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Development of the Fertiliser Industry in Cambodia: Structure of the Market, Challenges in the Demand and Supply Sides, and the Way Forward

Theng Vuthy, Khiev Pirom and Phon Dary

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CONTENTS

List of Figures and Tables

Acronyms and Abbreviations

ADB	Asian Development Bank
AIC	Agriculture Inputs Company
BAMS	Bureau of Agricultural Materials Standards
CARDI	Cambodian Agricultural Research and Development Institute
CSES	Cambodia Socio-Economic Survey
DAL	Department of Agricultural Legislation
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
HYV	High-Yielding Variety
ICT	Information and Communication Technology
ITC	International Trade Center
LCC	Leaf Colour Chart
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economy and Finance
MOC	Ministry of Commerce
NPK	Nitrogen, Phosphorous and potassium
NUE	Nutrient Use Efficiency
OAL	Office of Agricultural Legislation
SSNM	Site Specific Nutrient Management

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Abstract

Agriculture plays a crucial part in Cambodia's economy, accounting for about 27.3 percent of GDP in 2010. The sector engages at least 59 percent of the economically active population, and over 90 percent of the population lives in rural areas where agricultural activities remain the primary source of livelihood. Agricultural growth, on average, was about 4.6 percent per year over the period 1994–2010. This growth is largely attributable to the crops sub-sector, which contributes more than 50 percent of agricultural GDP. Increased agricultural productivity improves farmers' income, enhances consumption of high quality nutritious food and helps people (mainly smallholder subsistence farmers) escape poverty.

Crop production growth over the last decade has been driven largely by higher yields. These higher yields are attributable to the increased use of farm inputs—fertilisers, improved seeds and irrigation. It is estimated that the green revolution package (fertiliser, irrigation and seeds) in Cambodia has increased rice production by 15 percent, farm income by 7 percent and rice export by 228 percent.

The fertiliser market in Cambodia is evolving rapidly to meet farmers' demands. It is a free market, led by a competitive private sector with prices determined by market forces. Fertiliser supply has increased rapidly in response to high demand prompted by the shift towards crop intensification. Cambodia imported about 433,120 tonnes of NPK fertiliser products in 2011 compared with 137,877 tonnes in 2002. There is no policy to "protect" or favour local fertiliser production plants; the government promotes a free market, allowing fertiliser suppliers to compete in quality and prices at all levels along the supply chains.

Yet, although the fertiliser sector performs well and can serve domestic demand, government policy and trade regulations through licensing and tonnage quota-systems restrict the free market economy and increase trade transaction costs. Weak regulatory enforcement and lack of clear roles and responsibilities between the government agencies responsible for regulating fertiliser trade have caused problems in the market. As a result, many farmers are suspicious of the market and abstain from using fertiliser or increasing application rates. At the same time, the underfunding of scientific research on fertiliser use and inadequate provision of extension services have resulted in low fertiliser use efficiency and thus hindered further improvements in crop productivity.

Future gains in crop production are expected to come mostly from increased farm yields, and fertilisers will remain essential to meet the demands of crop intensification. Therefore, to enhance the role of fertiliser in transforming agriculture for food security, agricultural growth and export promotion, the factors restricting the fertiliser market should be addressed. Actions could include:

- Reforming and simplifying import licensing procedures and regulations;
- Removing tonnage restrictions and allowing importers to bring in unlimited amounts of registered products based on market risk assessment;
- Harmonising the roles and line responsibilities of the ministries involved in fertiliser trade by merging human resources from the Ministry of Commerce (MOC) and the Ministry of Agriculture, Forestry and Fisheries (MAFF) to create one department that regulates distribution operations at import, wholesale and retail levels;

- Strengthening data collection systems by requiring importers to furnish import data and prices to MAFF, and developing a market information system to make data on trade, production and market prices available to the public; and
- Expanding scientific research and public extension services to improve fertiliser use efficiency through increased public funding for agricultural research and development.

1
Introduction

1.1. Background

The agricultural sector plays a crucial role in Cambodia's economy, accounting for about 27.3 percent of GDP in 2010.[1] On average, agricultural growth was about 4.6 percent per year over the period 1994–2010, and the sector engaged at least 59 percent of the economically active population. In 2010, the key sub-sectors were crops (53.8 percent, of which 31 percent was paddy rice), fisheries (24.8 percent), livestock (15 percent), and forestry and logging (6.3 percent) (NIS 2011). The country's agricultural sector is predominantly characterised by small-scale farming: about 40 percent of farmers own less than one hectare of agricultural land (Theng 2013). Over 90 percent of smallholder farmers live in rural areas and rely on agriculture for their primary sources of livelihood (World Bank 2005, 2009).

Cambodia has an abundance of fertile agricultural land, accounting for about 4 million ha in 2012, of which 3 million ha is under rice crop production. Wet season rice occupies about 83 percent (2.5 million ha) of the total rice farming area (MAFF 2013). Most of the soils used for crop cultivation are commonly described as lowly fertile, and contain low levels of the major nutrients—nitrogen (N), phosphorous (P) and potassium (K)—and low levels of organic matter (White *et al.* 1997). In addition, soil fertility declines further every year due to nutrient extraction from the soil by cereal grain cropping and by-products removal (Seng 2011), unless the nutrients are replenished in sufficient quantities through balanced fertiliser application. Therefore, the efficient use of fertiliser plays a crucial role in raising crop yields and sustaining the natural resources of farming land (Bumb and Baanante 1996).

Fertiliser helps to increase crop production in several ways. First, it helps to replenish nutrients and enhance soil fertility. Second, it helps to increase crop productivity because it can adapt high-yielding varieties (HYVs). Third, in the nutrient-poor or depleted soils of the tropics, fertiliser is used to increase both crop yields and biomass; additional biomass augments the supply of organic matter, improves moisture retention and nutrient use efficiency and thereby contributes to increased crop yields (Bumb and Baanante 1996). Because future increases in crop production will have to come mostly from intensification (higher crop yields, multiple cropping), fertiliser will remain an essential input in meeting projected production levels and greater food security (RGC 2010). Other endorsements for the important role fertiliser is set to play come from Yu and Fan (2009), who argue that fertiliser, seeds and irrigation are major determinants in the rice-supply response in Cambodia. Similarly, Arulpagasam *et al.*(2003) highlight the promotion of the Green Revolution package of seed-fertiliser-irrigation as key to Cambodia realising its aspirations to increase crop productivity, enhance agricultural income, and promote milled rice export.

The fertiliser market in Cambodia has evolved rapidly to serve the demands of Cambodian farmers. It is a free market, led by the private sector operating in a competitive manner with prices set by market forces (IFDC 2010). The supply of fertilisers has increased rapidly in response to agricultural intensification. In 2011, around 433,120 tonnes of NPK fertiliser

[1] This estimate is based on constant prices in 2000. In current prices, the agricultural sector accounted for about 33.9 percent of GDP in 2010 (NIS 2011).

products were imported compared with about 137,877 tonnes in 2002, indicating a 210 percent rise in demand in a 10-year period (section 4.1). However, in recent years, higher fertiliser prices have prevented farmers from applying fertiliser in sufficient quantities: about 79 percent of farmers report the underuse of fertiliser, with financial considerations as the main reason (Lim 2006). Poor fertiliser quality is another problem, with labels often misstating the actual nutrient content (IFDC 2010). The presence of poor quality fertiliser has made many farmers suspicious of the market, and consequently to abstain from it altogether (Schamel and Hongen 2003). Given that fertiliser plays an important role in promoting crop productivity and food security, it is important to review the structure of the fertiliser industry, trends in fertiliser use, policy and the regulatory environment influencing the market, as well as the consumption of fertiliser, along with possible interventions to improve the situation.

1.2. Research Objectives

The research objectives for the study are:

1. To review the structure of the fertiliser industry in Cambodia
2. To identify key constraints on the fertiliser market with a focus on both the demand and supply sides
3. To review the efficiency of fertiliser use and the role of fertiliser in agricultural transformation and food security
4. To identify possible policy options to enhance the role of fertiliser in the agricultural transformation and food security agenda in Cambodia.

1.3. Structure of the Report

The report is structured as follows. Section 2 provides a brief review of the role fertiliser plays in transforming the agricultural economy and achieving food security. Section 3 details issues on the demand side. Section 4 reviews the structure of the fertiliser industry in Cambodia. Section 5 presents issues on the supply side. Section 6 describes the influences of the pricing environment on fertiliser consumption. Section 7 provides policy implications for improving the fertiliser industry in Cambodia.

2
Role of Fertilisers in Transforming the Agricultural Economy and Food Security

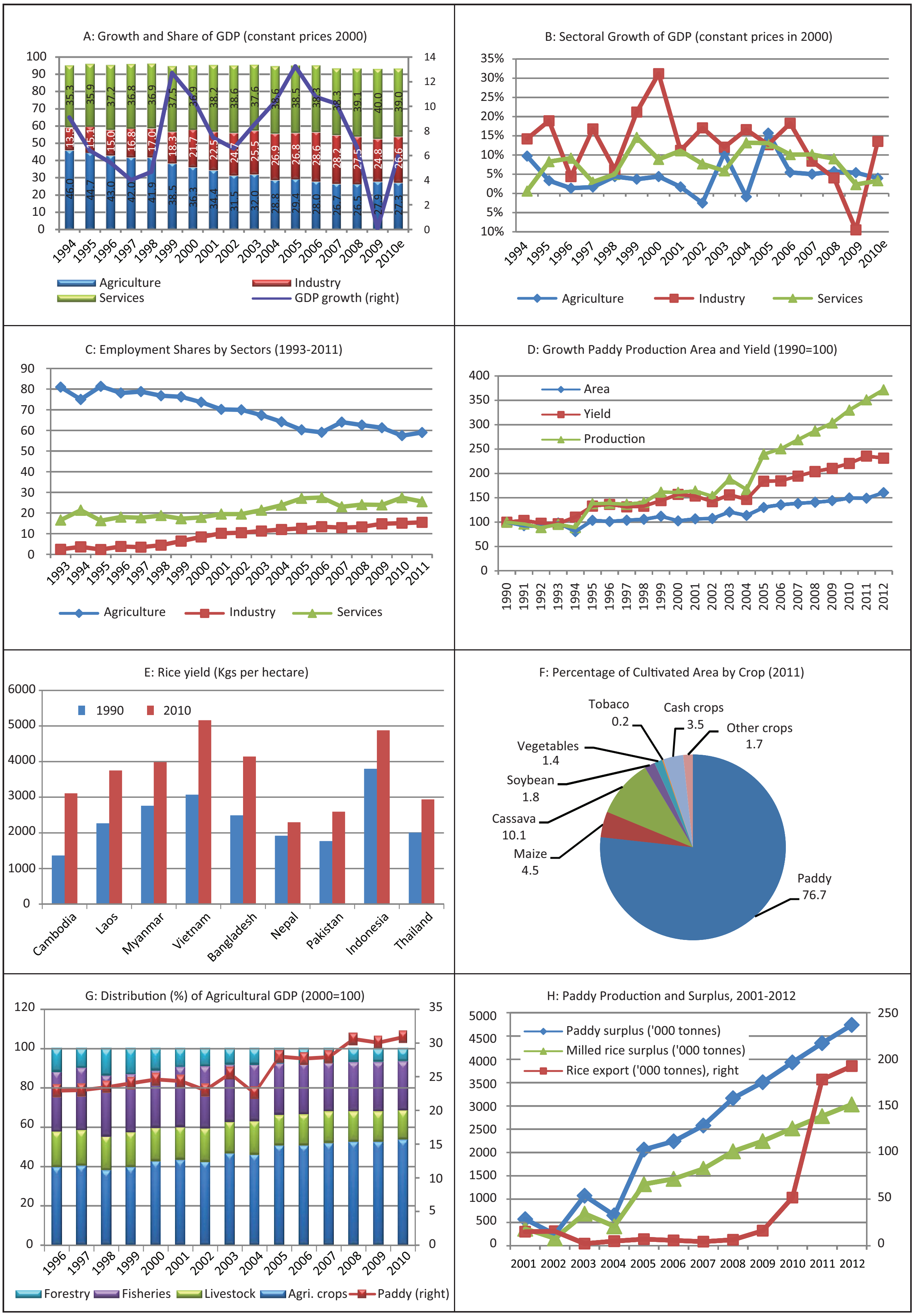
2.1. Transforming Agriculture for Growth and Export Promotion

The structure of the Cambodian economy has undergone profound transformation—a shift in the sources of growth from agriculture towards labour-intensive industrial and service sectors. From 1994 to 2010, industrial and service sector outputs grew at impressive annual rates of close to 12 percent and 8 percent, respectively, while agricultural output increased at a robust rate of more than 4 percent. As a result, the production structure of the economy has undergone significant changes. In 1994, agriculture accounted for 46 percent of GDP, with industry contributing 13 percent and services 35 percent. But by 2010, agriculture's share had fallen to about 27 percent, that of industry had doubled to 27 percent, and that of services had edged up to 39 percent. The decline in the share of agriculture to total output has been accompanied by a decline in the share of employment in agriculture from about 81 percent in 1993 to about 60 percent in 2011. Concomitantly, industry's share in total employment has increased from about 2 to 15 percent, while that of services has risen from 17 to 25 percent (Figure 2.1 A, C). Although agriculture's share of national GDP has been declining overtime, its role remains crucial in driving economic growth and reducing poverty (Theng and Koy 2011).

Cambodia's structural transformation has been intertwined with solid gains in productivity in the agriculture sector. Between 1993 and 2012, crop and food production increased nearly fourfold, while cultivated land areas increased one and a half times (Figure 2.1 D). The increase in agricultural output/production was driven by farm yield: agricultural yield per hectare more than doubled, from about 1360 kg in 1990 to 3100 kg in 2012 (Figure 2.1 D)—the largest per-hectare yield increase among selected comparator countries (Figure 2.1 E; CDRI 2013). This impressive agricultural transformation was especially attributed to the increase in the use of chemical fertilisers, the gradual switch to improved medium and early high-yielding cultivars, and better irrigation systems (Yu and Fan 2009; USDA 2010). A 1 percent increase in fertiliser use is estimated to increase wet season rice yield by 0.1 percent and dry season yield by 0.2 percent (Yu and Fan 2009). The use of chemical fertiliser in Cambodia is still much lower than in comparator countries in Southeast Asia (Yu and Diao 2011), thus the intensification that is needed to increase agricultural output to meet expected demand could be achieved by increasing the efficient application of appropriate inputs (Yu and Fan 2009).

The increase in agricultural crop output has contributed to agricultural GDP growth and exports over the past decade (Figure 2.1 B, G); the subsector now contributes more than 50 percent of total agricultural GDP. Paddy production contributes significantly to agricultural GDP, accounting for about 25–30 percent of the total over the past 15 years. The country has had a history of rice self-sufficiency as far back as 1995, and since then the paddy surplus has increased so that enough is now available for export (Theng and Koy 2011). The Green Revolution package in Cambodia (fertiliser and irrigation) has helped to increase rice production by 4 percent, agricultural income by 1.5 percent and rice export by 31 percent (Arulpagasam *et al.* 2003). Additional investment to improve traditional rice seeds was projected at that stage to increase production by 15 percent, agricultural income by 7 percent and rice export by 228 percent (Arulpagasam *et al.* 2003).

Figure 2.1: The Agricultural Situation in Cambodia



Sources: MAFF Annual Report 1999–2013; FAOSTAT 2013; IMF 2004, 2009; NIS 2011; CDRI 2013

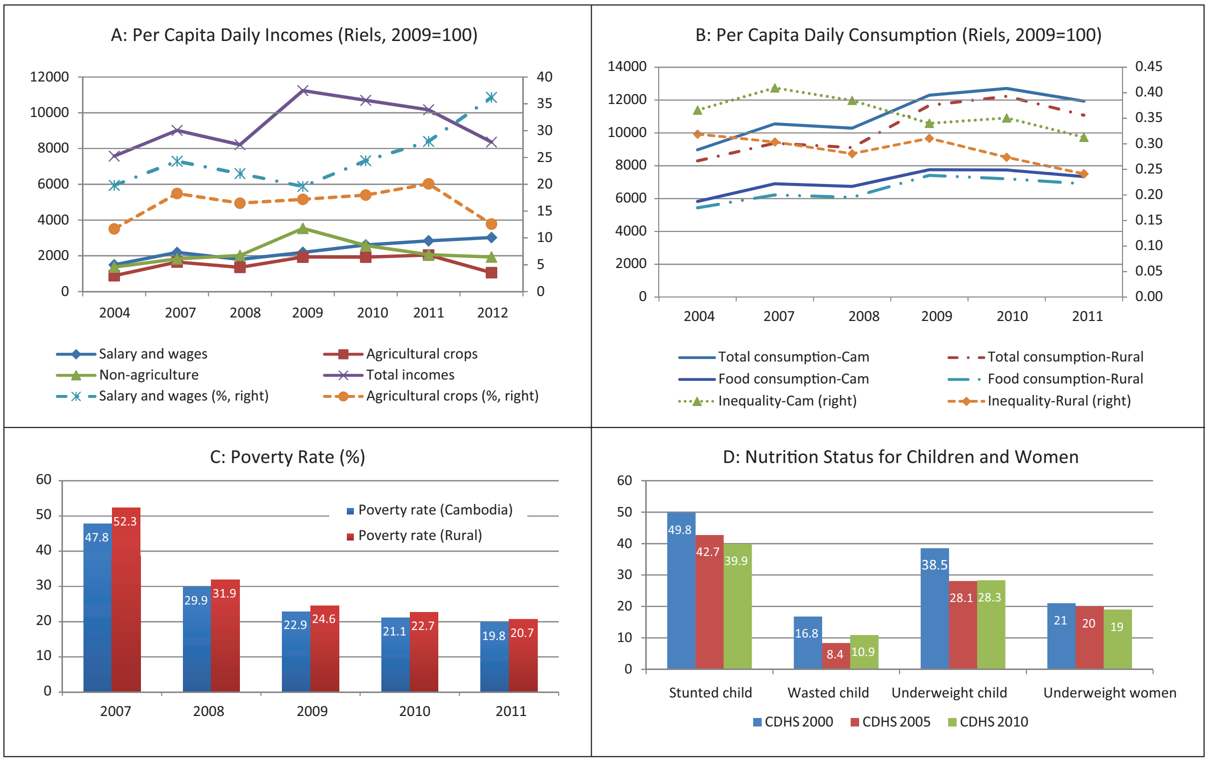
Cambodia's paddy surplus has increased remarkably over the past 10 years, reaching about 4.7 million tonnes in 2012, equal to about 3 million tonnes of milled rice for export (Figure 2.1 H). Although a huge volume of paddy can be processed for export, the official statistics recorded very low figures—less than 20,000 tonnes a year between 2001 and 2009. Most of the surplus is exported as paddy to Vietnam and Thailand (JICA 2012). However, since the launch of the Rice Policy in mid-2010 (RGC 2010), milled rice exports have grown at a rapid pace, boasting a tenfold increase to 200,000 tonnes in 2012. The government has set an export target of one million tonnes of milled rice by 2015 (RGC 2010), but this goal might not be reached due to constraints in the rice sector ranging from primary farm production to postharvest handling and processing, export logistics and physical infrastructure. The underperformance of the milling sector is mainly attributable to low milling capacity, high energy costs, lack of paddy market and poor paddy quality (Theng 2013). The production and yield of other crops such as cassava, maize and soybean have also markedly increased over the past decade; these crops produce a marketable surplus and have export potential (MAFF 2013). Non-rice crop surpluses are also exported to neighbouring countries, in particular as raw materials for industry. The level of production of these crops is affected by the same postharvest constraints that trouble the rice sector (JICA 2012).

2.2. Maintaining Food and Nutrition Security

Fertiliser is important for achieving an increase in crop productivity (Tong 2010). If there is a sufficient supply of nutrients in the soil is enough, crops will grow well and produce high yields (FAO 2000). Since the majority of the poor depend largely on farming for their livelihoods, increasing crop productivity is a key to improving the income of farmers and rural people and, ultimately, to reducing poverty (Yu and Fan 2009). Figure 2.2 shows the relationship between per capita daily incomes and consumption and poverty reduction in Cambodia between 2004 and 2011. Increased income from agricultural crops contributed to higher household incomes, thus people were able to increase their food consumption. Moreover, increased food crop production also helps to reduce domestic food prices, which in turn helps the urban poor since this group spend a large share of their incomes on food (Yu and Fan 2009). Theng and Koy (2011: 28) confirm the relationship between income and food security; the income of rural households decreased by 31 percent, food consumption dropped by 32 percent and non-food consumption declined by 10 percent between September 2008 and September 2009. Rice consumption reduced by 36 percent on average over the same period. Ecker and Diao (2011) have also argued that increases in per capita GDP and household incomes contribute to poverty reduction.

Historical evidence shows that economic growth generally leads to an improvement in human nutrition, while the most obvious and direct pathway from economic growth to improved nutrition is via household income. If the growth leads to higher income at household level, people are able to consume more food with a higher nutritional value (Ecker and Diao 2011). However, in Cambodia, empirical study shows that although economic growth has contributed to an improvement in food security and poverty reduction, it has not reduced the degree of undernutrition. Agricultural growth significantly contributed to the increase in dietary diversity, but it had no significant impact on improving child nutrition, suggesting that to make agricultural transformation more nutrition-sensitive, complementary nutrition-specific interventions are needed (Ecker and Trinh Tan 2013). National household survey data (CDHS 2010) confirms the slow progress in improving the nutritional status of children and women for the period 2000 to 2010 (Figure 2.2 D). This result suggests that further intensive interventions are needed.

Figure 2.2: Food Security and Nutrition in Cambodia



Sources: CSES database 2004, 2007–2011; MOP 2012; CDHS 2010

3
Demand-side Issues

3.1. Trends in Fertiliser Use

Modifying the soil through the addition of fertilisers is considered essential to promote strong crop growth and increase yield. The primary nutrients in fertilisers are nitrogen (N), phosphate (P2O5) and potash (K2O). Fertiliser products containing these macronutrients have been imported into Cambodia and used by farmers (section 4.1). As FAO statistics show, in 2002 total nutrient consumption was 21,555 tonnes and this rose sharply to 46,048 tonnes in 2010; however, consumption fell by almost one-third to 14,275 tonnes in 2003, recovering to just under 20,000 tonnes in 2004 (Table 3.1).[2] The lower NPK fertiliser use in 2003 and 2004 may be due to natural calamities; there was severe flooding in 2002 and drought in 2004. Of the three nutrients, phosphate (P2O5) consumption showed a relatively higher annual growth than nitrogen (N) and potash (K2O) over the period 2002–2010. Nitrogen consumption rose significantly to above 20,000 tonnes, except for the drastic drop in 2003.[3]

Table 3.1: Fertiliser Consumption by Nutrient in Cambodia, 2002–2010 (tonnes)

Item	2002	2003	2004	2005	2006	2007	2008	2009	2010
Nitrogen (N)	7763	5209	7467	11053	10657	8590	12447	16905	21022
Phosphate (P2O5)	12829	8166	11672	17380	18190	23882	14874	19502	23998
Potash (K2O)	963	899	715	1556	763	792	952	947	1028
Total	**21555**	**14274**	**19854**	**29989**	**29610**	**33264**	**28273**	**37354**	**46048**

Source: FAOSTAT 2013 (http://faostat.fao.org/site/575/default.aspx#ancor, accessed 9 July 2013)

Figure 3.1 shows trends in fertiliser use over the period 2007-2010 aggregated from data of the Cambodia Socio-Economic Survey (CSES).[4] Fertiliser use by wet season rice farmers shows a gradual upward trend, except for a drop in 2008 and a peak of 267,848 tonnes in 2009.[5] The drop in 2008 responded to a spike in fertiliser prices, while the high fertiliser use in 2009 is attributable to the drop in fertiliser prices and farmers consequently increasing their use (see section 3.2 and Figure 3.6). Trends in fertiliser use in the dry season show a range from 75,000 tonnes to more than 80,000 tonnes a year, except in 2009 when the total fell to about 65,000 tonnes. Again, the drop in fertiliser use was due to the high fertiliser prices that continued up to the first quarter of 2009 (Figure 3.6) when dry season rice cultivation started. Overall, fertiliser use increased for all crops, with a slow rate of increase in the period 2009–2011 given the high prices of fertiliser.

2 Table 3.1 gives the nutrient content of fertiliser in elemental form (N, P2O5 and K2O); elsewhere in this report, the term "fertiliser" refers to compound fertiliser products containing these elements.

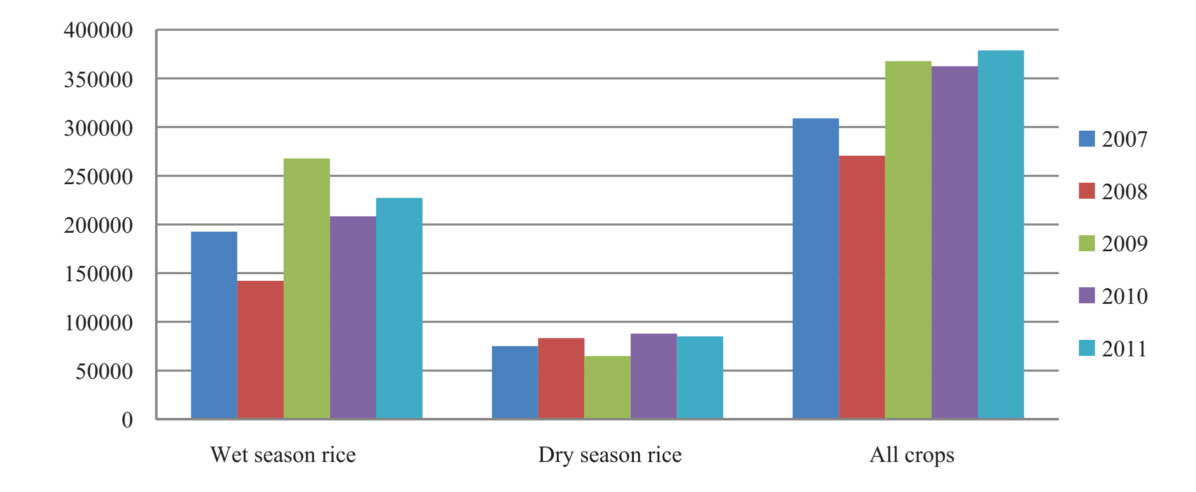
3 Because of the extensive crop failure caused by severe floods in 2001 and 2002, farmers had less money to buy fertiliser, resulting in a drop in fertiliser use in 2003. Drought in 2004 also caused a reduction in fertiliser use.

4 The CSES does not record the amount of fertiliser used; instead, it records total expenditure on fertiliser and other agrochemicals. Due to data limitations and the high proportion of expenditure on fertiliser (90 percent) to total expenditure on agrochemicals, we make the assumption that total expenditure equals fertiliser expenditure, and then estimate the amount of fertiliser used by dividing total fertiliser expenditure by average fertiliser price. The household sample sizes for the CSES were 3593 in 2007, 3548 in 2008, 11,971 in 2009, 3592 in 2010 and 3592 in 2011.

5 The amount of fertiliser used at the national level was scaled up by the average amount of fertiliser used (sampling weight applied) multiplied by total cultivated area (proportion of land fertilised).

There is a large discrepancy between FAO statistics for NPK fertiliser consumption (Table 3.1) and CSES data on farmers' fertiliser consumption (Figure 3.1). This discrepancy can be attributed to a very large volume of unrecorded informal trade between Cambodia and Thailand and Vietnam (see section 4.1 for further detail). High domestic demand and regulations that restrict imports might stimulate informal trade with neighbouring countries (see section 4.4).

Figure 3.1: Trends in Fertiliser Use by Rice Farmers, 2007–2011 (tonnes)



Source: CSES 2007–2011, estimated by authors (sampling weight applied)

3.2. Fertiliser Use by Crops, Farm Size and Regions

Table 3.2 describes the trend of fertiliser use intensity (fertiliser product use per hectare) by crop categories, estimated using data from the Cambodia Socio-Economic Survey (CSES) 2007–2011. Due to data limitations, it is possible to estimate the seasonal use of fertiliser in terms of dry and wet season for rice production only. The quantities of fertiliser used for both dry season rice and vegetables are the highest among all crops because these generate notably high returns for producers. Fertiliser use in wet season rice production dropped dramatically in 2008 due to soaring prices during the global food price crisis. Similarly, fertiliser use in dry season rice production (late 2008/early 2009) also declined sharply from around 245 kg per ha to about 181 kg per ha because of the high fertiliser prices that continued up to the first quarter of 2009 (Figure 3.6).

Overall, on average, vegetable growers apply around 190 kg to 330 kg of fertiliser per ha on their fields, while rice farmers use 180 kg to240 kg per ha for dry season rice and around 80 kg to 150 kg per ha for wet season rice. Dry season rice farmers apply higher rates of fertiliser than do wet rice farmers because there is enough water during this period, from either natural sources or irrigation systems, to last throughout the growing season. In addition, dry rice farmers grow high-yielding varieties (mostly IR cultivars) which require large inputs of fertiliser to achieve their yields compared with traditional wet season varieties.

Generally, the trend in fertiliser use for all crops fluctuates in line with fertiliser prices. Overall, fertiliser use in 2011 was slightly lower than it was in 2010 because fertiliser prices resumed their climb in 2011 and rose to the same level as during the spike in 2008. This indicates that the price farmers pay for fertiliser is a major determinant of fertiliser use. Lim (2006) also found in his survey that about 79 percent of farmers had reduced the amount of fertiliser they used because of an increase in prices.

Table 3.2: Quantity of Fertiliser Product Used by Crops (kg per ha)

Crop type	2007	2008	2009	2010	2011
Dry season rice	232.9	245.9	181.4	229.2	183.7
Wet season rice	108.8	79.1	156.0	115.5	118.1
Corn	138.7	132.2	75.5	107.4	133.8
Cash crops*	163.5	174.4	125.1	146.1	112.1
Cassava	48.2	73.5	77.1	151.5	92.8
Vegetables	330.2	212.0	247.9	277.5	192.8
Other crops	222.4	107.7	192.4	187.6	145.6

* Note: cash crops are cowpea, mungbean, grains, leguminous plants, sugar cane, groundnut (peanut), soybean, sesame, oilseed crops, jute and kapok.
Source: CSES 2007–2011, estimated by CDRI (sampling weight applied)

Table 3.3 presents the average rates of fertiliser use for dry and wet season rice production by farm size over the period 2007–2011. On average, fertiliser use for dry season rice is around 200 kg per ha, which is higher than that for wet season rice. The higher fertiliser consumption in the dry season reflects the fact that dry season rice production is associated with higher yields than wet season rice.[6] At the farm level, it is noted that fertiliser use is quite high in the smallest farmland ownership group (less than 1 ha), ranging from 170 kg to 200 kg per ha. This is in line with the well-known inverse relationship between farm size and productivity, usually explained by the fact that small farms are better able to use more inputs and therefore produce more grain per hectare than larger farms (Lipton 2009; Ngo and Chan 2010).[7] Farmers in the 1–2 ha land size group applied about 100–140 kg per ha, those with 2–3 ha applied about 120–140 kg per ha, and those with more than 3 ha applied 130–230 kg per ha—about the same amount as farmers owning less than 1 ha. By farmland size, the trend in fertiliser use follows the trend in fertiliser prices—lower in 2008, then recovering to normal application levels from 2009.

Table 3.3: Rate of Fertiliser Use for Rice Production by Farm Size (kg per ha)

Farm Size	2007			2009			2011		
	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
Less than 1ha	220.0	144.4	199.8	169.7	186.3	170.1	174.6	140.4	169.1
1ha–2ha	202.7	82.3	106.9	187.4	139.1	135.5	194.1	96.5	146.0
2ha–3ha	302.6	63.5	124.4	174.9	108.3	130.3	200.3	93.1	146.0
More than 3ha	323.6	60.8	159.3	291.4	93.3	132.3	226.8	96.1	229.4
Total	**232.9**	**108.8**	**158.4**	**181.4**	**156.0**	**152.0**	**183.7**	**118.1**	**163.2**

Source: CSES 2007–2011, estimated by CDRI (sampling weight applied)

An analysis by region shows that fertiliser use for all kinds of crops in the Mekong Plain is higher than in the other regions because the use of supplementary irrigation has increased the productivity of rainfed areas and enhanced cropping intensity. In general, dry season rice consumed more fertiliser than wet season rice, except for in the plateau/mountain region.

6 In 2011, average dry season rice yield was 4288 kg per ha compared with only 2712 kg per ha for wet season rice (CSES 2011).

7 Farmers with less than 1 ha obtained an average yield of 3111 kg per ha, those with 1–2 ha got 2505 kg per ha, those with 2–3 ha obtained 2829 kg per ha, and farmers with more than 3 ha got 3050 kg per ha (CSES 2011)

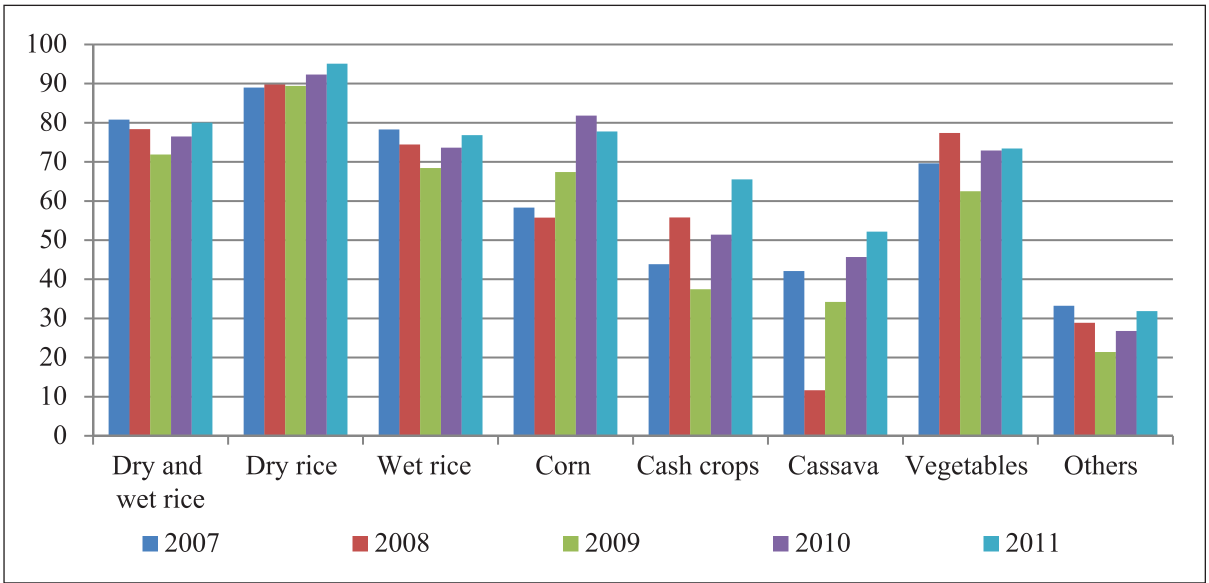
Note that the dominant form of dry season rice farming practiced in the mountain areas is shifting (slash-and-burn) agriculture: thus, farmers grow crops with little fertiliser. It is noted that fertiliser use on vegetables is more than 200 kg per ha in the Mekong Plain, Coastal, and Plateau/Mountain regions and around 100 kg per ha in the Tonle Sap region (Table 3.4).

Table 3.4: Fertiliser Use by Region (kg per ha)

	Quantity of fertiliser (kg per ha)					
	Mekong Plain			Tonle Sap		
	2007	2009	2011	2007	2009	2011
Dry season rice	261.7	199.4	194.2	108.2	101.4	153.2
Wet season rice	127.0	200.1	142.8	79.4	103.5	84.4
Corn	112.6	129.9	176.8	161.1	52.3	55.0
Cash crops	179.7	206.9	170.0	46.1	50.4	67.3
Cassava	48.2	82.8	95.8	0.0	27.2	85.3
Vegetables	365.0	293.4	203.8	141.2	201.6	71.9
Others	188.2	221.4	161.5	135.6	134.0	158.3
	Coastal			Plateau/Mountain		
Dry season rice	0.0	182.2	179.4	50.4	61.3	177.0
Wet season rice	163.3	141.0	105.2	93.3	124.4	126.4
Corn	377.5	39.9	174.5	0.0	25.2	50.4
Cash crops	342.9	195.8	145.5	65.0	52.8	69.4
Cassava	0.0	35.5	70.9	0.0	90.1	30.9
Vegetables	566.1	118.2	235.7	340.1	257.4	225.0
Others	416.1	179.1	116.7	118.6	104.0	89.1

Source: CSES 2007–2011, estimated by CDRI

Figure 3.2: Proportion of Farmers Using Fertilisers (percent)



Source: CSES 2007–2011, estimated by CDRI

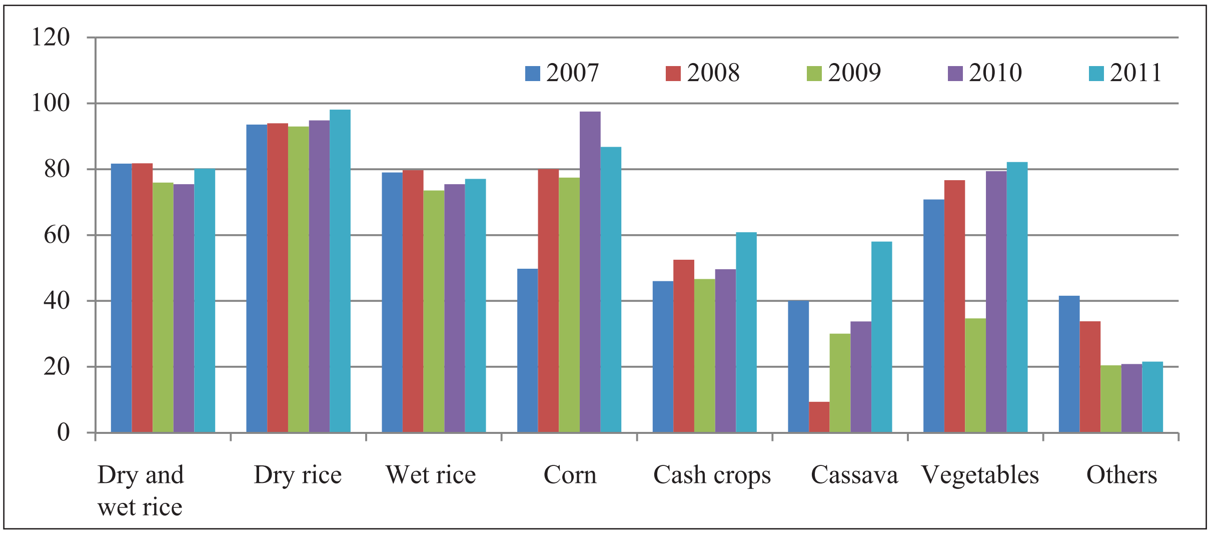
Figure 3.2 illustrates fertiliser use by farmers.[8] Overall, between 2007 and 2011, the average proportion of farmers using fertilisers was about 70–80 percent. Rice crops (dry and wet rice) accounted for the highest proportion (77.5 percent), followed by vegetables (71 percent), corn (68 percent), cash crops (50 percent), cassava (37 percent) and other crops (28 percent). Note

[8] All farmers who used fertiliser in their farming.

that dry season rice demands more fertiliser than wet season rice; during the years 2007 to 2011, approximately 90 percent of dry season farmers applied fertilisers. Generally, there was a steady increase in total fertiliser consumption for all crops.

By land area, fertiliser was applied to more than 90 percent of the area devoted to dry season rice. This is the highest proportion among all crops (Figure 3.3). Fertiliser was applied to approximately 75 percent of the area devoted to wet season rice, and around 70 percent of that under vegetable crops. The trend of fertiliser use for rice crops did not change between 2007 and 2011, except for during the dry season; almost 100 percent of the dry season rice area was fertilised in 2011. However, the trend in terms of the fertilisation of land areas for corn, cassava and vegetables reveals a rapid increase between 2007 and 2011.

Figure 3.3: Proportion of Cultivated Areas Fertilised (percent)



Source: CSES 2007–2011, estimated by CDRI

3.3. Nutrient Use Efficiency

Fertiliser or nutrient use efficiency (NUE) can be defined in several ways, depending on the perspective. Environmental NUE can be quite different from agronomic or economic efficiency, and maximising efficiency may not always be advisable or effective (Roberts 2008; Prasad 2009). Four indices are commonly used to describe fertiliser use efficiency; they are:

1. Partial factor productivity (PFP, kg crop yield per kg nutrient applied) = *Yf/Na*
2. Agronomic efficiency (AE, kg crop yield increase per kg nutrient applied) = *(Yf-Yc)/Na*
3. Apparent recovery efficiency (RE, kg nutrient taken up per kg nutrient applied) = *[(NUf-NUc)x100]/Na*
4. Physiological efficiency (PE, kg crop yield increase per kg nutrient taken up) = *(Yf-Yc)/(NUf-NUc)*

where *Yf* and *Yc* are the yields (kg per ha) in fertilised and control plots, respectively; *NUf* and *NUc* are the amounts of fertiliser taken up by the crop in fertilised and control plots, respectively; and *Na* refers to the amount of nutrient applied (kg per ha).

AE is a crop response ratio or productivity index and can be determined for a single nutrient or combination of nutrients (N, P, K, NP, NK, PK, or NPK). PFP can also be estimated for a single or a combination of nutrients. A recently introduced index, PFP does not require a non-fertilised control plot yield (i.e. it is not very scientific) and can be used to compare different countries or different regions in a country and to indicate the trend of fertiliser use over time. RE is normally used by soil and environmental scientists to identify the part of the nutrient taken up by a crop and the part of the nutrient lost to the atmosphere. PE is used by plant breeders and plant physiologists to investigate the efficiency of different crops or different crop cultivars in utilising the absorbed nutrient (Prasad 2009). Due to a lack of available data, this section discusses only AE and PFP. Please note that the P and K symbols in this section refer to phosphate (P2O5) and potash (K2O), respectively.

It is challenging to find data to estimate NUE in Cambodia: there is scant experimental data available to estimate for AE and PFP. Data from research stations and on-farm trials conducted by the Soil and Water Science Division of CARDI shows that the rice yield response ratio (AE) for the single nutrient N was about 10.9 kg grain produced per kg N applied. The AE of P was higher than the AE of N at 24.35 kg grain per kg P. The nitrogen use efficiency was higher when P was added, with AE of about 14.9 kg grain per kg nutrient applied (Table 3.5); this means that soils are deficient in phosphate and need balanced fertilisation for maximum yield. The yield responses of Sen Pidao IR cultivar, both AE and PFP, are similar to those of local cultivar CAR4.The result shows that the agronomic N use efficiency for rice crops in Cambodia is much lower than the global value of around 20 kg grain per kg N (Ladha *et al.* 2005: 103). This indicates there is high potential to improve fertiliser use efficiency in Cambodia by improving nutrient balance and better management.

Table 3.5: Estimates of N, P and NP Use Efficiency in Different Rice Varieties on Prateah Lang Soil

Nutrient (kg per ha) N-P2O5-K2O	Yield (tonnes per ha)	AE	PFP
		(kg grain per kg nutrient)	
Sen Pidao (IR fragrant cultivar)			
0-0-0	1.51	-	-
66-0-0	2.23	10.91	33.79
0-46-0	2.63	24.35	57.17
66-46-0	3.18	14.91	28.39
CAR 4 (local late cultivar)			
0-0-0	1.76	-	-
66-0-0	2.47	10.76	37.4
0-46-0	2.77	21.96	60.2
66-46-0	3.38	14.46	30.2

AE=Agronomic Efficiency; PFP=Partial Factor Productivity
Source: CARDI 2011a; AE and PFP calculated by CDRI

Balanced fertilisation and site specific nutrient management (SSNM), a plant-based approach for supplying rice with essential nutrients to optimally match the needs of the crop, is becoming increasingly familiar to research and extension workers and has been disseminated to farmers in Southeast Asian countries (Buresh *et al.* 2007). The approach aims to apply nutrients (N, P and K) at optimal rates and at the right time (N timing) to achieve high yields and high efficiency of nutrient use by the rice crop.[9] The leaf colour chart (LCC) is a simple and inexpensive

[9] The balanced fertilisation and SSNM approach provides the principles and practices for: 1) estimating the total amount of fertilisers N, P and K required for optimal rice yield; 2) prescribing the amount of N in the first application at establishment; 3) adjusting the N rate within the season to match the spatial and temporal needs of the crop for N; and 4) tailoring fertiliser management to the specific conditions of farmers' fields (Buresh *et al.* 2007).

tool used to monitor the need for N within the growing season, guiding the application of N fertiliser to achieve a high rice yield with effective N management (IRRI 2007). CARDI has also conducted research on nitrogen use efficiency using the above principles and practices, and the results are shown in Table 3.6. When PK fertilisation was balanced, the rice grain yield increased (2.81 tonnes per ha), higher than that obtained from a single N application (2.23 tonnes per ha) (Table 3.5). But the AE of N was similar at 10.9 kg grain increase per kg nutrient, suggesting that the response ratio of N is more efficient when NPK fertilisation is balanced. LCC3 achieved a similar yield to that of N application at the recommended rates (RR) (30 percent N at basal stage (BS), 40 percent N at tillering stage (TL) and 30 percent N at panicle initiation (PI)), but the AE using LCC is lower than RR at a similar balanced PK rate of 53 kg per ha due to the higher N fertiliser rate applied.

Table 3.6: Effect of Balanced NPK Fertilisation and N Use Efficiency on Rice (cv. Sen Pidao) on Prateah Lang Soil

Treatment (kg per ha)		Yield (tonnes per ha)	AE	PFP
N-P2O5-K2O	N Timing		(kg grain per kg nutrient)	
0-0-0	0	1.69	-	-
50-25-25	RR	2.81	10.87	27.28
25-25-25	LCC 1	2.35	8.46	30.13
50-25-25	LCC 2	2.57	8.54	24.95
75-25-25	LCC 3	2.81	8.75	21.95

AE=Agronomic Efficiency; PFP=Partial Factor Productivity; RR=recommended rate (3 splits N: BS, TL, PI); LCC1: 25 kg N per ha at 14 DAT (day after transplanting); LCC2: 25 kg N per ha at 14 and 21 DAT; LCC3: 25 kg N per ha at 14, 21 and 28 DAT.

Source: CARDI 2011a; AE and PFP calculated by the author

The study also looked at the interaction between different rice cultivars and nitrogen fertiliser on the same Prateah Lang soil types (PL, Plinthustalfs) (Tables 3.6 and 3.7). Under the same balanced NPK rate and N management approach, the yield of cultivar Phka Rumduol was about 3.66 tonnes per ha while that of Sen Pidao was only 2.81 tonnes per ha. The AE of N was also higher for Phka Rumduol than it was for Sen Pidao (15.3 vs. 10.87 kg yield increase per kg nutrient applied). SSNM N fertiliser trials conducted in different regions and soil types show different yield responses and AE levels across Cambodia (Table 3.7). Kork Trap soil achieved the lowest yield response, as this soil type is classified as acidic and is a Cambodian soil of poor quality (White *et al.* 1997). Bakan soil types had the lowest AE. These results suggest that rice cultivars, site-specific balanced nutrient management, and timing of application (N application method) contribute significantly to increase the crop yield, the numerator of AE and PFP, in Cambodia. Note that the LCC approach (N5) provides a higher yield but lower AE than SSNM (N1) for almost all soil types except acidic Kork Trap soil in Svay Rieng. Roberts (2008) suggests that higher AE could be simply achieved by scarifying yield (lower nutrient application rate), but the efficiency does not come at the expense of farm economic viability (see section 6.2 for further detail).

In most rainfed lowlands of Cambodia, soils used for rice cultivation have serious nutrient deficiencies, particularly very low levels of available N, P and K (White *et al.* 1997; Seng *et al*. 2001). Among the ways to improve yields and fertiliser/nutrient use efficiency on these rainfed lowlands, the following should be seriously considered: SSNM including balanced NPK doses and timely fertiliser application using appropriate methods, plus agronomic practices including the proper selection of cultivars and proper water management, the factors that significantly improve crop yield and direct or indirect numerators for AE and PFP estimation (Buresh *et al.* 2007; Roberts 2008; Prasad 2009).

Fertiliser trials conducted so far have used NPK in the ratio of 2:1:1. Given that in the flooded rice cultivated areas N uptake is low, and thus the experimental trials with 3:1:1 application of NPK will be more enlightening, this is a suitable focus for further research.

Table 3.7: Effect of Balanced NPK Fertilisation and Agronomic Efficiency of N Timing in Different Soil Types in Cambodia, 2006–2009

Treatment (kg per ha)				Yield	AE	PFP
N timing	N	P2O5	K2O	(kg per ha)	(kg grain per kg nutrient)	
Prateah Lang (PL) soil (Plinthustalfs), CARDI, Phnom Penh (cv. Phka Rumduol)						
N0	0	0	0	2123.3		
N1	50	25	25	3656.7	15.3	36.6
N2	50	25	25	3473.3	13.5	34.7
N3	50	25	25	3366.7	12.4	33.7
N4	50	25	25	3523.3	14.0	35.2
N5	105	25	25	4000.0	12.1	25.8
Kampong Siem (KS) soil (Vertisols), Kampong Cham (cv. Sen Pidao)						
N0	0	0	0	2125.0		
N1	90	60	30	3240.0	6.2	18.0
N2	90	60	30	3025.0	5.0	16.8
N3	90	60	30	3060.0	5.2	17.0
N4	90	60	30	3040.0	5.1	16.9
N5	117	60	30	3570.0	7.0	17.2
Prey Khmer (PK) soil (Psamments), Kampot (cv. CAR 1)						
N0	0	0	0	2423.3		
N1	60	30	30	3653.3	10.3	30.4
N2	60	30	30	2986.7	4.7	24.9
N3	60	30	30	3176.7	6.3	26.5
N4	60	30	30	3076.7	5.4	25.6
N5	108	30	30	3686.7	7.5	21.9
Kork Trap (KT) soil (Kandic Plinthaquults), Svay Rieng (cv. CAR 3)						
N0	0	0	0	1150.0		
N1	75	35	30	2030.0	6.3	14.5
N2	75	35	30	1740.0	4.2	12.4
N3	75	35	30	1876.7	5.2	13.4
N4	75	35	30	1970.0	5.9	14.1
N5	117	35	30	1886.7	4.0	10.4
Bakan (BK) soil, Prey Veng (Alfisols/Ultisols) (cv. Mahos)						
N0	0	0	0	2060.0		
N1	75	30	30	2485.0	3.1	18.4
N2	75	30	30	2245.0	1.4	16.6
N3	75	30	30	2415.0	2.6	17.9
N4	75	30	30	2800.0	5.5	20.7
N5	117	30	30	2680.0	3.5	15.1

AE=Agronomic Efficiency; PFP=Partial Factor Productivity

Note: yield data (kg per ha) represents the mean of three years with four replicates, except for on Kampong Siem soil in Kampong Cham and on Bakansoil in Prey Veng where yield data represents the mean of two years with four replicates.

N timing: N1: 3 splits (BS, TL, PI); N2: Briquette (BS); N3: Delayed (15, 30, 70 DAT); N4: Delayed (30, 70 DAT); and N5: leaf colour chart (LCC, critical value 3). P and K were applied 100 % at BS.

Source: CARDI 2011a; AE and PFP calculated by the author

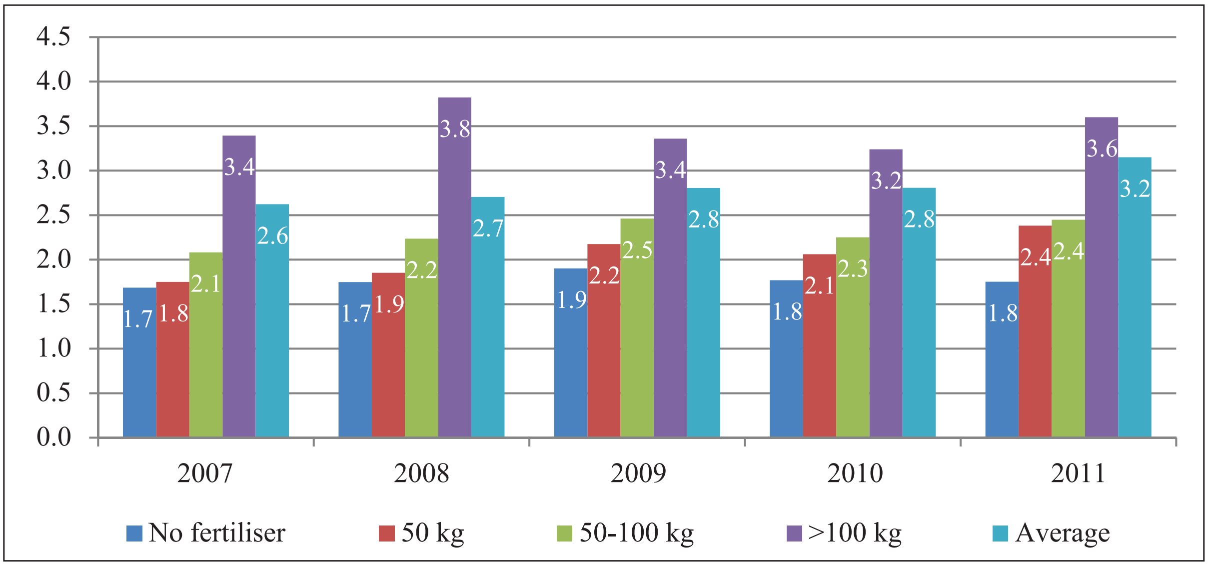
3.4. Micronutrient Deficiency

Through fertiliser response trials using an omission plot approach, the major Cambodian lowland soils showed deficiencies in some micronutrients such as sulphur (S), boron (B) and magnesium (Mg) (Lor *et al.* 1996). Deficiency in S has been clearly established in field experiments, while B and Mg deficiencies have not yet been confirmed by a larger study (Seng *et al.* 2001). The highest mean rice yields were obtained only when adequate quantities of N, P, K and S were applied to some rice soils in the rainfed lowlands. The omission of some nutrients significantly reduced rice yields. Deficiency in S, for example, restricted the potential crop response to P application in some soils (Lor *et al.* 1996). Although the deficiency of micronutrients such as S in some areas is a critical issue, the fertiliser experiments conducted by CARDI have mainly focussed on macronutrients N, P and K and on the appropriate timing of nutrient application. This was largely due to lack of funding (CARDI 2011a, 2011b, 2012; USDA-FAS 2010). In addition, fertiliser recommendations for rice also focus on the main nutrients N, P and K (Seng *et al.* 2001). Field experiments to diagnose micronutrient deficiencies and to validate crop response to added micronutrients of interest are urgently needed to discover the best ways to improvenutrient use efficiency and site-specific nutrient management to increase the productivity of rainfed lowland rice, which represents 86 percent of the total annual rice cultivated area of Cambodia.

3.5. The Yield Gap

Figures 3.4 and 3.5 show data on rice yield from farmers' fields and on-farm research trials. From 2007 to 2011, the average yield from non-fertilised farmers' fields was about 1.8 tonnes per ha, while that of fertilised fields was about 2.8 tonnes per ha (Figure 3.4). For all years during that period, the yield gap increased when the amount of fertiliser applied increased; the gap in yields between non-fertilised fields and fields fertilised with more than 100 kg of fertiliser per hectare varied from 43 to 54 percent. The yearly increase of the trend (the yield increase obtained in one year) varied from year to year in both non-fertilised and fertilised fields.

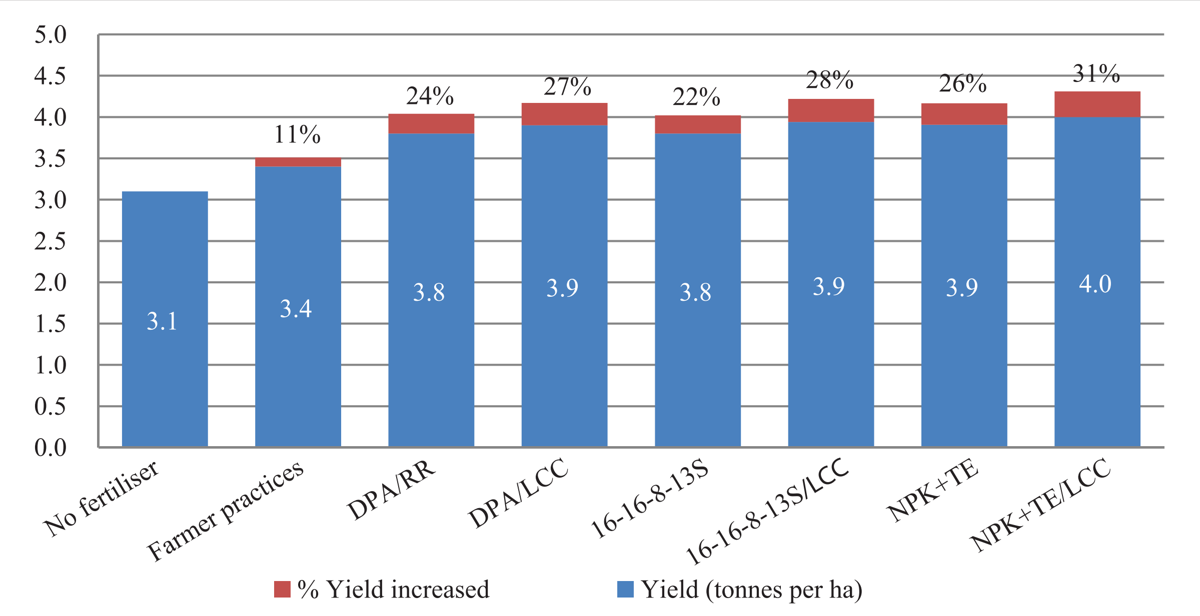
Figure 3.4: Response of Rice Grain Yield to Fertiliser Application in Farmers' Fields (tonnes per ha)



Source: CSES 2007–2011

Results from on-farm trials conducted in 30 locations across Cambodia in 2011 show yield gap increases between non-fertilised and fertilised plots of 24 to 31 percent, while the yield difference between non-fertilised plots and those under farmers' normal practices is about 11 percent. The gap of about 10–15 percent between fertilised plots and plots under farmers' normal practices indicates that farmers have partly adopted or followed the method of fertiliser application (Figure 3.5). These results indicate that fertiliser is a significantly important input in improving rice productivity across Cambodia. Potential rice yield of up to about 4.0 tonnes per ha (Figure 3.5) could be achieved if fertilisers are applied at the recommended rates per growth stage. However, using fertiliser at a rate of more than 100 kg per ha, farmers can achieve a yield of only about 3.5tonnes per ha (Figure 3.4). The recommended rate of fertiliser application in on-farm trials (Figure 3.4) ranged from 180 kg to 260 kg of fertiliser products per hectare depending on soil type (CARDI 2012), while wet and dry season rice farmers (Figure 3.4) typically use 110 kg to 160 kg of fertiliser products per hectare (Table 3.3). These results indicate a much different application rate and yield response: the higher the rate of fertiliser applied, the higher the yield obtained. Therefore, there is some potential to increase fertiliser use efficiency to intensify rice productivity by expanding the coverage of extension service delivery to farmers across Cambodia.

Figure 3.5: Response of Rice Yield (cv. Phka Rumduol) to NPK Fertiliser in On-Farm Trials, 2011 (mean of 30 sites, tonnes per ha)



Note:	No fertiliser	Control
	Farmer practices	Application under normal/traditional farmer practices
	DAP/RR	Prescription (diammoniumphosphate (DAP), potassium chloride (KCl), urea)
	DAP/LCC	Prescription (DAP, KCl, urea) + LCCfor N management
	16-16-8-13S	Prescription (16-16-8-13S, KCl, urea)
	16-16-8-13S/LCC	Prescription (16-16-8-13S, KCl, urea) +LCC
	NPK+TE	Prescription (20-20-15, KCl, urea)
	NPK+TE/LCC	Prescription (20-20-15, KCl, urea)+ LCC

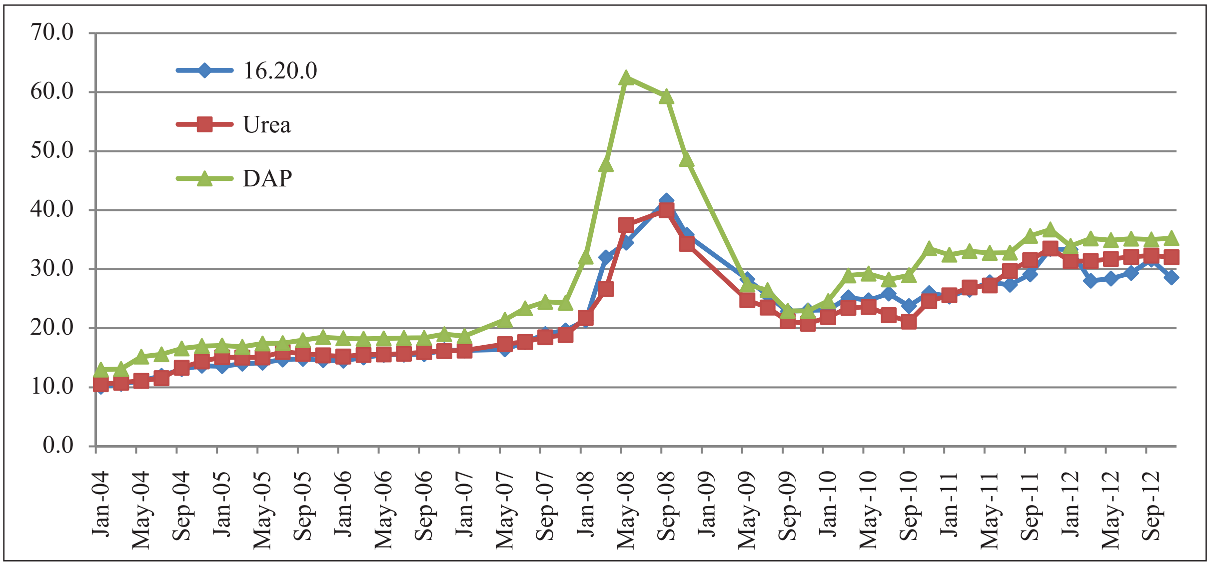
Source: CARDI 2012

3.6. Key Constraints Affecting Fertiliser Use

Price issues: the high price of fertiliser is one of the key constraints on fertiliser use, accounting for about 37 percent of total production costs for dry season rice and about 21 percent for wet season rice, or for about 15 percent of the overall value of the harvest (Chhim *et al.* 2013;

Ovesen *et al.* 2012). During 2008, the price of urea increased to about USD40 per 50-kg bag, while that of DAP (diammonium phosphate) rose to about USD60 per 50-kg bag: at those levels, all kinds of fertiliser were unaffordable for most smallholder farmers, and the economic return on fertiliser use was negative (Figure 3.6). In addition, fertiliser consumption by farmers decreased during the record-high fertiliser prices in 2008 (Figure 3.1 and Table 3.2).

Figure 3.6: Monthly Average Retail Prices of Fertilisers in Four Provinces in Cambodia, 2004–12 (USD per 50-kg bag)



Note: Prices of fertiliser are current prices; 16:20:0 refers to ammonium phosphate sulphate.
Source: AMI 2004–2012

Credit access: Most farmers apply inorganic fertiliser only when they have sufficient surplus cash to buy it. Farmers usually have surplus cash at the beginning of the dry season (after the wet season harvest) to afford fertiliser purchases for the dry season crop. However, due to the limited extent of dry season production, most farmers do not have surplus cash at the planting of the wet season crop. Therefore, purchases of fertiliser for wet season rice depend almost entirely on available credit. Microfinance institutions provide credit to most farmers in most rural areas, but not to the poorest farmers (Kem 2012; Ovesen 2012). Microcredit interest rates are around 2.5 to 3 percent per month, a high burden on smallholders. Lack of surplus cash and high interest rates are key constraints affecting investment in farm inputs. Lim (2006) revealed that approximately 79 percent of farmers reported underuse of fertiliser, citing financial limitations as the main reason.

Quality issues: Another major constraint to fertiliser application is the quality and variability of fertiliser products. Farmers have come to recognise low quality fertilisers because of the poor crop response to applications of those fertilisers. The nutrient analyses of almost all compound NP and NPK fertilisers sold on the market were well below acceptable quality indices (IFDC 2010). The popular belief is that fertiliser contamination, product tampering and substitution by mixing low quality fertiliser with higher quality fertiliser are the main causes. Another common malpractice in the fertiliser sector is re-bagging less expensive fertilisers (e.g. DAP and urea) in sacks labelled with a high quality brand and selling them under that brand name to customers who think they are buying genuine products. The selling of short-weight bags and the practice of coating low quality grade NPK fertiliser with oil to change its appearance were also found, although these two issues are not currently as common (Theng 2012). The low quality of fertiliser sold on the market is a critical problem affecting crop yield and resulting in financial loss for farmers (IFDC 2010). It is estimated that the potential rice yield lost to the application of low quality fertiliser represents a financial loss of between USD285 to USD350 per farmer (Theng 2012). Consequently, farmers may choose to abstain from buying fertilisers available in the marketplace or decrease the application rate to below the recommended level for fear of the damage that poor quality fertiliser can wreak (Schamel and Hongen 2003).

Extension constraints: Weak extension services are another key constraint to fertiliser use in Cambodia. Few Cambodian farmers are aware of the effective use of chemical fertilisers; most learn through public agricultural extension programmes, NGOs, and practice, i.e. crop yield responses. For Cambodia's farmers who are unaware of the proper use of fertilisers, coupled with their inability to read labels, financial loss and ineffective crop production often result (MOE 2004).[10] Although government has prioritised the agricultural sector as the engine for economic growth and poverty alleviation,[11] the proportion of the budget allocated to the sector has been extremely limited—about 1 percent of agricultural GDP (Theng and Koy 2011). This has left agricultural extension programmes significantly underfunded, leading to an acute shortage of trained and experienced extension officers and insufficient on-farm technology transfer and support. The current extension system does not have the capacity (less than 500 public extension officers nationwide) to provide enough services to meet the needs and support the efforts of farmers. In addition, scientific research is significantly underfunded; agricultural research relies almost totally on the support of development partners, and the current research-funding crisis threatens to cripple CARDI's research activities. The lack of sufficient public funding and focus severely constrains current and future agricultural research and extension activities throughout the country (USDA-FAS 2010).

In summary, high fertiliser prices, low fertiliser quality, high interest rates and poor extension services are the main concerns/constraints that limit any increase in agricultural productivity for some smallholder farmers in Cambodia. In addition, lack of irrigation water and surface water sources discourages farmers from accessing credit for farm inputs investment, consequently restraining fertiliser use.

[10] Most fertilisers sold on the market have Khmer language labeling, except for a few kinds such as NPK 16-16-8-13s from the Philippines and prilled urea from China.

[11] Articulated in Rectangular Strategy Phase I, Phase II (2008–13) and Phase III (2013–18) and the National Strategic Development Plan and its Update, NSDP 2009–13

4
Structure of the Fertiliser Industry

4.1. Trends in Fertiliser Supply

Cambodia is a net importer of fertiliser. Until late 2012, there was no fertiliser production plant in the country, and most supplies came from neighbouring countries such as Vietnam and Thailand. This section elaborates the history of, and trends in, fertiliser supply in Cambodia.

History of fertiliser supply in Cambodia: Between 1979 and 1993 the government was responsible for most of the import and distribution of agrochemicals, in particular fertilisers and pesticides. Limited amounts were imported and distributed by NGOs. During the Vietnamese occupation from 1980 to 1989, about 35–40,000 tonnes of fertilisers were imported annually from Vietnam, and from 1991 to 1996, the FAO, Japan and the Asian Development Bank (ADB) donated 92,966 tonnes of inorganic fertilisers. These were used mainly in rice production.

After the UN-organised national election in 1993, Cambodia adopted an open economy system, allowing both emerging private companies and the public sector to supply and distribute fertilisers in a free market. Between 1993 and 2000 the Agriculture Inputs Company (AIC), a public company under MAFF, imported and distributed 131,424 tonnes of various types of fertilisers and 89,353 tonnes of pesticides (Table 4.1). From 1996, the private sector largely assumed responsibility for fertiliser imports and was seen to be generally efficient in terms of quantity, variety, availability and prices of inorganic fertilisers (Young and Raab 2000:14). Currently, the fertiliser market is led by the private sector operating in a competitive manner with prices set by market forces (IFDC 2010).

Table 4.1: Fertilisers Imported and Distributed by AIC, 1993–2000 (tonnes)

Year	Fertiliser	Urea	DAP	16.20.0	15.15.15	Others	Mix	Total
1993	Imported	15403	16288	3456	484			35631
	Distributed	5026	5093	4032	7			14158
1994	Imported	5970	9889					15859
	Distributed	16147	20781	155	372	34		37489
1995	Imported	22397	29972	10776	483	483		64111
	Distributed	12657	4313	1444	11	18		18443
1996	Imported	3377		5089	357			8823
	Distributed	5440		746	76			6262
1997	Imported							0
	Distributed	16	897	4496	26			5435
1998	Imported	7000						7000
	Distributed			23	348			371
1999	Imported							0
	Distributed				195			195
2000	Imported							0
	Distributed						7000	7000
1993-2000	Imported							131424
	Distributed							82353
	End Stocks							49071

Source: ACI 2002

Trends in fertiliser supply: It is difficult to find public sector information about fertiliser supply in Cambodia. Therefore, the study used official statistics from various sources to determine trends in the volumes of fertiliser imported into Cambodia. A comparison of the official data on fertiliser imports into Cambodia from Vietnam and Thailand recorded by the Customs and Excise Department of the Ministry of Economy and Finance (MEF), and the statistics obtained from the database of the International Trade Center (ITC) shows huge discrepancies. The official data recorded by Cambodia may not reflect the real situation (real demand for fertilisers), since the amount of fertiliser consumed by farmers (calculated using data from CSES 2007–2011) is significantly higher than that imported in the same years (Table 4.2 and Figure 3.1). Further comparison using ITC import statistics confirms that the volume of fertiliser imported into Cambodia is lower than that consumed by farmers. This suggests that there is substantial and thriving informal trade between Cambodia and neighbouring Thailand and Vietnam (IFDC 2010; ADB 2002: 27).[12] Easing entry to the industry might increase formal trade and competition, which would serve to bring prices down, while strengthening data management systems for collecting and storing data would facilitate the monitoring of fertiliser industry trends and help to resolve the discrepancies between macro (import statistics) and micro (household surveys) data.

Fertiliser supply has increased rapidly over the last few years, especially since the launch of the Rice Policy Paper for Promotion of Paddy Production and Export of Milled Rice, better known as the Rice Policy, in mid-2010. This policy promotes high and sustainable growth in paddy rice production through agricultural intensification (RGC 2010). Fertiliser imports into Cambodia doubled in 2011, after the launch of the Rice Policy (Table 4.2).

Table 4.2: Volume of Fertiliser Imports by Product, 2002–2012 (tonnes)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Customs and Excise Department, MEF Cambodia*										
Nitrogen	2218		56		97	3995	7837	17052	25977	56644
Phosphate	24206	33773	32921	51624	50276	49131	47262	61930	62158	72591
Potash	8						29	25		120
NPK	51866	39731	46595	59843	60873	58988	56784	67591	86012	103098
Other	320	381	21	2830	1190	428	17280	42238	25066	28907
Total	**78618**	**73885**	**79593**	**114297**	**112436**	**112542**	**129192**	**188836**	**199213**	**261360**
International Trade Center (ITC)										
Nitrogen	58592	77457	63695	56604	76519	74652	95184	79591	42164	200816
Phosphate		35	66	46		346	719	2412	4934	11821
Potash	849	35	201	134	218	185	6	367	1954	3990
NPK	78261	78157	80409	97363	99871	100769	101859	70168	119648	198792
Other	175	131	547	1413	602	6505	24919	45320	18990	17701
Total	**137877**	**155815**	**144918**	**155560**	**177210**	**182457**	**222687**	**197858**	**187690**	**433120**
Vietnam (%)	**64.5**	**71.3**	**68.8**	**56.0**	**63.0**	**64.3**	**63.6**	**41.7**	**46.3**	**72.7**
Thailand (%)	**34.5**	**27.9**	**30.2**	**42.1**	**36.6**	**34.4**	**31.9**	**52.0**	**49.9**	**23.9**
Others (%)	1.0	0.7	1.0	1.9	0.4	1.3	4.6	6.2	3.8	3.5

* Note: No specific products are reported in respect of nitrogen, phosphate, potash, NP and NPK. Thus it is not possible to calculate the import of single element fertilisers recorded by MEF of Cambodia.

Sources: Customs and Exercise Department, MEF Cambodia; ITC calculations based on UN COMTRADE statistics on fertiliser exports to Cambodia (http://www.trademap.org/Product_SelCountry_TS.aspx, accessed 9 July 2013)

12 “In the case of large movements of fertiliser, as would be carried out by the five major fertiliser companies, the bulk of unofficial imports from neighbouring countries would need to be conducted by traders aligned with those companies in their particular zone of operations in order for those traders to have “permission” to operate” (ADB 2002: 27).

Various kinds of fertilisers have been imported in the forms of single (N, P and K) and mixed nutrition (NP and NPK). Single N fertilisers are imported in the forms of ammonium nitrate and urea, while the mixed nutrition imports are NP (DAP-18:46:0 and 16:20:0) and NPK (15:15:15, 20:20:15 and 16:16:8:13s). The single K nutrition import is muriate of potash (0:0:60), commonly called potassium chloride (KCI). All of these products are imported in 50-kg bags. In accordance with regulations, all chemical fertilisers imported and marketed in Cambodia must have labels in Khmer on the packaging. However, some fertiliser products do not comply with this regulation; these include16-16-8-13s from the Philippines and prilled urea from China. The major suppliers of fertiliser to Cambodia are Thailand, accounting for 35 percent of total fertiliser imports, and Vietnam with a 65 percent share (Table 4.2), though the share of trade with Vietnam is expected to grow in the next few years (IFDC 2010).

4.2. Role of the State in Improving Fertiliser Supply in the Country

Cambodia has no government fertiliser subsidy programmes. After the 1993 national election, the state withdrew from the marketing of fertiliser; today, private-sector traders almost exclusively supply the market. However, there are laws that provide some incentives to ease the supply of, and support access to, agricultural inputs including fertiliser. For example, the Law on Investment (5 August 1994) and the Amendment on the Law on Investment (23 March 2003) provide price incentives in the form of zero tariffs on importing agricultural materials such as seeds, fertilisers, pesticides and agricultural equipment. In addition, Royal Decree NS/RK/0609/009 (20 June 2009) provides profit tax exemption for qualified investment projects (QIP) in agriculture and agro-industry for a total of nine years (trigger period three years, grace period three years and priority period three years) (CDC 2009).

The Policy Document on the Promotion of Paddy Rice Production and Export of Milled Rice (RGC 2010) promotes the provision of agricultural inputs. It does this by facilitating import clearance procedures for seeds, fertiliser, other farm inputs and machinery, and by continuing to provide tax incentives, mainly in the form of zero tariffs, to encourage imports of materials and equipment. Since the launch of the Rice Policy in mid-2010, custom clearance times at border entry points have been reduced by half, from 30 days to about 15 days; however, fees (official and unofficial) have not been reduced.

MAFF, the government authority responsible for overseeing and regulating fertiliser imports into Cambodia, controls this trade through granting licences to all relevant companies. MAFF approves both the products and quantities to be imported. It is believed that the current fertiliser trade regulations through the licence and tonnage quota-system encounter barriers, consequently restricting competition and increasing trade transaction costs (see sections 4.4 and 5.4 for detail). Overall, government policy and legislation affecting import regulations have a significant effect on fertiliser supply in Cambodia, although the state has no direct influence over the private sector in this market.

4.3. Structure of the Fertiliser Industry

Cambodia is a net importer of fertiliser, and Thailand and Vietnam are its major suppliers. Cambodia has no domestic fertiliser manufacturing plants. However, a fertiliser blending plant in Kandal province, the construction of which started in 2009, began operating in early 2013. It is a joint venture between Vietnam's Five Star International Group and the Investment and Development Company of Cambodia, with total investment capital of USD65 million. The annual blending capacity in this first phase of operation is around 350,000 tonnes of NPK fertilisers, and the full capacity is around 500,000 tonnes. Even so, it is estimated that Cambodia needs about 617,000 tonnes of products annually to fertilise about 4.1 million hectares of farmland, so local production capacity is not going to meet local market demand.

The Five Star Group produces NPK fertilisers to international quality standards, which means they can compete with products imported into Cambodia. Yet, domestic factories find it difficult to compete with imported products, and thus need to devise appropriate marketing strategies to prosper in the marketplace. High quality products and low prices are factors that local producers can use to achieve a competitive advantage against imported products. Some major importers have stressed that they will cut imports if locally manufactured products are available at low prices; but if the quality of local products is similar to that of Vietnamese products, they do not foresee a problem, i.e. they believe there will be no threat to their existing export trade to Cambodia. It should be noted, however, that almost all compound NP and NPK fertilisers produced in Vietnam reportedly have below acceptable quality index values (IFDC 2010).

The government has no protectionism policy to ban imports and consequently protect domestic producers. In contrast, it promotes the free-market by providing zero tariffs for importing agricultural inputs including farm machinery and milling equipment. Therefore, local producers and importers play an equal role in the free market and compete at all levels of the fertiliser distribution channel, from producers and importers to village retailers.

4.4. Structure of Importing Organisations

MAFF is the government authority that controls fertiliser trade in Cambodia. The Department of Agricultural Legislation (DAL) and Bureau of Agricultural Materials Standards (BAMS) of MAFF control fertiliser imports and provide import licences for importers. All agrochemical importers have to register at the Ministry of Commerce for business operation and taxation purposes, and then have to apply to MAFF for a licence to import agrochemicals such as fertilisers and pesticides. In this application, importers have to provide details about the products and quantities to be imported, with a laboratory analysis to confirm quality. An official fee of USD75 for each product registration is applied. On receipt of this application, BAMS initiates the process to get approval from eight MAFF offices: the technical office; Deputy Director General of Legal Department; Director General of Legal Department; Deputy Director General of MAFF; Director General of MAFF; Undersecretary of State of MAFF; Secretary of State of MAFF; and Minister of MAFF.

The licensing process takes about four to 12 weeks, and a licence requires an official fee of USD150. The licence is valid for one year, and must be re-applied for annually. To smooth the application process through the multiple MAFF offices involved in the import licensing procedure, most potential importers seek a facilitator. It has been reported that many unofficial fees are paid through the facilitator to ensure granting of the licence (IFDC 2010). MAFF approves the product registration and makes recommendations for the quantity to be imported. MAFF can adjust the licence tonnage applied for under a quasi-quota system, which is restricted to a maximum of 30,000 tonnes for a single or multiple-product shipment per licence.

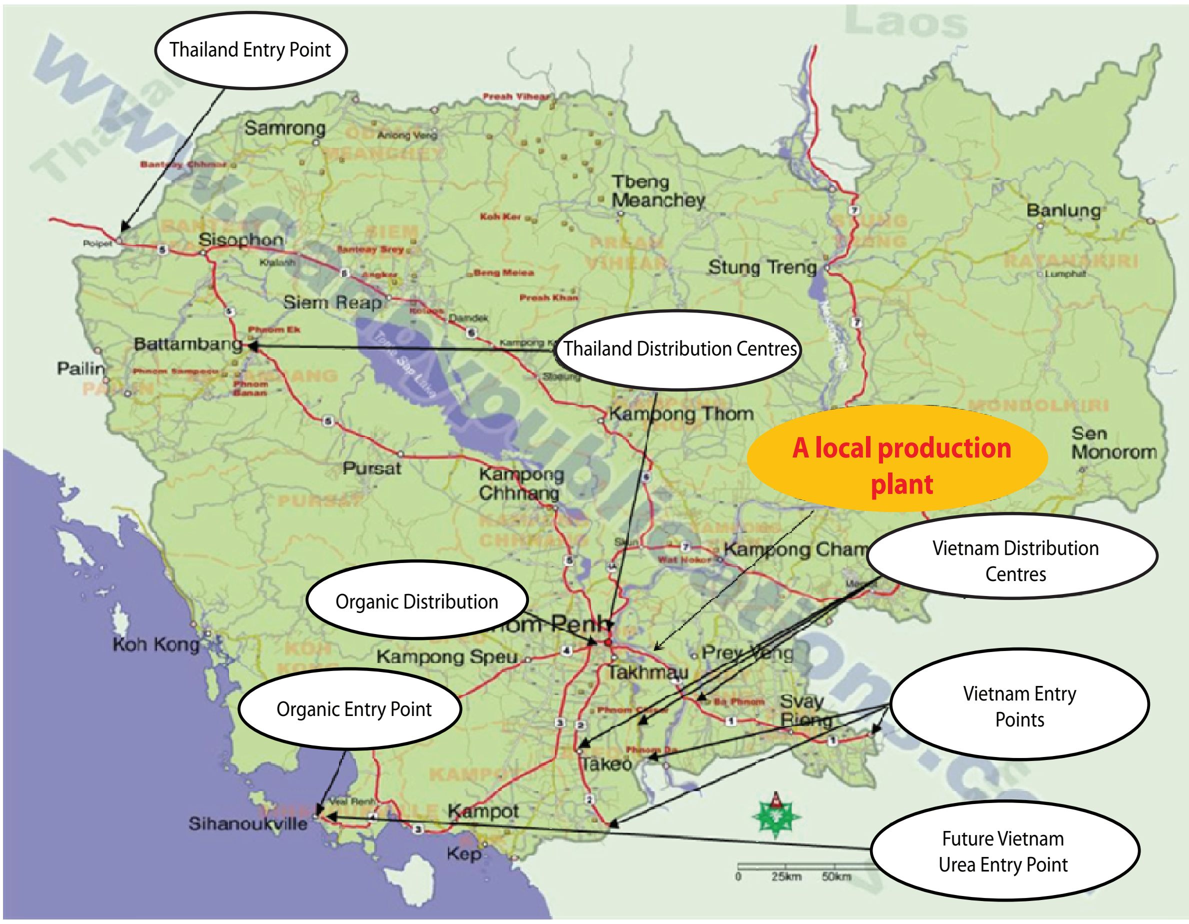
Of the 20 registered companies importing fertiliser into Cambodia in 2009, only six were especially active, namely YETAK Group, Heng Pich Chay Import Export Company, Sayimex Co. Ltd., Heng Ny Heng Co. Ltd., EScor Co. Ltd., and Chhun Heng Company (IFDC 2010). As part of the import licence application, importers are required to submit their business plans outlining their proposed sales and distribution activities. Most large importers can distribute products to all provinces in Cambodia, but small companies restrict their operations to between one and three. There is fierce competition at all levels of the fertiliser supply chain among importers, distributors, wholesalers and retailers across the country, keeping the margins and retail prices at a low level (IFDC 2010; Theng 2012).

4.5. Cross-border Trade

Since Cambodia's new fertiliser blending plant is not yet operating at full capacity, most supplies are still imported from Vietnam and Thailand and a few come from the European Union or the United States (see section 5.1). Imports by road over the Thai border mainly enter Cambodia through Poipet checkpoint, and are then transferred to a warehouse at the border or distributors' warehouses in Battambang and Phnom Penh. Imports from Vietnam are transported by river barge (Chrey Thom in Kandal province) or by road transport (Phnom Den in Takeo province and Bavet in Svay Rieng province) to warehouses in three locations in southern Cambodia—Kandal, Takeo and Prey Veng (Figure 4.1).

Although in principle there are no restrictions on trade with neighbouring countries, there is a quantitative restriction through Cambodia's tonnages and quota system limiting fertiliser imports (see section 4.4). This policy hinders economies of scale as it effectively prevents large importers from linking Cambodia's domestic markets with better-regulated and more cost-effective international markets, instead forcing reliance on importation from neighbouring countries.

Figure 4.1: Ports of Entry and Wholesale Distribution Locations for Fertiliser in Cambodia



Source: IFDC 2010

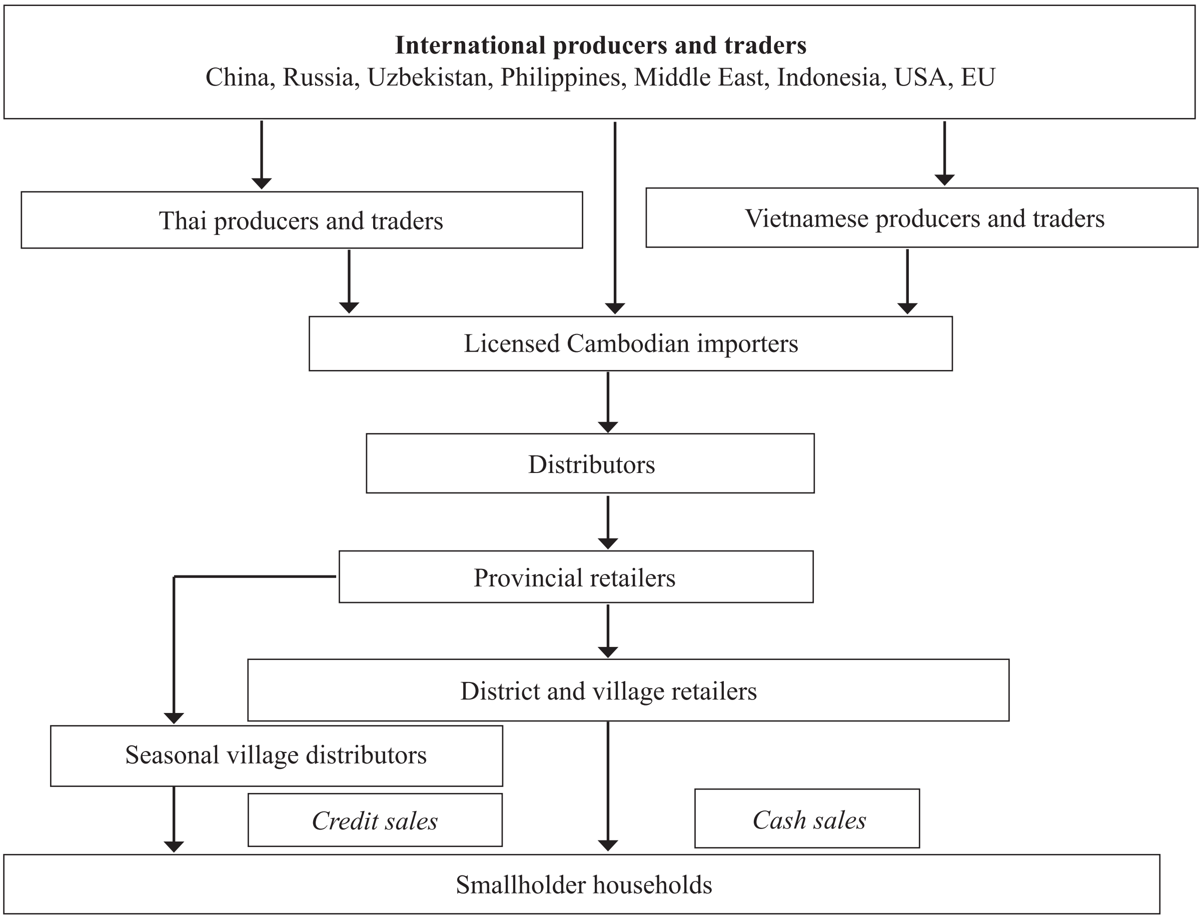
The actual business of importing fertiliser from Thailand is conducted through Thai traders rather than directly with the producers (there are three fertiliser producers) in Thailand. Cambodian importers contact Thai traders with respect to the products and quantities they require subject to issuance of an import licence. Once the licence has been granted, it usually takes 15 days minimum to import the fertiliser products via border checkpoints. When it comes to trade with Vietnam, however, Cambodian importers can import from both producers and traders. Three major fertiliser producers, namely Binh Dien, Five Star Group and Petro Vietnam, have representative offices in Cambodia and distribute their products through sales representatives nationwide. YETAK Group has an exclusive contract with Binh Dien Fertiliser Co. to supply NPK fertilisers to Cambodia.

5
Supply-side Issues

5.1. The Supply Chain

Market channel: The fertiliser market structure is evolving rapidly to meet farmers' demands and to respond to Cambodia's thriving crops sector. The market is well organised with a network of importers, province-level distributors/wholesalers and province, district and village-level retailers, and is led by the private sector operating in a very competitive market with prices set by market forces (Figure 5.1).

Figure 5.1: Fertiliser Distribution Channels in Cambodia



Source: IFDC 2010

Licensed Cambodian importers store fertiliser in warehouses near the ports of entry and/or in Phnom Penh, and their distributors transport the products to provincial retailers in the main provincial cities (IFDC 2010).[13] The volumes of fertiliser handled by the main provincial dealers vary depending on the planting season: larger distributors have warehousing facilities with capacities of 2000–3000 tonnes to handle demand during peak season. Transport costs vary according to the distance from the main warehouse to the distribution points; haulage

[13] Except for those products imported directly from Vietnamese producers, the fertilisers that Cambodian importers purchase from Thai and Vietnamese traders were originally imported into Thailand and Vietnam in bulk from international markets, re-bagged and then re-exported to Cambodia.

costs are about USD0.25 per bag per 100 km, and loading fertilisers on and off the trucks costs about USD0.05 per bag (Theng 2012). Most of the larger distributors have trucks to deliver to district and village retailers. District and village shops, being generally smaller with limited storage (less than 100 tonnes), usually order fertilisers during the planting seasons to save space for other merchandise.

Village retailers are typically a one-stop-shop selling a wide range of farm inputs including animal feed, pesticides, seeds and fuel, as well as fertilisers. Village retailers typically buy fertilisers from the representatives of a main provincial dealer, although some also use different suppliers depending on the prices and services offered and/or to meet the specific demands of their customers/farmers. Retailers' transactions are conducted in cash or on credit. Approximately half of all retail sales are made on credit, with an added mark-up of 15,000 to 20,000 riels (USD3.5–5) per bag per planting season (3–6 months) (Theng 2012).

Some provincial distributors and district retailers resell fertilisers to seasonal village traders who sell directly to farmers. All traders selling agrochemical products need to be registered annually at the legislation office of the Provincial Department of Agriculture (PDA), otherwise their business activities are deemed illegal. However, seasonal village traders are not required to register with MAFF and can sell fertilisers in many locations in rural areas. They can be farmers in the villages who are slightly better off and possibly well connected with the main dealers. Seasonal traders generally resell fertiliser on credit to farmers, who repay the loan at harvest time. Such sales can result in a mark-up of as much as USD5 per bag per planting season (three months for dry season, and six months for wet season).[14]

Value chain analysis: Supply chain analysis was performed for prilled urea and DAP imports from Vietnam since these are the common fertilisers used in Cambodia. The evaluation for urea traces the chain back to international bulk market prices (Table 5.1; IFDC 2010), while the value chain for DAP goes back to the price at the point of entry from Vietnam (Table 5.2; Theng 2012).

Prilled urea value chain analysis shows that the mark-up added by traders beyond the importers is very low, at around 2 to 4 percent, whereas that of import companies is about 6 percent (Table 5.1). The DAP value chain is similar in that the retail mark-up is about 1.5 to 2 percent (Table 5.2). These figures indicate that the local fertiliser market is very competitive, particularly for the most common products. The retail prices of urea paid by Cambodian farmers are about 50 percent higher than international bulk prices. When operating costs are taken into account, the margins for province, district and village-level traders are very low, and the most value-added beyond producers' factory gates accrues to importers (IFDC 2010; Theng 2012). The prices of urea and DAP recorded in both studies matched the monthly retail prices recorded by MAFF (Tables 5.1 and 5.2; Figure 3.6).[15] The different retail prices in Cambodia could be lowered if importers' logistics costs, including transaction costs, were to be reduced through easing import entry. This could be achieved by reforming the licensing regulations and removing the import tonnage restrictions (see section 4.4 for detail), allowing small importers entry to the market and thus widening competition in price and quality.

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14 Heng Pich Chhay Import Export Company also sells fertiliser on credit to farmers, but only in the villages located near its warehouse in Takeo province. During the 2011 planting season, farmers bought approximately 500 tonnes of products directly from the company at an added cost of about USD1.5 per bag for three months, a much cheaper option than buying from village traders.

15 Due to budget and time constraints, the data used to perform the value chain analyses presented in this study depends largely on secondary data and previous studies.

Table 5.1: Prilled Urea Value Chain Analysis, May 2010

	Prilled urea (fob Arab Gulf)		
	USD per tonne	USD per 50-kg bag	% of fob
Bulk Prilled Urea fob Arab Gulf	300.00	15.00	100.00
Ocean freight and insurance	28.00	1.40	9.33
Discharge and inland freight	10.00	0.50	3.33
Bagging	15.00	0.75	5.00
Mark-up	8.00	0.40	2.67
Urea Cost per Bag from Importer in Vietnam	361.00	18.05	120.33
Barge transport to Cambodia (Takeo)	6.00	0.30	2.00
Into store	1.00	0.05	0.33
Cost into Border Warehouse	368.00	18.40	122.67
Importer's mark-up	18.40	0.92	6.13
Importers' Selling Price	386.40	19.32	128.80
Transport to province (200 km @ 0.15 per km)	30.00	1.50	10.00
Distributor's mark-up and handling	5.00	0.25	1.67
Into Store Provincial Distributor	421.40	21.07	140.47
Provincial distributor's mark-up	14.75	0.74	4.92
Distributor's selling price	436.15	21.81	145.38
Transport to village dealer (30 km)	4.50	0.23	1.50
Into store at village dealer	1.00	0.05	0.33
Dealer's mark-up for cash sale	8.83	0.44	2.94
Retail Cash Price	450.48	22.52	150.16

Source: IFDC 2010

Table 5.2: DAP Value Chain Analysis, February 2012

	DAP (USA origin)	
	USD per 50 kg	% of imported price
Bag Cost Importer at Vietnam Border	**31.5**	**100.0**
Transport to Cambodia (<100 km@$0.25 per bag)	0.3	0.8
Into store	0.1	0.2
Cost into Border Warehouse	**31.8**	**101.0**
Label changes and importers' mark-up	1.7	5.3
Importers' Selling Price	**33.5**	**106.3**
Transport to province (100 km @ $0.25 per bag)	0.3	0.7
Distributor 'smark-up and handling	0.8	2.2
Into store Provincial Distributor	**34.5**	**109.3**
Provincial distributor's mark-up	0.5	1.4
Distributor's selling price	35.0	110.7
Transport to village dealer and handling	1.0	2.9
Into store at village dealer	36.0	113.6
Dealer 's mark-up for cash sale	0.5	1.4
Retail Cash Price	**36.5**	**115.0**

Source: Theng 2012

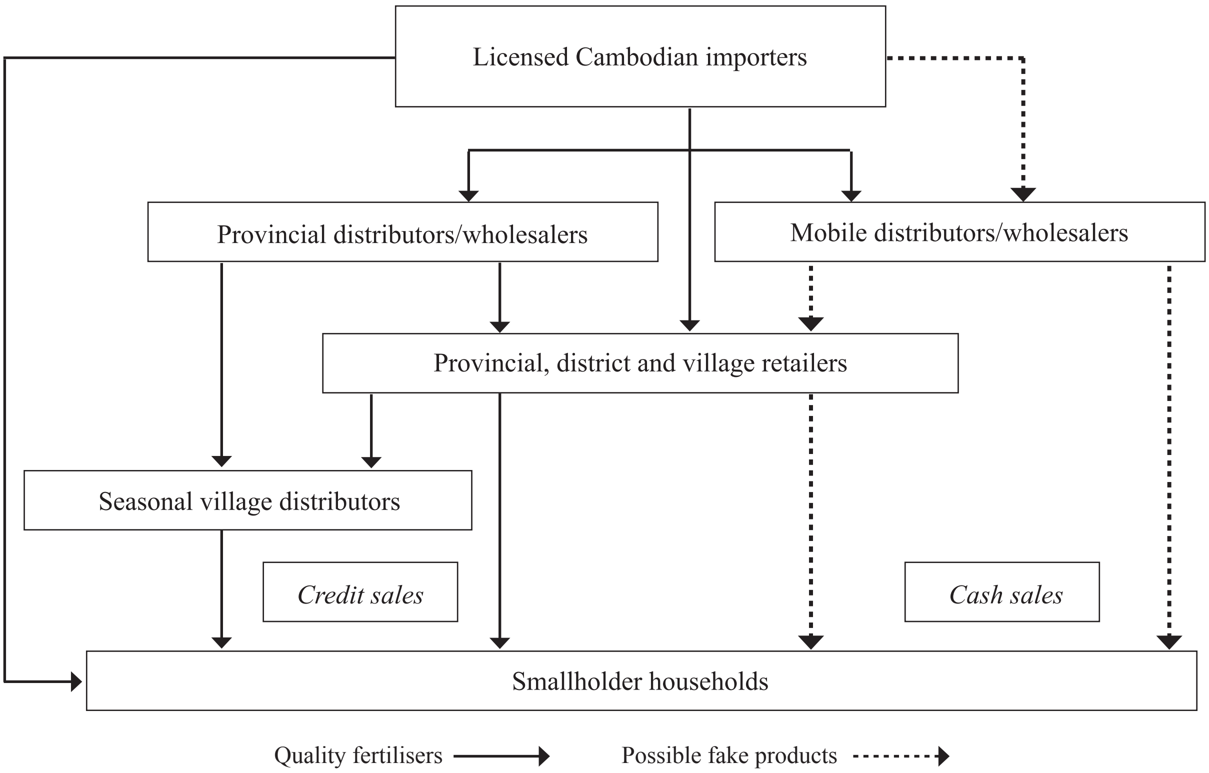
The results suggest that the fertiliser market is very competitive among traders for marginal profits beyond the importers. The most value-added beyond the importers is the high transport cost from provincial distribution points to village shops, which is largely due to the high unofficial fees paid to roadside police during transportation. Therefore, when operational and logistics costs are accounted for, the mark-up does not allow high marginal profits for most fertiliser traders; the high value-added cost of fertiliser is composed of importers' mark-up (5–6 percent) and transport and logistics costs (3 percent).

5.2. The Regulatory System

Variability in the quality of fertilisers sold in the marketplace is a critical issue. The quality problems stem either from the source of supply or from the distribution channel within the country, and are associated with the limited capacity of regulatory authorities (weak law enforcement) and the unclear structure and allocation of responsibilities among the different government agencies that control the fertiliser trade.

Nutrient analysis found that almost all of the NP and NPK compounds coming from Vietnam have below-acceptable quality index values (IFDC 2010). This is the result of both poor blending and poor quality raw materials supplied to fertiliser factories. Vietnamese producers, for example, use raw fertiliser materials imported from China, where they are subject to generally substandard chemical testing (IFDC 2010).

Figure 5.2: Fertiliser Distribution Channel in Takeo Province—Possible Flow of Fake Products



Source: Theng 2012

The fertiliser chain analysis for Takeo province found that mobile distributors/intermediaries form another distribution channel (Figure 5.2; Theng 2012). They have no specific business premises nor is it clear exactly where they originate from, but they circulate their contact details and deliver fertilisers as and when retailers need their services. They are well connected and have long-standing business relationships with some importers. They purchase fertiliser from importers/distributors or their sales representatives and load it onto trucks for delivery and re-sale to provincial, district and village retailers, and direct to farmers. IFDC (2010) reported that there is a very high opportunity for traders to adulterate fertiliser in this process, either by mixing low and high quality products and selling them on as higher quality fertiliser, re-bagging low quality fertilisers in bags labelled with a higher quality brand, and selling short-weight bags. For example, it is estimated that during the fertiliser price spike in 2008, about

30 percent of fertiliser products available on the market were fake. Although these problems have since diminished significantly, they still affect about 5–10 percent of fertilisers sold on the market (Theng 2012). The significant drop from the 2008 levels is due to the reduction in fertiliser prices, increased competition among importers, farmers' increasing awareness that cheap fertiliser is not good, the crackdown by MAFF and PDA on fake fertilisers through increased certification of retailers/dealers, more inspection, and training for retailers and farmers on how to inspect fake products.

According to regulations, all agrochemical dealers and retailers have to get a certificate of trade registration at the Office of Agricultural Legislation (OAL) of PDA, otherwise their business activities are deemed illegal. However, intermediaries, mobile distributors and/or small seasonal village retailers are unidentified and unregulated (IFDC 2010). These operators are blamed for creating problems in the fertiliser market and selling counterfeit fertilisers, causing huge financial losses to growers (Theng 2012). They should be regulated, and, as a minimum requirement, they should be registered/authorised so that their business activities can be monitored and controlled. Even so, tightening certification and regulation of dealers and retailers means very little when the government authorities concerned do not maintain strict control and supervision over these operators.

DAL of MAFF lacks both the capacity and authority to control the fertiliser trade in Cambodia: its quality control efforts to date have been confined to visual inspections due to the limited analytical capacity and resources at headquarters in Phnom Penh. The ability of the visual inspection system to detect adulterated or low analysis fertilisers is limited. What is really needed is chemical analysis, but this is not available. Furthermore, DAL inspectors are authorised only to enter shops; they have no authority to inspect dealers or retailers' warehouses, where malpractices are likely to occur. In addition, the division of ministerial authority is unhelpful in that DAL inspectors have no authority to check bag weights; this belongs to the Ministry of Commerce (MOC).

Another critical issue is that MAFF, which is responsible for administering the import and distribution of fertilisers through DAL, has no authorisation to inspect fertiliser quality at border entry points. Camcontrol of the MOC is officially authorised to regulate the entry of fertiliser products by checking licences, tonnage, and laboratory certificates of quality assurance. Counterintuitively, Camcontrol's testing laboratory has no capacity to analyse fertiliser nutrient content, whereas MAFF's BMAS laboratory has same capacity albeit limited.

5.3. Key Constraints Affecting Fertiliser Supply

Fertiliser distribution is hampered by an array of constraints. Importers need to obtain an import licence approved by MAFF. In addition, MAFF limits import tonnages to a maximum of 30,000 tonnes per importer per year. The import licensing procedures are complex, out of touch with market demand and restrictive to competitive market operation. The licensing process is not transparent and creates opportunities for rent-seeking; it has been reported that the liaison officers/facilitators who expedite individual licence applications through the eight MAFF departments involved demand significant fees, which add considerably to trading costs. Further, it is widely reported that some businesses acquire import licences only to sell them to other companies to import fertilisers on their behalf, and then the licence holders are subsequently paid between 2 to 3 percent of the import value (IFDC 2010).

The restrictions on import tonnages per importer/licence are contrary to market principles, imposing considerable commercial drawbacks and restricting economies of scale for importers.

The quota system constrains importers' market power to bargain for better prices and quantity, especially when obtaining import licences meets with considerable delays and uncertainties. In principle, in an open market economy, the private sector should be free to procure supplies of goods and services based on market and commercial risk assessment. The government's role should focus on monitoring product quality based on truth-in-labelling legislation. The licensing and tonnage quota system not only prevents larger importers from gaining comparative advantages (for example, high quality products and low prices) they could otherwise access in international markets, but also forces importation through either Vietnam or Thailand. Aside from adding to the transaction costs for consumers, the system encourages illegal imports and prevents small firms from entering markets and widening market competition, which, in turn, would bring retail prices down and benefit Cambodian farmers.

6
The Pricing Environment

6.1. Factors Affecting Fertiliser Prices

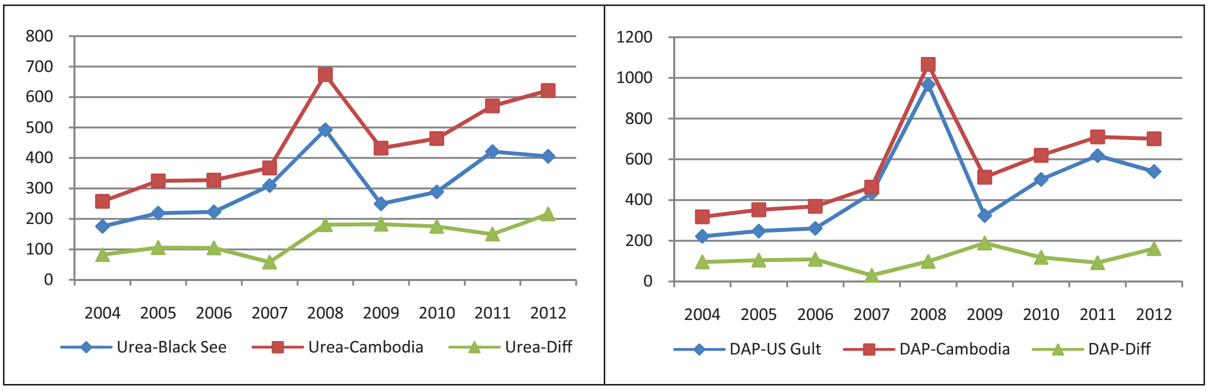
Fertiliser prices in Cambodia are set by the free interplay of market forces; the public sector has no influence here. The two factors that primarily affect fertiliser prices in Cambodia are international prices and domestic seasonal demand.

International market prices: Domestic retail prices for the most common fertilisers changed following the fob[16] international prices (IFDC 2010: 14-16). All common fertiliser retail prices in Cambodia increased steadily from 2004, and peaked in 2008 (Figure 6.1). During 2008, on average, the retail price of urea in Cambodia increased to about USD800 per tonne, while DAP rose to about USD1300 per tonne (Figure 6.2). At those levels, all types of fertilisers were unaffordable for most smallholder farmers, and the economic return from fertiliser use was negative. Note that the differences between the domestic and international prices of DAP and urea appear to have widened since 2008, in the range of USD100 to USD200 per tonne. The large differences may be partly caused by the high logistics costs of re-export via neighbouring countries (Vietnam and Thailand), and other country-level logistics costs. The logistics costs associated with re-export (bagging, labelling and storage) add about USD68 per tonne or 23 percent of the fob bulk price (IFDC 2010: 17). The high value-added factor cost within country is transport, and is largely due to unofficial fees exacted by roadside police during transportation and high costs of road haulage attributable to diesel fuel prices (Theng 2012: 8).

Figure 6.1: Yearly Average Cambodian Retail Prices and International fob Bulk Prices for Urea (A) and DAP (B), 2004–12 (USD per tonne at current prices)

A: Yearly Average Urea Retail Price in Cambodia and International Price Bulk fob (USD per tonne)

B: Yearly Average DAP Retail Price in Cambodia and International Price Bulk fob (USD per tonne)



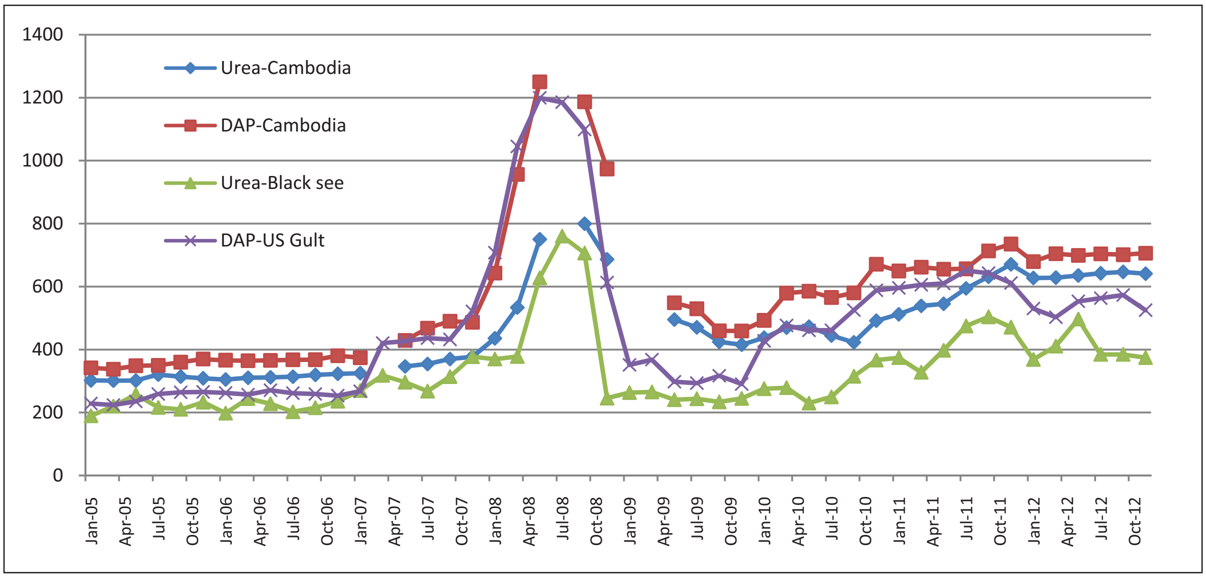
Source: AMI 2004-2012; Indexmundi (http://www.indexmundi.com/commodities/, accessed 5 July 2013)

Seasonal demand: another factor affecting domestic wholesale and retail prices is seasonal demand. According to a recent study by Theng (2012), retail prices during the peak production season increased by about USD40 per tonne or USD5 per 50-kg bag. Purchase terms also affect retail prices in most rural areas in Cambodia, where retail transactions are done using cash or credit. For instance, in Takeo, approximately 30–50 percent of retail sales are made through

[16] fob stands for free on board: the cost of traded goods at the port of origin, excluding the cost of sea freight and insurance (Minot 2011).

credit, with an added value of about USD5 per 50-kg bag per planting season (3–6 months), which farmers pay off at harvest time when they have cash (Theng 2012: 7).

Figure 6.2: Monthly Retail Prices for Urea and DAP in Four Provinces in Cambodia and International fob Bulk Prices, 2005–12 (USD per tonne at current prices)



Source: AMI 2004–2012; Indexmundi (http://www.indexmundi.com/commodities/, accessed 5 July 2013)

6.2. Profitability of Fertiliser Use

Data on rice yield responses to site specific nutrient management (SSNM) in field trials by CARDI and at other experimental sites associated with CARDI (Table 3.7) was used to estimate economic profitability based on the prices in 2009 of rice (USD250 per tonne) and fertiliser (urea USD440, DAP USD520 and KCl USD550 per tonne). The results show that the economic profitability (value-to-cost ratio) of fertiliser use was very poor and varied significantly across soil types. Among the soil types tested, Prateah Lang soil (CARDI site) and Prey Khmer soil (Kampot province) had high value-to-cost ratios, whereas Bakan soil had the lowest (Table 6.1). These results were confirmed by a later study, which also found that the value-to-cost ratio of rice yield response to SSNM was highest on Prateah Lang soil and showed the lowest return on Bakan soil (G. Blair and N. Blair 2010). Economic profitability using balanced NPK nutrients plus N LCC management seems to be higher than that using SSNM with 3-splits N timing (BS, TL and PI), except for on Kork Trap soils (Table 6.1). The findings suggest that although SSNM had a higher AE than the LCC approach (Table 3.7), it had a lower farm economic viability (Table 6.1). This result is consistent with the response curve of the relationship between yield response and nutrient use efficiency suggested by Roberts (2008: 181): "higher nutrient efficiencies could be obtained simply through scarifying yield, but that would not be economically effective or viable for the farmers".

The economic profitability of fertiliser use by farmers was estimated using the Cambodia Socio-Economic Survey (CSES) national datasets from 2007 to 2011. The results are shown in Table 6.2. Generally, the yield increases and economic profitability for wet season rice are much lower than for dry season rice; these results are due to farmers' relatively lower average fertiliser application rate for wet season rice (Table 3.2). In contrast, the yield increases and economic profitability for dry season rice are comparable to those obtained from on-farm trials (Tables 6.1 and 6.2) owing to the comparable amounts of fertiliser used (Tables 3.2 and 6.1).

Therefore, as for dry season rice, there is potential to improve the productivity of wet season rice through better nutrient management given adequate supplementary irrigation.

Table 6.1: Economic Profitability of Fertiliser Application in Rice Using SSNM

N timing/soil type	N-P2O5-K2O rate (kg per ha)	Yield increase (kg per ha)	Value-to-cost ratio
SSNM			
Prateah Lang	50-25-25	1533	4.3
Kampong Siem	90-60-30	1115	1.8
Prey Khmer	60-30-30	1230	2.9
Kork Trap	75-35-30	880	1.8
Bakan	75-30-30	425	0.9
LCC			
Prateah Lang	105-25-25	1877	5.2
Kampong Siem	117-60-30	1445	2.3
Prey Khmer	108-30-30	1263	2.9
Kork Trap	117-35-30	737	1.5
Bakan	117-30-30	620	1.3

Note: SSNM: 3-splits N (BS, TL, PI); LCC critical value 3; PK applied 100 % at BS.
Sources: CARDI Experiment Data from 2007–2009; CARDI 2011a

Table 6.2: Economic Profitability of Fertiliser Use

		Yield increase (kg per ha)	Value-to-cost ratio
2007	Wet-Rice	846.6	3.0
	Dry-Rice	1643.7	2.6
	Total	937.5	2.7
2008	Wet-Rice	999.5	3.2
	Dry-Rice	1862.7	3.8
	Total	1416.4	3.6
2009	Wet-Rice	593.2	1.8
	Dry-Rice	1919.4	2.9
	Total	913.0	2.2
2010	Wet-Rice	740.4	3.1
	Dry-Rice	2096.3	4.0
	Total	1072.2	3.2
2011	Wet-Rice	1175.6	4.0
	Dry-Rice	2349.5	5.0
	Total	1608.0	4.3

Note: See section 3.2 for detail on the average quantities of fertiliser applied to wet and dry season rice
Source: CSES 2007–2011

Economic profitability estimated from trials and farmer practices shows the potential for increasing the grain yields of rice under better nutrient management, especially for wet season rice, which accounts for about 85 percent of the country's total cultivated rice area. Proper selection of rice varieties, proper nutrient management, right timing of nitrogen fertiliser applications, and sufficient water supply for irrigation contribute significantly to improving yields in station trials. This indicates that if farmers could access appropriate and adequate extension services, rice production would improve in the very near future.

6.3. Availability of Market Information

The role of information and communication technology (ICT) in disseminating market information is very important in a free market economy. It enables all actors in the value chain, from importers to farmers, to get better price information and better access to resources. For instance, a programme promoting an ICT application for the dissemination of market information about vegetables, where traders and farmers can get up-to-date price information via text messages sent to their mobile phones, has been piloted in some provinces in Cambodia. The project design is appropriate for Cambodia; it can help farmers decide what products they need to produce, strengthen their bargaining power against collectors or traders, and thus make better profits. The implementation of the project, however, has not gone smoothly due to many challenges including limited human capacity and resources (Neth *et al.* 2009; Manopimoke 2008). Such ICT applications for agribusiness supply chains, including fertiliser, are not presently available in Cambodia. Yet they would be an important aid in promoting the country's market economy not only for farm inputs but also for other agricultural commodities, and especially in providing market information for the rice sector.

7
Conclusion and the Way Forward

7.1. Summary of Key Issues

Demand-side: Key constraints affecting fertiliser demand-side efficiency include high fertiliser prices, low quality fertilisers, high interest rates on credit and loans, and poor extension services. High fertiliser prices associated with high-interest loans have prevented farmers from applying fertiliser to their crops in sufficient quantities. Poor fertiliser quality has made farmers suspicious of the fertiliser market and prompted them to abstain from it altogether, or to apply fertiliser at a rate below that which is recommended. Inadequate extension services significantly affect fertiliser use efficiency and result in financial loss. These factors are the main demand-side constraints facing Cambodian smallholder farmers who wish to improve fertiliser use efficiency to increase crop productivity. Lack of irrigation and surface water resources can also discourage farmers from investing in fertiliser.

Supply-side: Key issues affecting fertiliser supply-side efficiency include the import licensing and tonnage quota system, and the weak institutional and regulatory environment controlling fertiliser distribution. The licensing process is complex and restricts competitive market operation. Due to the complexity and high costs, some importers buy import licences from other businesspersons in exchange for fees of between 2–3 percent of the import value. Restrictions that limit import tonnages to a maximum of 30,000 tonnes per licence are contrary to free market principles and restrict economies of scale in terms of private sector investment. The licensing and tonnage quota system not only hinders large importers' ability to import cost-effectively from international markets, it also encourages illegal imports and prevents small firms from entering markets and widening market competition which would bring retail prices down and benefit farmers.

The regulatory system is another factor that affects the fertiliser supply chain. Some intermediaries and mobile distributors are unidentified and unregulated; they are blamed for creating fertiliser quality problems across the country, critically affecting the performance of the whole fertiliser market. These fertiliser operators should be registered so that their business activities can be monitored and controlled.

The limited inspection and certification capacity of DAL/MAFF inspectors is a problem that needs to be urgently addressed in order to control the supply side of the fertiliser market. Fertiliser consignments are visually inspected for quality, but this cannot detect adulterated fertilisers. Laboratories are under-resourced, and thus lack the equipment required to conduct chemical testing to ensure the authenticity and a more rigorous quality control of fertilisers that would protect consumers.

Inappropriate allocation of roles and responsibilities between the public institutions involved in regulating fertiliser imports also negatively affects the supply side. DAL officials of MAFF have no authority to spot-check samples of fertilisers at border points; Camcontrol of MoC, which has insufficient capacity to check the quality of fertiliser products, controls the import of fertilisers into the country. This can lead to the import of low quality products.

7.2. The Way Forward

The agricultural sector remains a crucial part of economic growth and poverty reduction in Cambodia. Agricultural crops contribute largely to agricultural growth and promote food security. Increasing crop production through the expansion of cultivation areas is not feasible because of population growth. Future increases in agricultural productivity, therefore, are expected to come mostly from agricultural intensification (CDRI 2013), and fertiliser will play a vital role in raising crop yields and in sustaining the natural resources of farming land (Bumb and Baabante 1996). Furthermore, the fertiliser industry in Cambodia has evolved rapidly in response to farmer demand, and the overwhelming majority of rice and vegetable farmers use fertiliser. Smallholder farmers are more productive than large farmers, given that all available inputs are applied to their small piece of farmland. This result indicates a positive development of the fertiliser industry and adoption of fertiliser use in this country. Consequently, a subsidy policy to support the fertiliser industry may be irrelevant. However, the key constraints affecting fertiliser demand and supply should be addressed in order to strengthen trade competition and widen market operations, which, in turn, would bring down prices and increase the quality of products delivered to farmers. Below are some policy options that could be considered:

- MAFF could amend the fertiliser import licensing procedures and regulations, simplifying the licensing process and removing rent-seeking opportunities; easing licensing procedures and regulations would increase market competition and reduce illegal imports
- MAFF could remove quantity restrictions, allowing importers to import any quantity of registered fertiliser products based on market demand and risk assessment: but MAFF should approve only products that are suitable for use in Cambodia. Making it easy to enter the industry and removing quantity restrictions would increase economies of scale for importers, widening market competition in quality and reducing retail prices
- Institutional restructuring: to harmonise the roles and line responsibilities of ministries involved in fertiliser trade, and to control the quality of fertiliser products on the market, the government could combine human resources from the MOC and MAFF to create one department to regulate distribution at import, wholesale and retail levels
- Data collection and monitoring: data collection systems should be strengthened, and all importers should be required to furnish import and distribution data and prices on a quarterly basis to DAL of MAFF. Market information systems about import products and prices should be developed and made available to the public so that farmers know what the prices are of different products in different markets
- All imported fertiliser products should be properly labelled with the name of the manufacturer and source/country of origin. This would enable farmers to identify the sources of substandard fertilisers—such as from Vietnam and China—which are of substandard quality
- Increase extension capacity and services delivered to farmers by increasing public expenditure for extension institutions. Extension services delivery could increase to about one official for every 500 farmers, or around 4000 extension officials nationwide. This would help to reduce the chances of financial loss and increase fertiliser use efficiency to improve productivity and benefits to farmers
- Increase scientific research and on-farm adaptation research by increasing public expenditure for research institutions so that they can generate appropriate and specific technology, which can be transferred more effectively and sufficiently to farmers.

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