986–1990). Aside from intermittent volatility, urea was to remain relatively inexpensive in real terms, until the oil price boom of the 2000s.

Unfortunately, there is no official data on prices at the level of the wholesaler and importer. Some information is available from key informant interviews, compiled in Table 4. The table is a semistylized disaggregation applicable to the northern island of Luzon where rice farming is widespread, and distance between dealers and distributors, as well as distributors and the nearest shipping port, are within two hours or less of land transport.

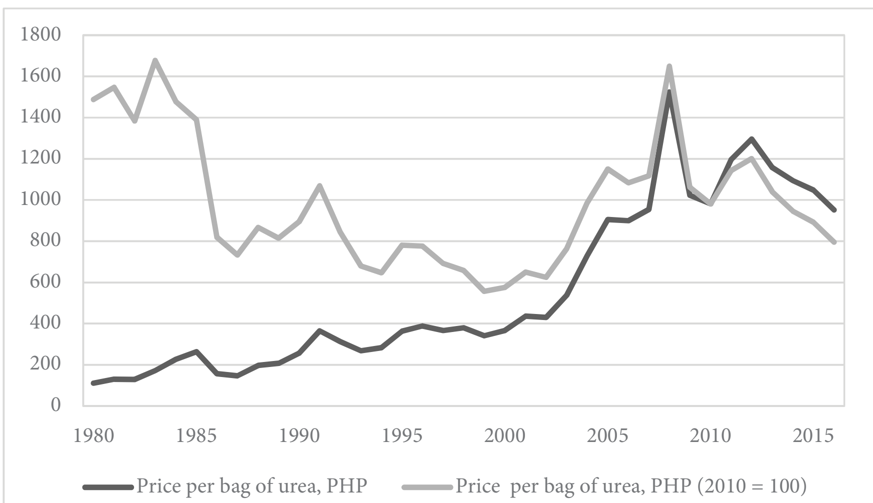
At the end of the chain are the dealers, who state that their markup is ordinarily PHP 30 per 50-kg bag, or about USD 0.71/kg (based on 2013 exchange rate of PHP 42.44/USD). This may occasionally fall even lower for long-time customers, or when they need to dispose of stocks, especially toward the beginning of the rice harvest season (the lean season for fertilizer sales). The miniscule margin is

Figure 8. Dealer's prices per 50-kilogram bag of fertilizer in PHP, national average, 1990–2016



Source: CountrySTAT (PSA n.d.)

Figure 9. Dealer's price per 50-kilogram bag of urea, national average, 1980–2015, nominal and real PHP (2010 = 100)



Source: CountrySTAT (PSA n.d.)

fixed, even during the period of soaring fertilizer prices, as in 2008. However, any attempt to adjust the markup would be counterproductive as farmers can easily shift to other dealers.

A key informant at the distribution node is located in Ilocos Norte. This distributor supplies dealers all over the province. They have been in the business since 1978. Their main fertilizer products are urea and complete NPK. Their main source is a large importer who lands the product in Port Poro Point located in the Ilocos Region. These days, the purchase price of the product is about PHP 1,000/bag for urea and PHP 1,050/bag for NPK (equivalent to USD 471/ton and

Table 4. Breakdown of markup and cost along the supply chain for imported urea, PHP per 50-kilogram bag, late-2013

	Selling Price[a]	Gross Markup	Net Margin (PHP per bag)	Net Margin (percent over selling price)[b]
Dealer	1,090	30	~30[c]	2.8
Distributor	1,060	60	~50[d]	4.7
Importer	1,000	86	~30[e]	3.0
Exporter's price (cost, insurance, and freight, bagged)	914	239[f]	-	-
Export price (free on board, bulk)	675	-	-	-

[a] Importer's actual price; distributor and dealer estimated from markups

[b] As a proportion of selling price

[c] For both informants, associated costs are trivial, as fertilizer forms only a small portion of deliveries of the agri-trading retail shop.

[d] According to the informant, the only nontrivial cost is that for delivery. Estimated from a delivery charge of PHP 3,500 for 25 tons of transport

[e] The implicit cost of PHP 56 is consistent with port and customs clearance charges of about PHP 20/bag (PHP 10,000 per container), estimated from Manila International Container Port tariff schedule, and transport cost of PHP 36/bag (PHP 18,000 per container) estimated by two trucking companies. According to the fertilizer importer, other cost items on a per-bag basis are minimal.

[f] Implicit markup only. Free on board price from World Bank Pink Sheet (WB 2013).

Blank denotes information not available.

Sources: Informant interviews and references cited

USD 495/ton, respectively). They sell this to their dealers with a markup of PHP 50/bag, plus delivery fee. They could not raise the markup without risk of losing their buyers to other distributors from adjoining provinces.

Lastly, an importer based in Metro Manila provided data on prices in the last quarter of 2013, as follows (in USD):

NPK (14-14-14):	475
16-20-0:	362–370
Urea (46-0-0):	425–442
Ammosul (21-0-0):	220–232
Muriate of potash:	450–454
18-46-0:	533–540

The informant claims that the margins vary depending on the competition. However, the normal margin is only 3 percent on price export (i.e., cost, insurance, and freight plus charges). They are not able to raise their margin beyond this due to the fact that they only have less than 10 percent of the market share in fertilizer trading due to stiff competition.

Lastly, all the informants state that licensing and product registration requirements are straightforward and easy to comply with. The FPA normally processes license renewal in just one day.

Domestic and border prices

David and Balisacan (1981) provide early estimates of the implicit tariff rate on fertilizer. In the latter half of the 1970s, the weighted average implicit tariff for urea is 16 percent, 27 percent for ammonium sulphate, 86 percent for muriate of potash, and -4 percent for mixed fertilizer (NPK). The policy stance at the time appears to be protective of domestic industry (except for mixed fertilizer). This is consistent with domestic resource cost (DRC) and shadow exchange rate (SER) estimates by Illo (1978), which found that domestic nitrophosphatic fertilizer has a DRC/SER far in excess of 1 (at low historical world prices).

More recent estimates of the nominal protection rate are unavailable in the absence of average wholesale price data. Figure 10 juxtaposes retail and world price data for urea from 1990 onward. In the figure, "spread" is defined as the ratio of the average national monthly retail price to the world price (in free on board), converted to pesos using the market exchange rate.

Both world and domestic prices are highly variable (standard deviations are PHP 6,000 and PHP 7,700, respectively). The spread is anywhere from 1.1 (in 2008) to 3.0 (in 1999). World and domestic prices are highly correlated (correlation coefficient of 0.95). Note, however, that the spread tends to be larger when the world price falls and shrinks when world price rises. This seems consistent with fixed markups, at least at the dealer level, as suggested by key informant interviews. The association, of course, is strongly influenced by the market exchange rate. For instance, during the Asian financial crisis, the world price of urea fell by 34 percent, implying a spread of 3.2 had the exchange rate remained constant. Instead, the peso price of the dollar soared, limiting the spread to its actual value of just 1.9.

A high correlation of domestic and foreign price suggests a domestic market that is well integrated with the world market. That is, arbitrage opportunities between domestic and foreign prices are rapidly dissipated. Such absence of arbitrage opportunity is an important indicator of the degree of competition in the domestic market. The following undertakes a more formal test of integration between domestic and world markets.

Market integration

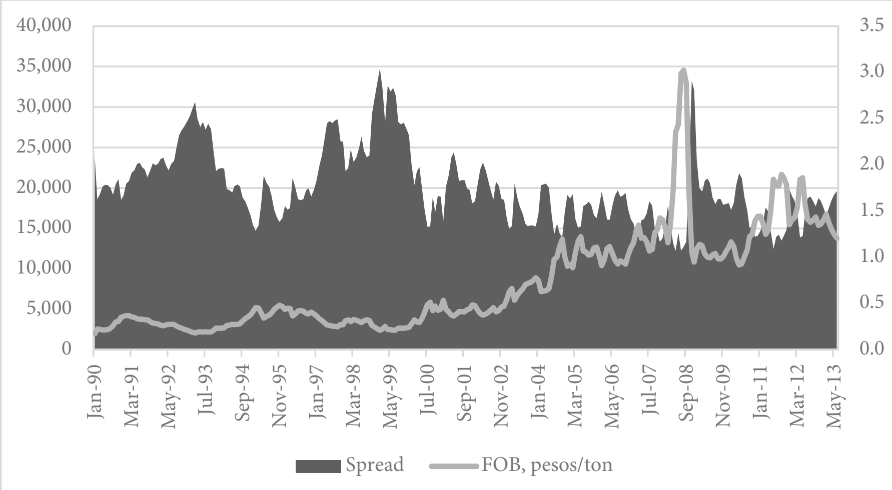
Following Fackler and Goodwin (2001), the concept of market integration adopted here invokes transmission of shocks between spatially separated markets—in this case between domestic and foreign market for fertilizer. Simple transmission can be tested by applying Granger causality, which checks whether shocks in one market (i.e., world) evoke significant responses in another market (i.e., domestic). Denoting monthly domestic and world prices (in common currency) as, respectively, DP_t, WP_t, with β_0, β_1, β_2 as parameters, and ε_t an error term. Taking natural logarithms (denoted by lower case), the posited relationship is as follows:

$$dp_t = \beta_0 + \beta_1 wp_t + \varepsilon_t \qquad (1)$$

The bivariate case traces from Richardson (1978), which handles prices in original or logarithmic form, and can incorporate other variables. For the markets considered here, another important source of systematic variation is the exchange rate. Hence, let the domestic price be expressed in local currency and the redefined world price in USD; denote the monthly exchange rate by ER_t. Equation (1) can be extended as:

$$dp_t = \beta_0 + \beta_1 wp_t + \beta_2 er_t + \varepsilon_t \qquad (1)$$

Figure 10. Monthly price of urea (Black Sea FOB), in USD per ton, and domestic price spread



FOB = Free on board

Source of basic data: World Bank (2013)

The relationship can be estimated by ordinary least squares if $\varepsilon_t \sim N(0,\sigma^2)$. However, finite variance may be violated if both time series are random walks. Prior to estimating (1), there is a need to check if the time series are I(0) stationary. If the series are not stationary but are stationary in first differences, i.e., I(1), then equation (1) can still be estimated if there is a set of parameters for which the following holds:

$$\varepsilon_t = dp_t + b_0 + b_1 wp_t + b_2 er_t \sim I(0) \qquad (1')$$

With multiple time series, if vector autoregression (VAR) of dp_t, wp_t, er_t on lagged values is I(1), the presence of a cointegrating relation (1') can be determined. The model determining the time series itself is a vector error correction (VEC) model of the form:

$$\Delta \mathbf{y}_t = \mathbf{\Pi y}_{t-1} + \sum_{i=1}^{p-1} \mathbf{\Gamma}_i \Delta \mathbf{y}_{t-i} + \varepsilon_t \qquad (2)$$

Here the y_t vector is a 1x3 element vector consisting of time-series variables of interest, while p is the maximum number of lags in the VAR model. The VEC form is useful as it provides information about the speed of adjustment to the long-run equilibrium relationship expressed by the cointegrating equation corresponding to (1). A similar approach is taken in previous studies of developing country agriculture, such as a multicountry study of the Food and Agriculture Organization (Rapsomanikis et al. 2003), a study of the fish market in India and the Philippines, respectively (Shinoj et al. 2008; Garcia and Salayo 2009). The market integration test is implemented in several steps:

Step 1. Test for stationarity: For all three time series, the test rejects I(0) stationarity but fails to reject I(1) stationarity (Table 5).

Table 5. Results of Dickey-Fuller tests in STATA

Variable	P-value for Z(t)	Decision
Domestic price	0.7297	Reject
Domestic price (-1)	0.0000	Fail to reject
Foreign price	0.6089	Reject
Foreign price (-1)	0.0000	Fail to reject
Exchange rate	0.2951	Reject
Exchange rate (-1)	0.0000	Fail to reject

Note: All variables are expressed in natural logarithms.
Source: Author's calculation

Table 6. Results of VAR model estimation with Wald test for Granger causality

Variable and Lags	Coefficient	z-statistic	P>z	χ^2 - statistic	P > χ^2
Domestic price (logs)	-	-	-	143.23	0.000
Domestic price (-1)	1.46	31.3	0.000	-	-
Domestic price (-2)	-0.52	-13.02	0.000	-	-
Foreign price (logs)		-	-	6.43	0.040
Foreign price (-1)	0.15	11.29	0.000	-	
Foreign price (-2)	-0.11	-6.86	0.000	-	
Exchange rate (logs)		-	-	2.74	0.250
Exchange rate (-1)	0.24	3.98	0.000	-	
Exchange rate (-2)	-0.19	-3.16	0.002	-	

VAR = vector autoregression
Source: Author's calculation

Step 2. Determine lag structure: The Hannan-Quinn information criterion and the Schwarz Bayesian information criterion, both point to lags of up to two periods.

Step 3. Estimate a VAR model and apply causality test: Estimates from the VAR model are shown in Table 6. Coefficients of the lagged variables are all statistically significant (based on the z-statistic). Not surprisingly, the hypothesis that lagged values of domestic price (in logs) do not Granger-cause the domestic price is rejected. Similar results hold for foreign price. Lastly, the null of no Granger causality from exchange rate (in logs) to the domestic price cannot be rejected. Nevertheless, the lagged values of the exchange rate individually have significant coefficients (at 1% significance). In short, domestic price and foreign price Granger-cause the domestic price.

Step 4. Apply Johansen test for existence of cointegrating vector(s): The Johansen test involves a null hypothesis of zero to three cointegrating vectors. Results are summarized in Table 7. The hypothesis of no cointegrating relation is rejected (52.2053 > 29.68); however, the hypothesis of at most one cointegrating relation cannot be rejected (7.24 < 15.41). The existence of a single cointegrating vector becomes the working hypothesis in the VEC model.

Table 7. Statistics from the Johansen cointegration test

Maximum Rank	Trace-statistic	5-percent Critical Value
0	52.2053	29.68
1	7.2483	15.41
2	3.3811	3.76
3	-	-

Source: Author's calculation

Step 5. Estimate parameters of cointegrating vector using VEC: VEC analysis is presented in Table 8. At the top of the table are the estimates of the cointegrating equation, which capture the long-run relationships. With domestic price variable restricted to a coefficient of unity, the signs of foreign price and exchange rate coefficients are negative as expected. The coefficients are all statistically significant at 1-percent level (or even lower). The values imply a transmission elasticity of about 0.82 from world to domestic prices (holding exchange rate constant); a similar transmission elasticity holds for changes in the peso-dollar exchange rate (holding world dollar prices constant).

The short-term adjustment relation is shown in the bottom part of the table. When the value of cointegrating equation is positive, i.e., the domestic price is "too high", then an increase in its value causes 0.06-percent decline in the domestic price of the next period. The difference is small on a monthly basis but adds up to a sizable proportion on an annual time scale. Note that in the short-run adjustment equations, the coefficients of logdom in the D.logfob and D.logpusd equations are not significant, consistent with the notion of a small open economy and small sector (i.e., fertilizer alone does not affect the market exchange rate).

Domestic fertilizer price dispersion

The abovementioned results analyze integration between average domestic price and a benchmark world price. It does not address subnational issues, i.e., whether or not domestic prices within the

Table 8. Results for VEC analysis using Johansen maximum likelihood

Variable	Coefficient	z-value	P>z
Cointegrating vector:			
Domestic price (in logs)	1.0000		
Foreign price (in logs)	-0.8222	-27.15	0.000
Exchange rate (in logs)	-0.8397	-14.45	0.000
Constant	-2.0334		
ECM (log of domestic price)			
Log of domestic price (-1)	-0.0569	-5.10	0.000
Change in log of domestic price (-1)	0.5209	12.86	0.000
Change in log of foreign price (-1)	0.1083	6.97	0.000
Change in log of exchange rate (-1)	0.2030	3.38	0.001
Constant	0.0022	1.71	0.088

VEC = vector error correction; ECM = error correction model
Source: Author's calculation

country are themselves integrated. Across the country, there is a wide dispersion in retail prices of fertilizer based on the dealer's price index (Table 9). Relative to the national average, the cheapest fertilizers are found in Ilocos, Cagayan Valley (in the north); Western Visayas (central); and Davao Region (south). The most expensive fertilizers, meanwhile, are in the Autonomous Region in Muslim Mindanao (ARMM) and Eastern Visayas, which also happen to be among the poorest regions of the country. Variations in fertilizer prices (as gauged by the standard deviation) are similar across fertilizer grades, i.e., in the range of 6–9 percent. The widest range in the index is for urea, followed by ammonium sulfate.

Galang (2014) has found that, in the case of urea, regional markets are integrated in the long run. This appears consistent with the results of this paper, which fails to find evidence of market

Table 9. Dealer's price index by region, average of 2010–2014 (Philippines = 1.00)

	Ammonium Phosphate	Ammonium Sulfate	Complex NPK	Urea	Average
Philippines	1.00	1.00	1.00	1.00	1.00
Luzon					
CAR	0.98	1.00	0.97	0.98	0.98
Ilocos	0.93	0.92	0.94	0.95	0.94
Cagayan Valley	0.95	0.92	0.93	0.94	0.94
Central Luzon	0.97	1.00	0.95	0.96	0.97
CALABARZON	1.10	1.11	1.04	1.03	1.07
MIMAROPA	1.09	1.13	1.04	1.06	1.08
Bicol	0.99	1.09	1.01	1.03	1.03
Visayas					
Western Visayas	0.93	0.89	0.95	0.92	0.92
Central Visayas	1.02	1.05	1.02	1.01	1.02
Eastern Visayas	1.15	1.17	1.10	1.11	1.13
Mindanao					
Zamboanga Peninsula	1.03	1.04	1.00	1.00	1.02
Northern Mindanao	1.05	1.03	1.01	0.99	1.02
Davao Region	0.94	0.91	0.97	0.94	0.94
SOCCSKSARGEN	0.96	0.92	0.97	0.94	0.95
Caraga	0.99	0.93	0.97	0.95	0.96
ARMM	1.00	1.02	1.13	1.19	1.09

NPK = nitrogen, phosphorus, and potassium
CAR = Cordillera Administrative Region
CALABARZON = Cavite, Laguna, Batangas, Rizal, and Quezon
MIMAROPA = Occidental Mindoro, Oriental Mindoro, Marinduque, Romblon, and Palawan
SOCCSKSARGEN = South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos City
ARMM = Autonomous Region in Muslim Mindanao
Source of basic data: CountrySTAT (PSA n.d.)

power in the fertilizer industry. The number of market players in the industry makes it highly unlikely for one or a small number of fertilizer dealers to control the market price, whether at the national or regional level. Nonetheless, the disparities in Table 9 are undeniable; these must therefore be attributed to transaction cost differences, perhaps due to meso-level gaps in infrastructure and logistics. Other sources of discrepancy may be at the micro level, due to tied credit-output transactions between farmer and trader causing failure of competition, especially in poorer and more isolated areas such as ARMM and Eastern Visayas. Explaining these interregional price differences warrants future research.

CONCLUSION

Summary and key challenges

The fertilizer sector has grown dramatically since the 1950s, owing to the adoption of modern technology in Philippine agriculture. From its initial concentration in export crops (mostly sugarcane), demand from cereals and other crops exploded after the Green Revolution in rice. Application of fertilizer realized the high-yield potential from modern technologies and varieties, which exhibited better fertilizer response compared to traditional varieties.

The policy regime has also evolved. Initially, policies aimed at establishing a strong domestic industry to substitute for imports by pursuing protectionist policies. This was followed by an even stronger interventionist approach that aimed at both protection of domestic investors and making cheap inputs (fertilizer, chemicals, credit) accessible to small farmers.

The current regime (beginning 1986) is market oriented. The market distortions over the previous three decades have largely been dismantled. Tariffs are now low; regulations are focused on maintaining product quality and safety; subsidies were eliminated, though strong incentives are in place through various exemptions such as from the value-added tax and tariff exemption for producer-importers.

However, significant challenges remain at two levels. First, at the market level, despite efforts of regulators and the private sector, the sale of substandard fertilizer is still being reported. However, how widespread the practice is remains unclear (beyond some anecdotes). A more serious challenge is the persistence of apparent inefficiencies in fertilizer marketing, as seen in the large discrepancies in pricing across adjacent regions for the same product. The fact that markets are competitive does not preclude inefficiencies in the fertilizer supply chain at least in some areas owing to poor transport infrastructure, weak logistics systems, and low investment. Addressing these inefficiencies is a priority area for public investment.

The second level is at the farm: rice farmers continue to apply suboptimal amounts of fertilizer, whether with the main nutrients (NPK) or the micronutrients (Mamaril et al. 2009). While knowledge dissemination does play a key role in remedying this—implying a more targeted extension program as a priority for rice farming—perhaps other factors are equally or even more important which, however, elude researchers to date.

Way forward

The foregoing suggests a few implications for policy and research. The first, of course, is to stay the course on the market-oriented regime in fertilizer policy. There certainly remains a persistent (though no longer vocal) constituency for interventionism, emphasizing fertilizer subsidies and industry protection. Inappropriate solutions to very real problems in the sector must always be resisted.

Identifying appropriate solutions is, however, far from easy. Priorities for further research involve evidenced-based analysis at both levels of the problem, i.e., the market and the farmer. The former warrants careful documentation of structure, conduct, and performance of fertilizer trading, along with assessment of binding constraints and choke points. On the other hand, the latter will entail a more flexible model building, together with primary data collection and hypothesis testing, to arrive at a comprehensive understanding of the farmer's goals, opportunities, and constraints. This will help improve the package of technologies, incentives, and infrastructure toward boosting competitiveness of smallholder systems in the Philippines.

REFERENCES

Abedullah and S. Pandey. 2004. Risk and fertilizer use in the rainfed rice ecosystem of Tarlac, Philippines. *Journal of Agricultural and Applied Economics* 36(1):241–250.

Alcala, P. 2012. Fertilizer market in the Philippines: Evolution, challenges, and outlook. Keynote paper presented at the International Fertilizer Asia Crossroads Asia-Pacific Conference, October 29–31, Manila.

Barker, R., R. Herdt, and B. Rose. 1985. *The rice economy of Asia*. Washington, D.C: Resources for the Future.

Bunoan-Olegario, A. 2011. Agriculture and fertilizer market in the Philippines: Current situation and outlook. Presented at the International Fertilizer Association Crossroads Asia-Pacific Conference, November 2–4, Sanya, People's Republic of China.

Castillo, G. 1975. *All in a grain of rice: A review of Philippine studies on the social and economic implications of the new rice technology*. Laguna, Philippines: Southeast Asian Regional Centre for Graduate Studies and Research in Agriculture.

David, C. and A. Balisacan. 1981. An analysis of fertilizer policies in the Philippines. *Journal of Philippine Development* 8(1&2):27–37.

Dawe, D., P. Moya, F. Gascon, and M.S. Valencia. 2007. Can nitrogen management in Philippine rice production be improved? In *Why does the Philippines import rice? Meeting the challenge of trade liberalization*, edited by D. Dawe, P. Moya, and C. Casiwan. Laguna, Philippines: International Rice Research Institute.

Dobermann, A. and C. Witt. 2004. The evolution of site-specific nutrient management in irrigated rice systems of Asia. In *Increasing productivity of intensive rice systems through site-specific nutrient management*, edited by A. Dobermann and C. Witt. Enfield, NH and Los Baños, Philippines: Science Publishers, Inc. and International Rice Research Institute.

Fackler, P. and B. Goodwin. 2001. Spatial price analysis. *Handbook of agricultural economics Vol. 1B: Marketing, distribution, and consumers*. North Holland, Amsterdam: Elsevier Science.

Fertilizer and Pesticide Authority (FPA). 2014. Fertilizer supply and demand. Quezon City, Philippines: FPA. http://fpa.da.gov.ph/images/FPAfiles/DATA/Regulation/Fertlizer/SupplyandDEMAND/1970-2008fertSDandaveprices.pdf (accessed on June 30, 2014).

———. 2016. Citizen's charter. Quezon City, Philippines: FPA.

Food and Agriculture Organization (FAO). 2006. Fertilizer use by crop. *Fertilizer and Plant Nutrition Bulletin 17*. Rome, Italy: FAO.

Galang, I. 2014. A spatial integration analysis of the regional fertilizer markets in the Philippines. PIDS Discussion Paper No. 2014–36. Makati City, Philippines: Philippine Institute for Development Studies.

Garcia, Y. and N. Salayo. 2009. Price dynamics and cointegration in the major markets of aquaculture species in the Philippines. *Asian Journal of Agriculture and Development* 6(1):49–82.

Gines, H., G. Redondo, A. Estigoy, and A. Dobermann. 2004. Site-specific nutrient management in irrigated rice systems of Central Luzon, Philippines. In *Increasing productivity of intensive rice systems through* *site-specific nutrient management*, edited by A. Dobermann and C. Witt. Enfield, NH and Los Baños, Philippines: Science Publishers, Inc. and International Rice Research Institute.

Herdt, R. and C. Capule. 1983. *Adoption, spread, and production impact of modern rice varieties in Asia*. Laguna, Philippines: International Rice Research Institute.

Horstkotte-Wesseler, G. 1999. Socioeconomics of rice aquaculture and IPM in the Philippines: Synergies, potential, and problems. ICLARM Technical Report No. 57. Makati City, Philippines: Gesellschaft fur Technische Zusammenarbeit and International Center for Living Aquatic Resources Management.

Illo, J. 1978. The Philippine fertilizer industry: A domestic resource cost analysis. *Philippine Review of Economics* 15(3):70–100.

International Trade Centre (ITC). n.d. Trademap. Geneva, Switzerland: ITC. http://www.trademap.org (accessed on June 30, 2016).

Mamaril, C., M. Castillo, and L. Sebastian. 2009. *Facts and myths about organic fertilizers*. Nueva Ecija, Philippines: Philippine Rice Research Institute.

Mariano, M., R. Villano, and E. Fleming. 2010. Are irrigated farming ecosystems more productive than rainfed farming systems in rice production in the Philippines? *Agriculture, Ecosystems, and Environment* 139(4): 603–610.

Mataia, A. and D. Dawe. 2007. Lack of credit is not a major constraint to improving the productivity of rice farmers. In *Why does the Philippines import rice? Meeting the challenge of trade liberalization*, edited by D. Dawe, P. Moya, and C. Casiwan. Laguna, Philippines: International Rice Research Institute.

Mojica-Sevilla, F. 2006. The Philippine fertilizer industry. *Food and Agri Business Monitor*. Pasig City, Philippines: Center for Food and Agri Business, University of Asia and the Pacific.

National Economic and Development Authority (NEDA). 2017. *Philippine development plan 2017–2022*. Pasig City, Philippines: NEDA.

Office of the President (OP). 1992. The Aquino management of the presidency. *The President's report 1986–1992*. Manila, Philippines: OP, Republic of the Philippines.

Philippine Statistics Authority (PSA). n.d. PSA CountrySTAT. Quezon City, Philipines: PSA. http://countrystat.psa.gov.ph (accessed on June 30, 2016).

Pingali, P., M. Hossain, S. Pandey, and L. Price. 1998. Economics of nutrient management in Asian rice systems: Towards increasing knowledge intensity. *Field Crops Research* 56(1):157–176.

Presidential Decree No. 1144. 1977. Creating the Fertilizer and Pesticide Authority and abolishing the Fertilizer Industry Authority. Manila, Philippines: Office of the President of the Republic of the Phililppines.

Rapsomanikis, G., D. Hallam, and P. Conforti. 2003. Market integration and price transmission in selected food and cash crop markets of developing countries: Review and applications. *FAO Commodity Market Review 2003–2004*. Rome, Italy: Food and Agriculture Organization.

Richardson, P. 1978. Some empirical evidence on commodity arbitrage and the law of one price. *Journal of International Economics* 8(2):341–351.

Shinoj, P., B.G. Kumar, R. Sathiadhas, K.K. Datta, M. Menon, and S.K. Singh. 2008. Spatial price integration and price transmission among major fish markets in India. *Agricultural Economics Research Review* 21:327–335.

Shively, G. and C. Zelek. 2003. Technical change, factor bias, and input adjustments: Panel data evidence from irrigated rice production in Southern Palawan, Philippines. *Philippine Journal of Development* 30(1): 91–110.

Sumayao, B. 1969. *The Bicolano farmers' response to an improved rice variety* IR-8-288-3. Laguna, Philippines: University of the Philippines College of Agriculture.

Tariff Commission (TC). 2015. Tariff finder. Quezon City, Philippines: TC. http://finder.tariff.gov.ph (accessed on June 30, 2015).

World Bank (WB). 2013. World Bank pink sheet. Washington, D.C.: WB. http://www.worldbank.org/en/research/commodity-markets (accessed on January 1, 2013).