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Who Is Benefiting from Fertilizer Subsidies in Indonesia?

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Abstract

Using the Agricultural Census 2003 and the Rice Household Survey 2008 for Indonesia, this paper analyzes the distribution of benefits from fertilizer subsidies and their impact on rice production. The findings suggest that most farmers benefit from fertilizer subsidies; however, the 40 percent largest farmers capture up to 60 percent of the subsidy. The regressive nature of the fertilizer subsidies is in line with research carried out in other countries, the result of larger farms using a larger volume of fertilizer. This paper confirms that fertilizer used in adequate quantities has a positive and significant impact on rice yields, but it also provides evidence that over-using fertilizer has an adverse impact on yields (an inverted U-curve relationship).

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WHO IS BENEFITING FROM FERTILIZER SUBSIDIES IN INDONESIA?

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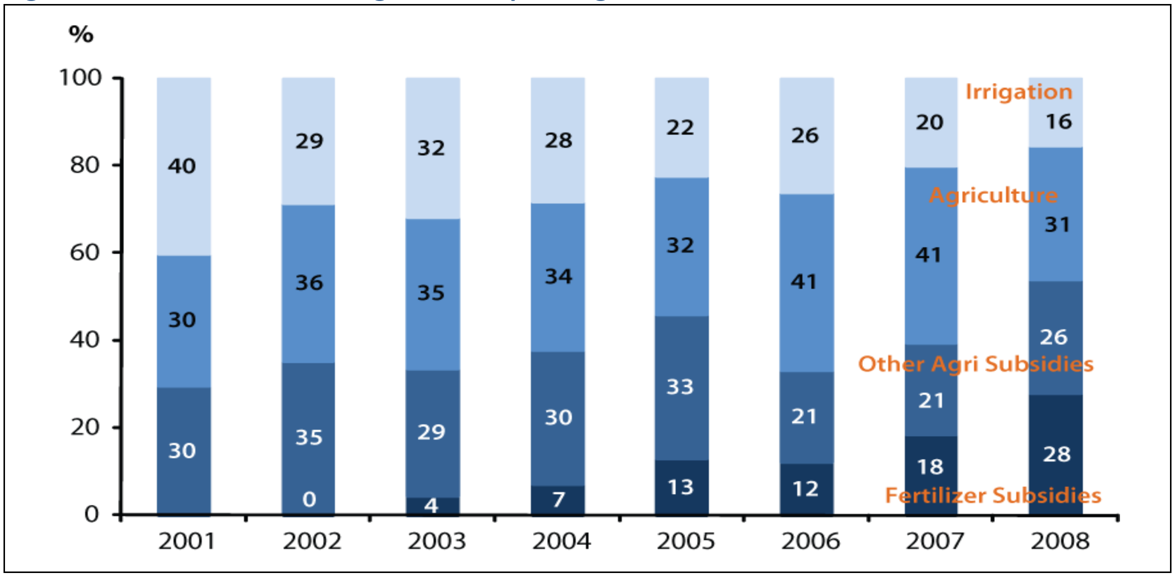
1. Introduction

Fertilizer subsidies have increased significantly since the beginning of the decade. In 2008, Indonesia directed over 50 percent of agriculture resources through direct subsidies for seeds, credit, fertilizer and rice (Figure 1.1). The budget for fertilizer subsidies, at over IDR 15 trillion, was almost double the budget for the Ministry of Agriculture (MoA) at the central government level, slightly above IDR 8 trillion.

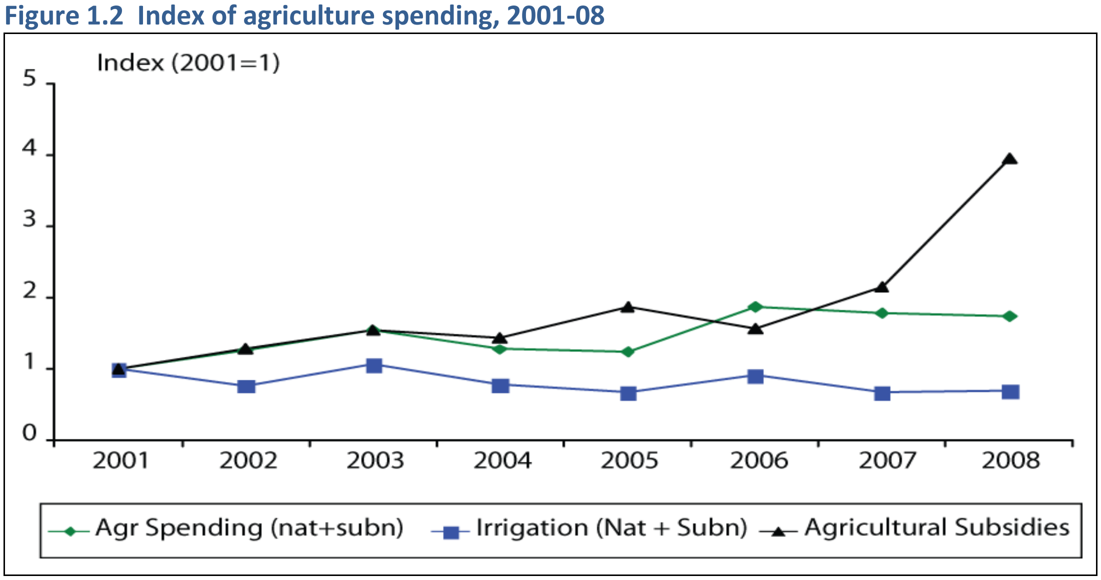
Figure 1.1 Share of national agriculture spending



Source: World Bank staff calculations.

Fertilizer subsidies have grown to become one of the largest spending items of the sector. As Figure 1.2 shows, by end-2008 the allocation for agriculture subsidies was four times its 2001 level, while resources for irrigation have remained flat over the same period. The budget of the MoA, while significantly higher than in 2001, has grown at a far slower pace than agriculture subsidies.

Figure 1.2 Index of agriculture spending, 2001-08



Source: World Bank staff calculations.

As in many countries, the provision of input subsidies is a highly political and very sensitive issue, particularly as it is linked to the long stated goal of the Government of Indonesia (GoI) of achieving self-sufficiency in rice production. The government continues to allocate a significant share of resources to subsidization in agriculture. The 2008 budget channeled close to 0.4 percent of GDP and Rp 29.4 trillion to subsidies for rice, fertilizers, seeds, and agricultural credit, of which the first two absorbed the bulk of the resources.

In this paper we seek to analyze the fertilizer subsidies from two different angles, both important for policy makers in the country. Firstly, we analyze who is benefiting from the current system of fertilizer subsidies, and secondly we estimate the impact that a removal of the fertilizer subsidies would have on rice production. Agriculture continues to play a very important role on the country's economy, but more importantly the production and price of rice is a key variable for Indonesian policy makers. As such, any analysis in this area has to look beyond efficiency and include equity considerations as well as the long-term goal of self-sufficiency in rice.

In the second section of this paper, we provide a short snapshot of the fertilizer system in Indonesia, as well as provide some data on fertilizer production and distribution. We focus on urea, since this fertilizer represents the bulk of the fertilizer used by rice farmers and it captures most of the subsidies being provided to the industry. In the third section, we conduct a benefit incidence analysis to show that the fertilizer subsidy is relatively regressive, with the 40 percent largest farmers capturing 60 percent of the total subsidy. In the forth section we estimate the impact of fertilizer use on rice yields, showing that the relationship is positive up to a point, beyond which the impact of additional use of fertilizer on yields is negative. We also show the relative inefficiency of the subsidy in increasing rice production, since fertilizer subsidies are significantly higher than the value of the increase in production achieved through the fertilizer subsidy. In the fifth section we discuss the rationale for subsidizing agricultural inputs and review some of the international experience to date. Finally, section six concludes and provides some policy recommendations.

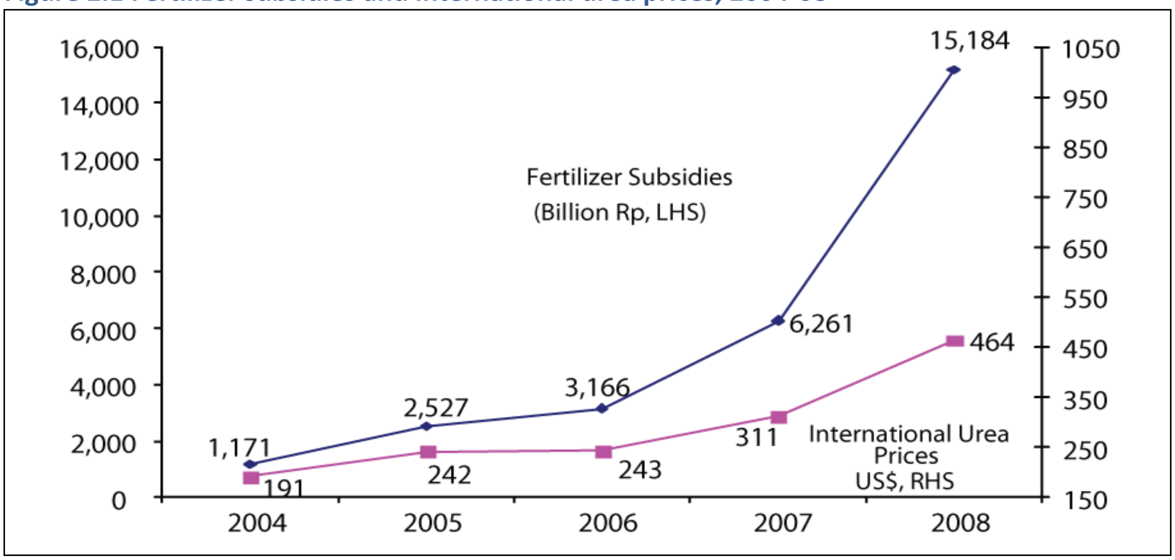
For this research we use two different surveys by the National Statistics Office (BPS), the Agricultural Census 2003 and the Rice Household Survey 2008. The first comprises a random sample of over 46,000 rice farmers in 29 provinces, while the latter uses a smaller sample of over 11,000 rice farmers from the 15 largest rice-producing provinces in Indonesia. The results of the benefit incidence analysis is very similar using both surveys; there is little targeting in the subsidy, with the largest farmers capturing a disproportionate share of the subsidy.

2. Fertilizer Subsidies in Context

As stated by the MoA, the fertilizer subsidy program in Indonesia seeks to achieve two objectives.[1] First, it seeks to increase agriculture productivity and preserve national food security and, second, it aims to enhance farmers' ability to optimize the use of fertilizer. However, there is also a sense that the program is a tool to achieve broader goals, ascribing to the program the objectives of maintaining farmers' welfare, poverty alleviation or a price stabilizer.

Public spending on fertilizer subsidies has increased far more than production costs for the industry. In the manufacture of urea, natural gas is the main input and the increasing gas costs worldwide drove international urea prices upward by 50 percent between 2007 and 2008. However, the subsidy in Indonesia grew even faster, at 142 percent over the same period, suggesting that production costs are not the sole driver of increased spending (Figure 2.1). Today, as this budget item represents an important component of agriculture assistance, it is crucial to understand who captures the benefits of these fertilizer subsidies and whether they result in increased rice production.

Figure 2.1 Fertilizer subsidies and international urea prices, 2004-08



Source: World Bank staff calculations.

Fertilizer production in Indonesia is dominated by a state-owned holding company. For more than three decades, Indonesia has pursued policies seeking to encourage greater fertilizer use by farmers as a way to enhance agricultural productivity. This has resulted in a fertilizer industry that heavily focuses on the production of urea and to a lesser extent other single compound fertilizers such as SP-36. Fertilizer production is a monopoly controlled by five state-owned companies that mostly produce urea under one holding company, PT Agro Kimia Indonesia. The two largest producers, PT PKT and PT Pusri, account for three-quarters of the total urea production. The main input for the production of domestic urea is natural gas, while the main raw material for non-urea fertilizers is potassium, which Indonesia imports for its domestic suppliers. The private sector only emerged as a player in the 1990s and holds a very small share of the market. It is involved only in the production of mixed-compound fertilizers and, due to price controls and subsidies, no private sector firms have entered the market to supply single-

1 Source: MoA Decree No. 42/Permentan/OT.140/2008 and Presidential Speech to the House of Representative, August 15, 2008

compound fertilizers. The subsidies for single-compound fertilizers have led to a wide price gap between single- and mixed-compound inputs, depressing the demand for mixed-compound inputs where the private sector could play a bigger role.

The distribution system of subsidized fertilizer is very complex, heavily regulated and involves several government layers. Ensuring the availability of fertilizer to the whole of Indonesia, including remote rural areas, is another key concern of the government. Distribution of fertilizer is regulated by a decree, which includes import quotas for certain companies, export restrictions, and it lays down the type of documentation that distributors and retailers have to present, all of which add to the heavy regulatory environment surrounding the production and marketing of fertilizer. Producers are only allowed to export fertilizer after domestic demand has been fully met, but despite frequently reported fertilizer shortages, legal exports of urea fertilizer were stopped only in 2006.

Distribution of fertilizer in Indonesia follows a ‘regionalization policy’, in which suppliers were assigned to geographical areas (mostly large islands). Each of the four urea producers is responsible for several provinces and tasked with identifying and monitoring distributors in each of the provinces, which are made responsible for organizing distribution down to the village level. As a way of avoiding urea shortages, the law requires producers to supply their mandated areas first. This regionalization of the distribution results in a lack of competition for market share and costumers that has removed incentives to innovate and to invest in producing and distributing fertilizer more efficiently. This in itself may be contributing to the reported fertilizer shortages. Limited competition for customers and markets and relative price distortions have led to low levels of investments by Indonesia’s fertilizer manufacturers, which has resulted in aging plants, difficulty in obtaining inputs such as natural gas and the impossibility to face higher production costs from rising fuel prices.

The GoI provides subsidies to the fertilizer industry to compensate for ceiling prices below market prices. The subsidy system to the fertilizer industry has undergone significant changes since its inception, from government purchasing of all fertilizer on a ‘cost plus fee’ basis to taking the border price as a reference for subsidizing production. The fertilizer subsidy system provides input subsidies for fertilizer producers (e.g. natural gas) to allow for a maximum retail price, which is determined annually by the MoA. In addition, to ensure availability of fertilizer, the MoA, in consultation with the provincial governments, determines production targets for each fertilizer firm based on estimated demand for fertilizer, both subsidized and non-subsidized. In 2006, as the fiscal cost of subsidies increased together with fuel prices, the government revised its subsidy system for fertilizer, providing subsidies to cover the difference between the maximum retail price set by the GoI and a breakeven point for fertilizer firms that is estimated annually by the State Ministry for State-Owned Enterprises.

Several attempts have been made to improve the targeting of fertilizer subsidies in order to avoid leakage to larger farms or estate crops and reduce the fiscal burden of fertilizer subsidies. These attempts include limiting beneficiaries of subsidized fertilizer to small farmers (with less than 2 hectares per planting season) or small aquaculture farmers (with less than 1 hectare) and piloting the use of ‘smart cards’ for the targeting of subsidies to small farmers. In 2009, the MoA plans to provide subsidized fertilizer only to those farmers who have registered in advance with the district agency for agriculture, which will need to be accompanied by certification by village authorities.

The government objective of ensuring wide access to fertilizer at affordable prices is only partially fulfilled. There are widespread complaints of fertilizer shortages, particularly as the planting season nears. Some of the reasons for these problems could be the regulated nature of the market, with the

MoA being responsible for estimating the need for fertilizer (both subsidized and unsubsidized), the location where it will be used, and the type of fertilizer that farmers will use, as well as the price at which it has to be sold. Changes in production trends are not easily incorporated into yearly production plans and price estimates. The type of information that would be necessary to project the correct amount (and price) of fertilizer is unlikely to be available to the MoA, leading to shortages in production and imports. Further regulations originating from the other ministries involved (Ministry of Trade, Ministry of Industry and State Ministry for State-Owned Enterprises) increase the uncertainty for the private sector, resulting in very little private sector involvement in the production of fertilizer.

The subsidy system itself is contributing to some of the fertilizer shortages. The price difference between subsidized fertilizer and the market price creates incentives for subsidized fertilizer to be sold outside the system, to other retailers/ dealers, exported to foreign buyers or to end users for whom it was not intended (e.g. large plantations). Although there are no estimates of how much subsidized fertilizer ends up exported or used for estate crops, it could be substantial and this would explain the persistence of fertilizer shortages despite large increases in the budget for fertilizer subsidies. Limits to the profitability of increasing production, such as the need to sell in Indonesia at depressed prices, also limits the incentives for producers to increase production. The central determination of quantities to be produced, the prices of the fertilizer and locations where the fertilizer can be sold, provides little room for fertilizer companies to expand production and compete with one another.

The demand for fertilizer in Indonesia has grown steadily over the past decade at around 5 percent per year. Indonesia has doubled its consumption of urea at 5 million tons in 2007 when compared with its level in the year 2000. Conversely, demand for other fertilizers such as SP36 increased by only 30 percent over the same period. Demand for urea is bolstered by the subsidies (to the detriment of other types of fertilizer), as suggested by the substitution of urea with AS (ammonia-based) and SP36 (super-phosphate-based) between 1999 and 2001, when Indonesia briefly stopped the fertilizer subsidies.

Table 2.1 Fertilizer agriculture consumption in Indonesia, 1994-2007

	UREA	AS	TSP/SP.36	KCL	TOTAL
1994	3,288,466	614,553	1,124,533	302,080	**5,329,632**
1995	3,710,455	652,999	1,069,909	403,900	**5,837,263**
1996	3,917,858	588,192	900,284	375,293	**5,781,627**
1997	3,323,601	350,503	663,478	350,270	**4,687,852**
1998	4,289,648	407,898	868,837	172,133	**5,738,516**
1999	3,140,033	243,906	394,949	380,000	**4,158,888**
2000	2,673,113	594,710	623,260	400,000	**4,291,083**
2001	4,069,585	580,724	778,689	425,000	**5,853,998**
2002	4,022,387	529,399	670,775	450,000	**5,672,561**
2003	4,336,729	511,129	1,414,091	63,715	**6,325,664**
2004	4,656,723	633,404	789,164	1,012,295	**7,091,586**
2005	4,842,537	651,986	778,706	947,212	**7,220,441**
2006	5,107,886	684,100	817,033	1,039,295	**7,648,314**
2007	5,010,434	745,378	802,812	1,382,166	**7,940,790**

Source: Indonesia Fertilizer Producer Association, 2007.

After briefly reviewing the characteristics of the fertilizer industry and the challenges ahead, the following section analyzes who is benefiting from the fertilizer subsidies.

3. Who Benefits from Fertilizer Subsidies in Indonesia?

The incidence of benefits from fertilizer subsidies is analyzed using two different rural household surveys by BPS: the Agriculture Census 2003 and the BPS Rice Household Survey 2008. The first survey comprises a random sample of 46,144 farmers for the rice subsector in 29 provinces. It was collected in 2004 and asked farmers about their usage of inputs in 2003. The latter survey entails data from a smaller sample of 11,297 rice farmers from 15 provinces regarding the harvest in 2007 (covering the 15 largest rice producers in Indonesia and collected in 2008).

Methodology

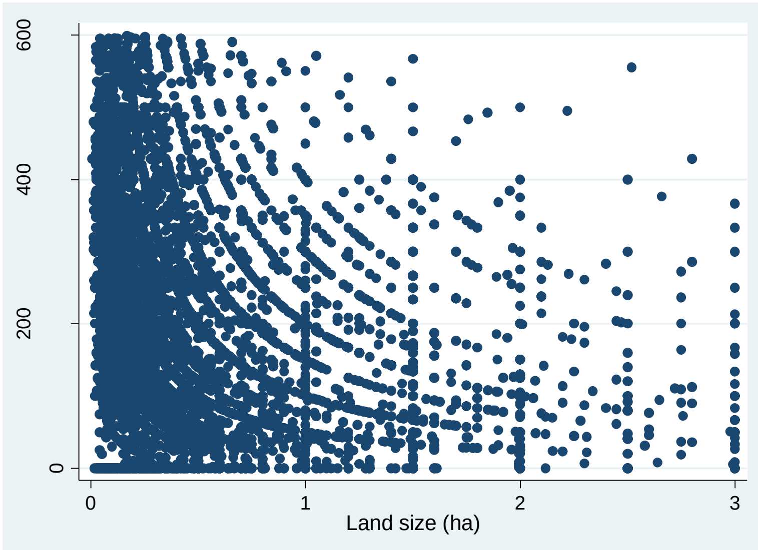
The incidence analysis looks at two types of fertilizers, urea and SP36, and estimates the spending share captured by farmers according to their land size. The subsidy is defined as the difference between the market price for fertilizer and the actual prices paid by farmers as reported in these two BPS surveys. In addition, the GoI established a ceiling price for fertilizer (HET) that is below the market price and market prices are reported by the State Audit Agency (BPK), the 'cost of goods sold' or CoGS.[2] Thus, one can estimate if farmers received subsidy benefits by looking at their paying prices. Those farmers reporting paying at the HET captured fully subsidized fertilizer, while those farmers paying below the market and above the HET, received partial subsidy assistance. The analysis looks at the volume of fertilizer used and at what price and divides the farmers in 5 equal quintiles by the size of their total agricultural land (where quintile 1 groups the smaller-plot farmers and quintile 5 the largest).[3] By aggregating the amount of subsidy spending captured by each farmer in a quintile, one can see how much subsidy assistance benefited each group. (See Annex I for a more detailed discussion on the methodology.)

Small farmers on average use more fertilizer per hectare. In 2007, the smaller rice producers used twice as much urea per hectare and harvested higher yields than farmers with the larger rice paddies (Table 3.1). This often leads to over-use of fertilizer (Figure 3.1). This may also reflect price distortions in input markets, which have led small farmers to substitute alternative inputs (other fertilizer, better seeds) for urea, as suggested by the increase in the demand for non-urea fertilizer following the removal of subsidies in 1999-2001. In contrast, larger farmers have greater access and better quality inputs, as well as better quality information and can, therefore, use an optimal mix of agriculture inputs.

2 The CoGS is taken as reported in the BPK reports, with the exception of the CoGS for urea in 2003 that is an estimate (see Annex I). In 2003, the HET price for urea was Rp 1,150 per kg and the CoGS was Rp 1,489, while for 2007 the HET was Rp 1,200 per kg and the weighted average of the CoGS of four producers stood at Rp 2,170.5. Consequently, the HET price for SP-36 in 2003 was Rp 1,400 and the CoGS was Rp 1,629, while by 2007 the HET reached Rp 1,500 and the CoGS was Rp 2,395.

3 The land size variable includes total agriculture land for farmers that either, rented, owned, or sharecropped rice paddies. A different analysis, grouping farmers by the size of their gross revenues from rice (where quintile 1 holds the poorest individuals and quintile 5 the richest), corroborates the findings reported in this section. The results of this analysis are reported in Annex III.

Figure 3.1 Urea use per/ha and land size, 2007



Source: World Bank staff calculations.

Table 3.1 Rice yields and urea/SP36 use by quintiles of land size, 2007

Quintile	Rice Yields (kg/ha)	Urea Use (kg/ha)	Intensity Urea/Yields	SP36 Use (kg/ha)	Average Land Size (ha)
1	4,836	343	7.1%	164	0.12
2	4,596	291	6.4%	151	0.25
3	4,447	268	6.1%	136	0.41
4	4,053	224	5.6%	118	0.73
5	3,490	170	5.0%	88	1.97
Average/Total	4,283	259	6.0%	132	0.7

Source: World Bank staff calculations.

The data on fertilizer consumption in Indonesia show that farmers use more urea than recommended by the MoA. While the optimal levels of urea required per hectare vary according to soil quality across islands in Indonesia, the MoA recommends using 200-250 kg/ha of urea and 50-100 kg/ha for SP36 fertilizer.[4] However, as Table 2.1 illustrates, all farmers in quintiles 1-3 used more than the suggested amount of fertilizer. In the case of SP36, only the larger farmers in quintile 5 consumed within the recommended range.

Benefit Incidence Analysis

There is no evidence of targeting subsidized urea. When looking at the incidence of benefits by land-size in 2003, there were subtle differences that favored the smaller farmers (those in land-size quintiles 1-3). Yet, while the coverage of the subsidy program increased in 2007 the targeting was ineffective and these differences disappeared. (See Figures 3.2 and 3.3, which show that all quintiles benefitted equally

4 These recommended level does not include blends with organic fertilizer. MoA Decree No. 01/Kpts/SR.130/I/2006 (Lampiran Keputusan Menteri Pertanian). The lower range is an average for off-Java provinces, while the higher range applies for Java.

from the fertilizer subsidy.) As the government increased spending on fertilizer subsidies, a larger number of farmers benefited. In 2003, close to 65 percent of surveyed farmers reported capturing either full or partial assistance, and this number increased to 96 percent in 2007.

Figure 3.2 Farmers receiving subsidized urea by quintiles of land size, 2003

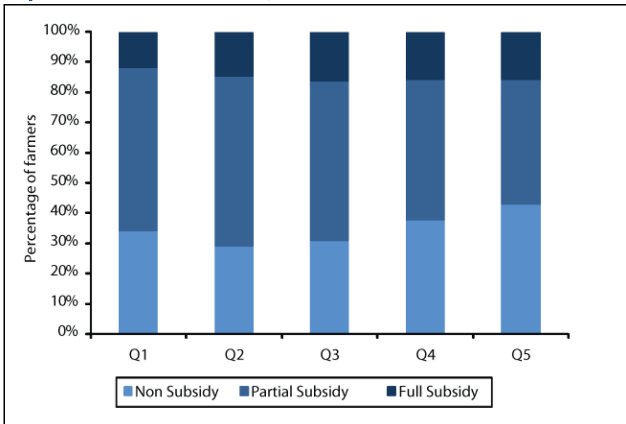
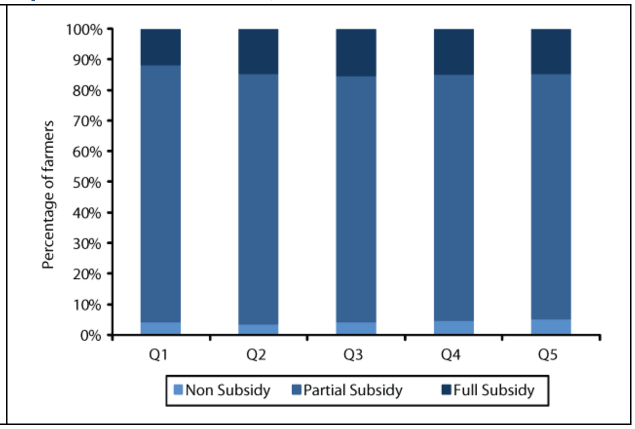


Figure 3.3 Farmers receiving subsidized urea by quintiles of land size, 2007



Source: World Bank staff calculations.

Very few farmers are paying for fertilizers at the HET regulated price. The fact that most beneficiaries belong to the partial subsidy group and the evident reduction of the full subsidy group over time suggest that fertilizer shortages drove prices upwards. In 2007, about 10 percent of the farmers paid the HET or below, while a large majority of the farmers in all quintiles paid above the HET regulated prices for fertilizer.

Table 3.2 Fertilizer prices by quintiles of land size

Quintile	Urea Price (Rp)	SP36 Price (Rp)	Average Land (Ha)
1	1,549	2,221	0.12
2	1,512	2,173	0.25
3	1,507	2,182	0.41
4	1,522	2,167	0.73
5	1,530	2,265	1.97
Average	1,524	2,202	0.7

Source: World Bank staff calculations.

There is evidence that, on average, farmers paid similar prices for fertilizer.[5] In 2007, farmers in the first quintile paid on average Rp 1,549 and Rp 2,221 per kg of urea and SP36, respectively, while those in quintile 5 paid on average Rp 1,530 and Rp 2,265 for these inputs. In general, farmers were charged 28 percent above the regulated urea price (HET), while a bag of SP36 was on average 45 percent more expensive than that of urea (Table 3.2).

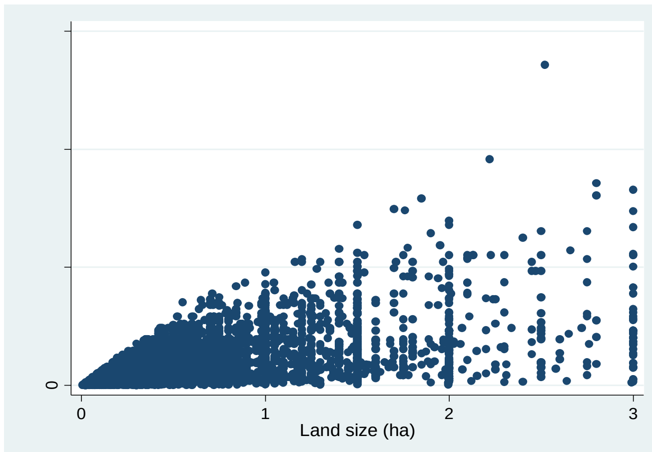
Public spending to subsidize urea is regressive and a large share of the benefits is captured by the larger farmers[6]. The larger farmers use greater quantities of fertilizer, which means they absorb more public resources. In both 2003 and 2007 surveys, the 40 percent largest farmers capture up to 60 percent of

5 The mean difference ANOVA tests between quintiles (Bonferroni, Scheffe, Sidak 1969) show small, but statistically significant mean differences in urea prices amongst the land quintiles 1, 2, & 3. In the case of SP36, the mean differences were only statistically significant between quintiles 2, and 5 and 3 and 5. (See for a discussion on these tests, Abdi, H (2007))

6 Throughout this policy note, large farmers does not necessarily mean large in absolute terms, since the average size even in the largest quintile is below 2 ha of land, but these farmers are large relative to the farmers in the other quintiles. These differences in land-size groups in the sample translate into significant differences in income across quintiles, where farmers in quintile 5 earn on average 7 times more gross revenues from rice than farmers in the lowest quintile. In interpreting the results of our analysis, it is important to keep in mind both the small size of most farms in the sample, as well as the large differences in average farm size and income between quintiles.

the total subsidy. (Figure 3.4 illustrates the positive relationship between urea subsidy spending captured and the size of farmers' agriculture land, while Figures 3.5 and 3.6 show how these public resources were distributed across these five farmer groups.)

Figure 3.4 Captured urea subsidy spending and land size, 2007



Source: World Bank staff calculations.

These findings are corroborated by the fact that both surveys show a similar distribution of benefits. However, these data were gathered at two different periods of the subsidy program and for two different random samples of rice farmers. Thus, the results raise equity concerns because the income differences between these farmer groups are striking: the larger farmers in quintile 5 generated on average gross revenues from rice seven times greater than the smaller rice growers in quintile 1.

Figure 3.5 Distribution of urea subsidy spending by quintiles of land size, 2003

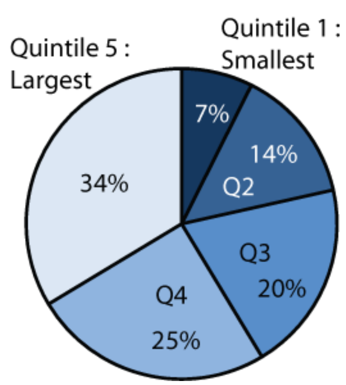
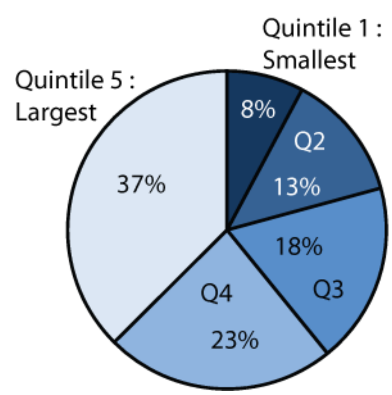


Figure 3.6 Distribution of urea subsidy spending by quintiles of land size, 2007

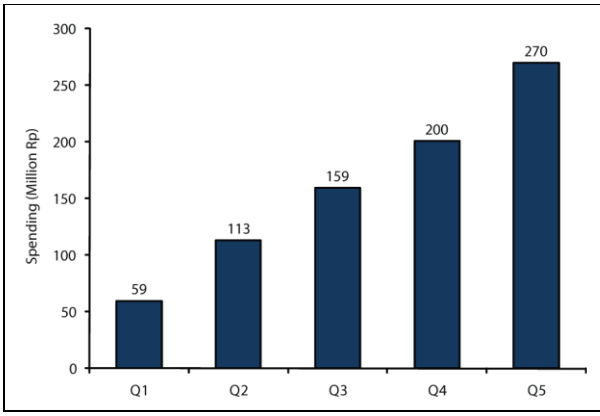


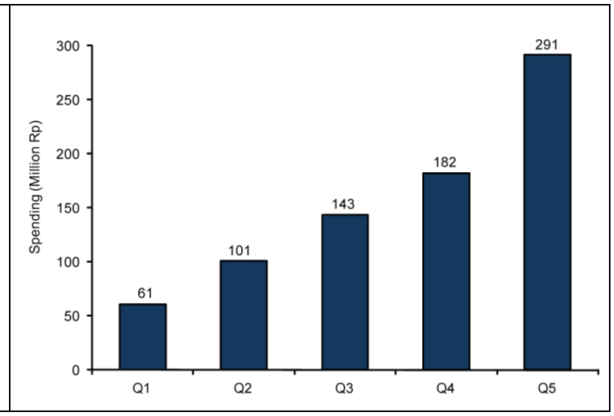
Source: World Bank staff calculations.

The total subsidy spending that benefited quintiles 4 and 5 was greater than the combined share captured by farmers in the three smaller quintiles, as seen in Figures 3.7 and 3.8. These findings are independent of the assumed market price for fertilizers. A sensitivity analysis, presented in Annex VII, shows that these results are independent of the market price (CoGs) reported by the BPK, over which the subsidy was estimated. Thus, increasing and decreasing the market price for urea by 10 percent does not alter the findings on the distribution of benefits and of captured spending per quintile.

Figure 3.7 Urea subsidy spending by land size, 2003

Figure 3.8 Urea subsidy spending by land size, 2007





Source: World Bank staff calculations.

As in the case of urea, there was no targeting of subsidized SP36 and the benefits were regressive, benefiting the larger farmers. SP36 is a more expensive input than urea that is produced by one company in Indonesia, PT Petro Kimia Gresik (PKG). It comprises a smaller share of the total subsidy expenditures, but the data show a similar incidence story (Annex II). While in 2003, the subsidies seemed to be benefiting a larger share of small farmers, by 2007 these differences across quintiles disappeared (Annex II, Figures II.1 and II.2). As in the case of urea, the share of farmers that received the subsidy increased significantly from 43 percent (2003) to 68 percent (2007), but it remains lower than the share of farmers benefiting from subsidized urea in 2007 (96 percent). As in the case of urea, a large share of the subsidies is captured by larger farmers in quintiles 4 and 5, with 62 percent of all subsidies going to these two quintiles in 2007.

There are significant fiscal savings to be made by improving targeting of the fertilizer subsidy. Assuming a similar distribution of subsidy spending for Indonesia such as that in Figures 3.7 and 3.8 and providing the same amount of subsidies to the smallest 60 percent of the farmers, the government would have saved over Rp 9 trillion from the fertilizer subsidy budget in 2008. Having explored the distribution of benefits of the fertilizer subsidy, one question remains unanswered. Has fertilizer usage translated into greater agriculture production in Indonesia?

4. What Is the Impact of Urea Consumption on Rice Production?

This section estimates the impact of fertilizer subsidies on urea consumption and the impact of urea use on rice yields. A simple micro-model using data from the 2007 household survey explores two important questions: What is the effect of the fertilizer subsidy on urea consumption, and what impact does urea usage have on rice production? The model proposed allows for diminishing returns to the use of fertilizer (by including a quadratic term for urea used), implying that there is an optimal point for urea usage beyond which yields start to decline. The quantity of urea consumed depends on: the price of urea, the price of other fertilizers (which are proxied with the price of SP36), the price of rice, and the price of rice seeds. In turn, the impact of urea on rice yields is dependent on: the quantity of urea used, the consumption of other inputs (land, labor, irrigation), and controls for soil quality (a dummy variable for Java-Bali) and human capital (in this case, the years of education and the age of the head of the household). The model to be estimated is summarized below:

$$ln\ rice\_yield = \alpha + \beta_1\ ln\ urea\_used + \beta_2\ ln\ urea\_usedsq + \beta_3\ ln\ land\_size_i + \beta_4\ ln\ labor\_cost + \beta_5\ irrigation + \beta_6 educ + \beta_7 age + \beta_8 Java\&Bali + \varepsilon \quad (1)$$

where *urea_used* is the fitted value of the regression: *(2)*

$$ln\ urea\_used = \alpha + \beta_1\ lnprice\_urea + \beta_2\ ln\ price\_SP + \beta_3\ ln\ price\_seeds + \beta_4\ lnprice\_rice + \beta_5\ ln\ land\_size_i + \beta_6\ ln\ labor\_cost + \beta_7 irrigation + \beta_8 educ + \beta_9 age + \beta_{10} Java\&Bali + \nu$$

And *urea_usedsq* is the fitted value of the regression: *(3)*

$$ln\ urea\_usedsq = \alpha + \beta_1\ lnprice\_urea + \beta_2\ ln\ price\_SP + \beta_3\ ln\ price\_seeds + \beta_4\ lnprice\_rice + \beta_5\ ln\ land\_size_i + \beta_6\ ln\ labor\_cost + \beta_7 irrigation + \beta_8 educ + \beta_9 age + \beta_{10} Java\&Bali + z$$

Variable Definitions[7]*:*

rice_yield is the quantity of rice (kg/ha)
urea_used is the quantity of urea used (kg/ha)
urea_usedsq is the square term of *urea used*
land_size is the size of the cultivated rice field (ha)
labor_cost is the total cost of labor ($/ha)[8]
irrigation is a dummy variable (1 for irrigated land)
price_urea is the price of urea
price_SP is the price of SP36 fertilizer
price_seeds is the price of the most commonly used rice seeds -superior ($/kg)
price_rice is the dried grain price of rice at which the farmer sold the last harvest.[9]
educ is the years of education of the head of the household
age is the age of the household
Java&Bali is a dummy variable (1 for provinces in Java and Bali)
e, v*, and z* are error terms

7 A word of caution is necessary when interpreting the results. This model focuses on understanding the relationship between fertilizer use and rice yields. A model to better understand the factors determining rice production is a far more complex undertaking which requires additional information unavailable at this stage, such as the quality of rice seeds, irrigation and soil.
8 Labor costs: The number of workers multiplied by their reported salary. For those non-wage workers, the average salary for men and women is assumed for the estimation. An alternate specification used labor inputs measured in man days per hectare and showed similar results.
9 The rice price influences the quantity of urea used by providing farmers with the means and incentives to buy fertilizer. Although the dried grain price at which farmer's sell their output rice (the information provided in the survey) may differ from the price farmers faced when buying inputs (not provided by the survey), both prices will be strongly correlated. Therefore, this model uses this post-harvest information from the survey as a proxy for the rice price.

There are some challenges in estimating this model, primarily the inability to take into account how farmers' incomes may drive both rice yields and urea use. Estimating the relationship presents a potential endogeneity problem. This is because urea used will most likely be correlated with the error term in the yields equation because of omitted variable bias.[10] Those omitted variables that have an impact on yields, but were not included in the regression, either observable or unobservable effects, will be captured in the error term. Farmers' incomes will most likely impact yields, but in the absence of a measure of wealth in the survey, it cannot be captured in the yields equation (1) explained below. Thus, income is a driver of yields if richer farmers have different production levels than poorer farmers as a result of being less credit constrained, risk averse, or having access to better farming techniques. On the other hand, income will determine how much urea farmers can buy and, for poorer farmers, spending on inputs accounts for a much higher share of their resources. Therefore, omitted variable bias can drive the relationship between urea usage and the error term when income is not accounted for in the yields equation. Other omitted variables that can impact yields include: the quality of irrigation, private capital, and effort or ability to grow rice.

To address this endogeneity problem, the model is estimated using an instrumental variable (IV) through a two-stage least square regression (2SLS).[11] The 2SLS estimator calculates the fitted values of the urea regression (2) and the fitted values of urea used squared (3) to use as IV's and indirectly capture the impact on the yields regression (1). In the first stage regression, it breaks urea used (and urea used squared) into 2 components, a "problematic one" correlated with the error term and a "non-problematic" exogenous component. Then, it takes the exogenous parts of urea used (and urea used squared) to capture the effect on the rice yields. There are two conditions to meet in order for this estimator to be valid: (i) instrument relevance, where the correlation between urea fitted and urea used is different from 0; and (ii) instrument exogeneity, where the correlation between urea fitted and the error term (e) is 0. Both these conditions are met by the model in this section.[12]

The model looks at the relationship across the overall sample and also within each quintile of land size, given that urea usage and yields vary significantly according to plot size. The overall model captures better the relationship as a whole, is estimated over a wider sample, and allows for geographical differences with a dummy for Java-Bali. However, estimating the relationship at the quintile level shows interesting differences that illustrate smaller farmers having higher yields and on average using more urea than recommended. Interestingly, by grouping individuals according to the size of their rice paddies also captures farming variations across provinces because farms tend to be much smaller in Java-Bali (and are planted more intensively). Table 4.1 below suggests that larger farmers (quintile 5) can be predominantly found off-Java, while the composition of quintiles 1-4 is two thirds either Javanese or Balinese. Therefore, breaking the sample into land groups allows for the production functions to vary by land size and by geographical location.

10 The results of the Durbin-Wu-Hausman test for endogeneity confirm that urea used is correlated with the error term in the yields equation (1), (Stock and Watson 2003).
11 See Annex VII for a comparison between 2SLS and OLS estimators.
12 Instrument exogeneity in the model was tested with the overidentifying restrictions test and failed to reject the null hypothesis of exogeneity. The instruments used and results presented in this section meet the condition of exogeneity and are statistically valid. (Stock and Watson, 2003).

Table 4.1 Distribution of farmers, model sample 2007

Farmers	Q1	Q2	Q3	Q4	Q5	Overall
Java-Bali (%)	89	79	76	68	36	70
Off Java-Bali (%)	11	21	24	32	64	30
Total (No of farmers)	1,575	1,576	1,577	1,577	1,578	7,883

Source: World Bank staff calculations.

The results below suggest there is a positive impact on rice yields when using urea at adequate levels, but there is a threshold that, if exceeded, the relationship reverses and fertilizer starts having a negative impact (Table 4.2 (1)).

Table 4.2 Estimation results (2SLS second stage regression) in 2007

Dependent variable: Rice yields	Overall	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
	(1)	(2)	(3)	(4)	(5)	(6)
Urea use	4.2098	0.4997	0.4269	0.3091	0.3506	0.1552
	(2.26)*	(7.54)**	(6.43)**	(4.28)**	(4.77)**	(2.31)*
Urea use squared	-0.3882					
	(-2.08)*					
Land size	-0.0959	-0.0685	-0.0472	-0.1029	-0.1383	-0.2004
	(-5.86)**	(-3.27)**	(-2.25)*	(-4.56)**	(-4.90)**	(-7.59)**
Labor cost	0.0431	0.0561	0.0540	0.0740	0.0958	0.0760
	(3.08)**	(5.50)**	(4.84)**	(5.84)**	(6.84)**	(7.24)**
Dummy irrigation	0.0339	0.0216	0.0089	0.0383	0.0403	0.1017
	(2.76)**	(1.18)	(0.53)	(2.03)*	(1.74)+	(3.25)**
Education	-0.0006	0.0034	0.0042	0.0026	-0.0012	0.0003
	(-0.32)	(1.32)	(1.64)	(1.01)	(-0.42)	(0.09)
Age	-0.001	-0.0007	0.0013	-0.0019	-0.0006	-0.0014
	(-1.82)+	(-1.04)	(0.34)	(-2.43)*	(-0.68)	(-1.22)
Dummy for Java-Bali	-0.0937	-0.1625	-0.1384	-0.096	-0.1148	-0.0021
	(-4.49)**	(-4.39)**	(-4.69)**	(-2.86)**	(-3.28)**	(-0.06)
Constant	-2.3646	5.8908	6.0816	7.1419	6.9928	8.5999
	(-0.52)	(17.11)**	(15.57)**	(15.84)**	(13.80)**	(17.43)**
R-squared	.	.	0.09	0.25	0.32	0.30

z statistics in parentheses.
+ significant at 10%; * significant at 5%; ** significant at 1%.
All variables are estimated in natural logarithm

The impact of fertilizer use on yields is not uniform, and smaller in magnitude and significance for larger farms off-Java. When looking at the relationship between fertilizer use and yields by quintile, a linear model seems to fit the relationship better (the urea squared term is not significant), which differs from the non-linear relationship found for the overall sample. The fact that the relationship is different when breaking down the sample by land size suggests that smaller farmers have a different production function than larger farmers. Also, the analysis by plot size captures geographical differences in rice farming that could lead to different production functions; for example, in Java, farms are not only smaller or sowed more intensively, but soil quality is better and farmers have higher years of schooling.

At the quintile level, estimating the model linearly shows that a 1 percent increase in urea use increases yields by 0.31-0.49 percent on Java and 0.16 percent mostly off-Java. Within Java-Bali, quintiles 1-4 show differences in the impact of urea use on yields and a much larger effect on the yields of smaller farms. Similarly, the urea consumption of the bigger farms in quintile 5, mostly off-Java farms, reflect the lowest boost in yields for the sample. This suggests that other deteminants (land size, irrigation, labor) are more significant drivers of yields than fertilizer for the larger producers, and it is not surprising that, since they are less credit constrained and have access to better information, other determinants are better able to explain their variation in rice yields.

Most control variables behave as expected: land size is negatively associated with yields, while agricultural inputs (labor and irrigation) are positively associated. Land size is negatively associated with rice yields, as anticipated given that smaller plots are farmed more intensively. The dummy for Java-Bali, which is introduced to proxy for different soil qualities, shows that on-Java more urea is consumed compared with off-Java (a positive and significant effect). Nonetheless, one would expect to find a positive relationship between the dummy for Java-Bali and yields, to reflect the better soil quality in these islands. As such, the significant and negative relationship in most quintiles is surprising (with the exception of quintile 5 where it is inconclusive),[13] and signals that the dummy may not be such a good proxy or the fact that other variables in the model (irrigation, fertilizer) are already explaining much of the impact from soil quality. Increased labor (including non-wage labor or unpaid family members) is also positively associated with higher rice yields, and this is particularly true in larger farms (quintiles 4 and 5), where the effect is greater in magnitude and significance. As expected the findings show that the effect on rice yields from using diverse inputs varied between small and larger farmers.[14]

Further research is required to capture the relationship between irrigation and rice yields. While the impact from the dummy for irrigation is positive and significant (and greater in magnitude for the larger farmers), the survey data did not allow capturing factors such as: maintenance, the quality of the irrigation network, or the extent to which existing infrastructure is operational, which are the true drivers of the relationship with yields. Therefore, further research may shed light on the impact of these factors in determining rice production.[15]

Not surprisingly, the urea price is negatively associated with urea use, although there are significant differences by farm size (Table 4.3). The consumption of urea in the smallest farmers (quintile 1) is the least affected by the urea price. However, urea consumption of the largest farmers mostly off-Java (quintile 5) is highly sensitive to changes in fertilizer subsidies, as well as quintile 2 farmers that are mostly composed of Javanese farmers.

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13 The fact that the dummy for Java-Bali is not significant in the quintile 5 suggests that for these larger farms, which are mostly located off-Java, soil quality is not a driver of yields and that soil characteristics are more homogenous.

14 One production input that could be controlled for is capital inputs. There is limited information from both surveys to control for investments that farmers may be doing in their fields.

15 There may be measurement error in the irrigation variable. The surveys show that about 50 percent of all rice farmers grow rice in irrigated fields (*sawah*), both in Java and outside Java. This is much lower than widespread perceptions and data published by BPS, which show that over 90 percent of rice produced in Indonesia is grown in irrigated fields.

Table 4.3 Estimation results (2SLS first stage regression) in 2007

*Dependent variable: Urea use and Urea use squared *)*	Overall (Urea use)	Overall (Urea use squared)	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Urea price	-0.4123	-4.0166	-0.2568	-0.4949	-0.3980	-0.2981	-0.5096
	(-11.30)**	(-11.19)**	(-3.76)**	(-6.29)**	(-5.12)**	(-3.58)**	(-5.40)**
SP price	-0.1901	-1.9744	-0.2587	-0.1535	-0.1614	-0.2699	-0.1745
	(-6.19)**	(-6.53)**	(-4.23)**	(-2.47)*	(-2.35)*	(-3.64)**	(-2.30)*
Seeds price	0.1343	1.301	0.109	0.0329	0.0992	0.1638	0.1924
	(7.40)**	(7.29)**	(-3.37)**	(0.86)	(2.43)*	(3.86)**	(4.07)**
Rice price	-0.2353	-2.4983	-0.3366	-0.0842	-0.1614	-0.2989	-0.3564
	(-4.74)**	(-5.12)**	(-3.83)**	(-0.83)	(-1.53)	(-2.49)*	(-2.59)**
Land size	-0.2834	-2.7681	-0.0231	-0.1166	-0.1993	-0.3188	-0.3497
	(-33.72)**	(-33.48)**	(-0.84)	(3.43)**	(-6.24)**	(-10.84)**	(-15.35)**
Labor cost	0.0846	0.7801	0.0223	0.0586	0.0865	0.1294	0.0938
	(12.91)**	(12.09)**	(1.52)	(3.54)**	(4.84)**	(7.83)**	(7.60)**
Dummy irrigation	0.0947	0.9417	0.0632	-0.0026	0.0458	0.1016	0.2276
	(6.99)**	(7.06)**	(2.49)*	(-0.10)	(1.55)	(3.13)**	(6.13)**
Education	-0.0005	-0.0003	0.0029	-0.0048	0.0023	-0.0016	0.0039
	(0.25)	(-0.02)	(0.77)	(-1.21)	(0.55)	(-0.38)	(0.86)
Age	0.0005	0.0036	0.0014	-0.0007	0.001	0.0009	0.0000
	(0.81)	(0.62)	(1.34)	(-0.63)	-0.75	-0.66	(-0.02)
Dummy Java-Bali	0.2976	2.9552	0.258	0.2696	0.2842	0.2595	0.3043
	(17.74)**	(17.90)**	(6.07)**	(7.53)**	(7.63)**	(7.02)**	(7.43)**
Constant	11.9444	96.2634	10.8608	11.0279	10.6926	11.9695	13.4387
	(26.10)**	(21.38)**	(12.40)**	(11.25)**	(10.79)**	(10.90)**	(10.99)**
R-squared	0.27	0.27	0.13	0.12	0.13	0.18	0.26

t statistics in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

All variables are estimated in natural logarithm

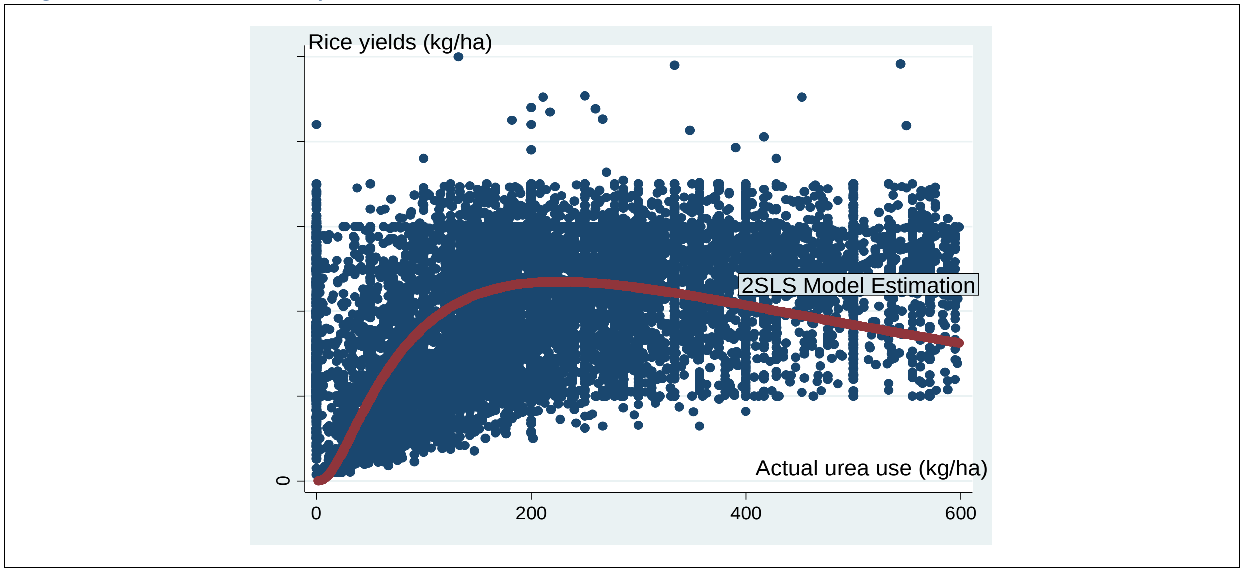
*) Dependent variable of estimation at quintile level is urea use

The model estimates the threshold at which the relationship between urea used and yields reverses at 226 (kg/ha) and in line with the recommended amounts by the MoA at 200-250 (kg/ha). However, it is important to note that the maximum of a 2SLS quadratic estimation is sensitive to omitted variable bias. The model supports the thesis that overusing urea will have an adverse impact on rice production. Many farmers in the survey report using 2 and 3 times the recommended urea levels (Figure 4.1). The overuse of urea in Indonesia, particularly when compared with some of its regional peers, and its negative impact on soil quality, are well documented.[16] This is mostly the result of distorted factor prices and is

16 Several studies conducted by agriculture research institutes in Indonesia document the negative effects of overusing urea on yields and soil quality. Pantjar and Timmer (2008) document the link between soil degradation and urea overuse and land farming intensity in Indonesia. In the same line, Supriono (2000) explored the impact of urea use on soy bean growth in Central Java and found that using urea at 100 kg/ha had a positive effect on increasing soy plant height, pod numbers per plant, and seed yields per plant, but that high levels or urea stifled plant enzymes and decreased soy bean yields and growth. Furthermore, Aribawa, et. Al., (2006) looked at the effect of urea usage and other organic fertilizer on the soil composition and the growth of long beans in Bali. They found that using urea, as the sole fertilizer, decreased the nitrogen elements and the acidity of the soil and recommended using a blend (urea and organic fertilizer) to maintain the high growth of long beans in Bali.

more prominent in smaller farmers. Figure 4.1 illustrates graphically the results from Table 4.2 and shows how beyond a certain point increasing the use of fertilizer has an adverse effect on yields.

Figure 4.1 Urea and rice yields in 2007 –2SLS model estimation



Source: World Bank staff calculations.

The analysis in this section supports the notion that urea usage has a positive impact on yields, with the exception of the larger farms, but it still leaves some questions unanswered. It does not answer whether the costs at which this improvement in yields is achieved outweigh the benefits. Neither does it discuss whether alternative public spending (on irrigation, improved R&D or extension services) may actually have a larger impact on productivity than the subsidization of fertilizer.

To assess the benefits of fertilizer subsidies in terms of rice production, one can look at the elasticities estimated in the model in Tables 4.2 and 4.3 and calculate the decline in urea usage and in yields that an increase in the price of the fertilizer would cause. A removal of the fertilizer subsidy and therefore an increase in prices from the average urea price paid by rice farmers according to the 2007 survey (Rp 1,524/kg) to the estimated market price of Rp 2,170.5/kg would translate into lower consumption of urea and a decrease of 6.3 percent in yields per hectare. (That is, assuming the effect of all other inputs is constant.) If one translates this decline to the total rice production for 2008, then, production would have been 3.8 million tons lower (from the estimated production of 60.3 million tons by BPS). At an average dried grain price of Rp 2,200/kg, the decline in production would have resulted in losses worth Rp 8.3 trillion. This decline is much lower than the cost of the fertilizer subsidy, budgeted at Rp 15.2 trillion in 2008. As such, the GoI could have saved Rp 7 trillion even after accounting for the production losses. Estimating the decline in yields resulting from an increase in urea prices using the linear model at the quintile level tells a similar story. If one assumes that a 1 percent increase in the urea price would result in a decline in urea usage of 0.35 percent, this would translate into a 5.1 percent decrease in rice production. In terms of the total rice production for 2008, it would represent 3.1 million tons less of rice and it would generate losses at around Rp 6.75 trillion. This figure is less than half the fertilizer subsidy budget for the year and shows how the benefits from higher production came at a very high cost The benefits of the fertilizer subsidy could be more widespread, for example other food crops and plantations are probably also benefiting from cheaper fertilizer. To the extent that the main policy objective of GoI with this subsidy is to increase rice production, a fair simplification for our purposes is to assess benefits solely based on the main policy objective – the increase in rice production. This rough estimate suggests that fertilizer subsidies supported increased rice production, but did so at a very high cost. It is very likely that the gap between the costs and benefits of this subsidy system has widened in 2009.

As initially indicated, this section does not attempt to determine what the drivers of rice production are, but instead to establish to what extent fertilizer subsidies have a positive impact on rice production. The findings show that fertilizer subsidies have a positive impact on fertilizer use and rice yields, but they do so at a very high cost. Also, while the larger farmers are capturing the majority of the subsidies this assistance has the smallest impact on yields compared with other farmers' groups. A reform that reduces or removes the fertilizer subsidy would have to take into account these tradeoffs, as well as the fact that smaller farmers are usually credit-constrained and their urea usage is a greater determinant of output. A reduction in subsidies could then be combined with assistance in the form of cash transfers to allow credit constrained farmers to buy an optimal volume of inputs. The next section discusses the benefits of providing public goods compared with subsidizing private inputs. It looks at examples in which subsidizing private inputs may correct market failures, while discussing elements that have positively contributed to subsidy programs.

5. Why Is the Provision of Public Goods Important?

Only the public sector can supply public goods efficiently (and in adequate quantities). Social returns for public goods are higher than private social returns due to positive externalities not captured through prices. This provides the rationale for public intervention to provide certain goods and services, since markets under-provide them. When supplied in a cost-effective way, public goods can generate higher returns than investments in private inputs because they create positive externalities in the economy as a whole. The public sector has the capacity to collect individual contributions, can capture economies of scale, and will access funding and manage risk better than farmers. Therefore it is better suited to supply public goods and services.

There are trade-offs between the provision of public goods and subsidization of private inputs. Governments that heavily subsidize private goods do so at the expense of deepening investment in public goods that have much higher returns. Investments in rural roads, irrigation, extension services or research are the main drivers of agriculture productivity.[17] Agricultural public goods also have a multiplier effect and generate positive externalities for society as a whole. Governments can significantly improve the quality of public expenditure in agriculture by shifting the composition of spending towards the provision of public goods and services, and away from private goods subsidization.

In certain instances, providing subsidies to private inputs may be desirable as a way of correcting for market failures, such as imperfect information, high transaction costs, or missing credit markets. The challenge for governments then is to identify the root of the market failure and seek to increase productivity by designing their subsidy program in a manner that corrects for the market failure (e.g. encouraging incremental use of inputs by groups that would under-utilize inputs in the absence of the subsidy). However, caution should be taken to avoid distorting the relative prices of agricultural inputs and encouraging their inefficient use.

Fertilizer subsidies are justifiable from an economic standpoint if they establish the foundations for a sustainable private sector-led input market. They can improve efficiency in the agriculture sector if they are able to:

- Develop a previously constrained or non-existent fertilizer market. That is, by offsetting high initial distribution costs until the market expands, economies of scale are realized and prices decline.
- Encourage technology adoption and diffusion by reducing the initial risk and costs of learning new technologies.
- Overcome constraints in credit markets, where farmers tend to use below optimal levels of fertilizers because of imperfect rural credit or insurance markets.
- Compensate for taxes or output price controls that make fertilizer financially unprofitable, when the removal of such taxes or price controls is not feasible.
- Generate positive environmental externalities by reducing deforestation and soil erosion.

The government should assess whether there are market failures that warrant the subsidization of inputs and whether this is the most cost-effective way to address them. In Indonesia's case, after three decades of fertilizer subsidies, it is debatable whether this subsidy is still necessary to develop a fertilizer

17 Spending on public goods is likely to have higher returns than private goods, as discussed in the policy note Agriculture Public Spending and Growth, Indonesia Public Expenditure Review, World Bank.

market or encourage the uptake of new technologies. Arguably, smaller farmers may be credit-constrained and rural credit markets relatively undeveloped. In this case, the lack of credit or purchasing power of smaller farmers should be addressed rather than subsidizing the production of one of the many agricultural inputs needed by farmers. The existence of market failures alone does not warrant government intervention. It could well be that government intervention in the form of input subsidies leads to a worse outcome than in the absence of such interventions or that a similar outcome can be achieved at a lower cost. The cost-efficiency of a subsidy system often depends on the design of the program, the objectives, the targeting of the beneficiaries, and the delivery mechanism used. Box 1 below illustrates some of the lessons learned from subsidy programs across the world.

Box 1 What are the lessons learned from input subsidy programs?[18]

Clear identification and definition of program objectives. This calls for knowledge of what the subsidy seeks to achieve and the potential positive or negative interactions between objectives. Most importantly, objectives should be clear, with no room for different interpretations; targets need to be established that allow their respective budgetary allocations to be set for short- and long-term plans. When objectives are realistic, stakeholder expectations can be managed and a sensible post-project impact evaluation can be carried out.

Setting the program within an agriculture development strategy. An input subsidy program is just one of several mechanisms that work together to promote agriculture productivity. When other links are missing, the subsidies alone may not do the trick because the market failures they attempt to correct have multi-dimensional causes. Thus, they require a multi-dimensional approach. In addition, only in a broader development strategy can the short-term and long-term objectives be well-linked together.

Targeting. The program design needs to take into account who are the target beneficiaries, what identification criteria to use, and the mechanism for the delivery of benefits, in order to minimize leakage. By improving coordination and linking the program with existing safety net initiatives, delivery costs were reduced.

Scale and costs. Program scale and costs need to be defined and limited from the early design stage. This is the area where most input subsidy schemes run into trouble. Input subsidy programs are prone to high risks and these costs should be accounted for and quantified. There are many factors that contribute to risk, such as: fiscal instability, fraud and corruption, leakage, and uncertainty from external shocks (poor weather conditions or international price changes). All of these can undermine the benefits of the program.

Monitoring and evaluation (M&E). Information is the key to understanding where the subsidy is going and what it is achieving. With adequate monitoring of expenditures, activities, outputs and impact, the Government can tailor the program to minimize costs and risks.

Engage with the private sector. Subsidies should be used to leverage broader private sector investment and not replace this investment. Subsidies may give businesses the incentive to investment further in commercially sustainable wholesale and retail input supply chains that can reach further into remote rural areas. The exclusion of the private sector from the program's design may drive suppliers/distributors out of business because the farmers substitute private with publicly produced fertilizer. This disrupts private activity and makes the market more dependent on public suppliers.

Exit strategy. Subsidies should always be implemented on a temporary basis and provide exit options that are conceived at their design stage. These should be clearly stated before implementation.

18 SOAS et al, 2008.

Input subsidies tend to perpetuate over time because they are a highly sensitive issue to voters and at the center of the political debate. As many countries have realized, it is politically costly to roll-back subsidies because the beneficiaries have politically significant constituencies that will challenge reform of the system. Larger farmers are well organized, have strong political power, and lobby for legislation that protects their interests. In the case of fertilizer subsidies in Indonesia, the system benefits both consumers, and fertilizer producers and distributors. Opposition to a reform to improve the fertilizer subsidy system is therefore likely to come from several fronts.

Subsidies are often justified to achieve social goals (poverty alleviation, reduction of inequality) rather than production goals. Governments have a complex set of objectives and besides increasing agricultural productivity, they may have objectives such as reducing poverty in rural areas or achieving food self-sufficiency. These multiple objectives have to be taken into account when designing a program (in Indonesia's case, both farmers' welfare and food security are mentioned as key objectives of the GoI in the area of agriculture). The attainment of these other goals is often accomplished in a more cost-effective manner by subsidizing consumption rather than production, through food aid, direct income support or cash transfers.

Lack of quality information to monitor the implementation of a subsidy system and evaluate its impact undermines the effectiveness of input subsidies. When spending on subsidies is poorly monitored, authorities have little information about who is benefiting and what the subsidy is achieving. This poor monitoring inevitably leads to waste. The lack of impact evaluations and data also render accountability mechanism that could provide checks and balances ineffective. Ongoing evaluation of the programs will be needed to allow the government to adjust the program as needed in order to increase its effectiveness.

International Experience with programs to subsidize agriculture inputs

The design of the subsidy system can stifle rather than encourage the development of dynamic agricultural input markets. The Government of Zambia distributes fertilizer to farmers through subsidized loans and often grants. Three main problems have affected the effectiveness of this program: there is a fairly poor record of loan repayments, at below 30 percent; late delivery of the fertilizer; and poor targeting. This all translates into relatively high fiscal costs, with over 50 percent of the agricultural budget (or 3 percent of the total budget) spent on fertilizer subsidies. Incidence benefit analysis showed that the wealthiest farmers (both in terms of income and land size) were the ones receiving most of the subsidy. Interviews with representatives of the private sector have revealed their unwillingness to compete with the government in supplying subsidized fertilizer.

Until the late 1980s, Bangladesh distributed all fertilizer through the Bangladesh Agricultural Development Corporation. In the late 1980s, Bangladesh reformed its fertilizer distribution system, focusing on supporting technology transfer to improve farmers' knowledge of fertilizer use and practices, and to increase private-sector participation in fertilizer imports and domestic marketing. The reform resulted in increased participation of the private sector, lower fertilizer prices and increased fertilizer use. Research on this reform has highlighted some of the factors behind this success: (i) a commercial credit program to facilitate access of farmers to credit, (ii) a program to foster dealer development and technology transfer, (iii) a strong monitoring and evaluation system, to allow for sharing of information among stakeholders and adjustment of programs, and (iv) involvement of all stakeholders (government, private sector, donors, banking community and farmers) in the design and monitoring of the program.

Kenya liberalized its fertilizer markets in the early 1990s, which resulted in a significant increase of fertilizer usage, both in food and estate crops. The increase has been driven primarily by small farmers, suggesting that they have benefited from this liberalized market. Several factors were behind this success. Since the early 1990s, the Kenyan government has pursued a stable fertilizer marketing policy, eliminating retail price controls, import licensing and quotas. This was followed by rapid investment in fertilizer distribution networks by the private sector, which resulted in a denser network of fertilizer retailers in rural areas, facilitating the access of farmers to fertilizer. Fertilizer importing and wholesaling were subject to intense competition, which led to a halving of marketing margins. Finally, the emergence of a very profitable horticulture sector increased farmers' incentives to use fertilizer both for horticulture and food crops.

6. Conclusions and Recommendations

Fertilizer subsidies account for a large share of the support that the GoI provides to the agriculture sector, and in 2008 they were almost double the entire budget for the Ministry of Agriculture. Although there are circumstances under which subsidies can lead to efficient outcomes, by addressing market constraints, we argue that this is not the case in Indonesia. In addition, in light of limited fiscal resources, there is a trade-off between providing subsidies for private inputs and the provision of public goods and services. As such, the Government of Indonesia is spending large amounts on fertilizer subsidies at the expense of providing support in other areas that may matter more to farmers and the agriculture sector in general (extension services, R&D, irrigation).

The findings from the two rural household surveys in 2003 and 2007 show there was no targeting of benefits for the fertilizer subsidy program. Thus, most rice producers benefit from subsidized fertilizer regardless of whether they had small/large paddies or their level of wealth. The effect of this policy is regressive and the 40 percent largest farmers capture up to 60 percent of the total subsidy. Fertilizer shortages also mean that very few farmers (less than 10 percent in 2007) pay the maximum price as stipulated by the Ministry of Agriculture.

The subsidies contribute to an increased use of urea, which in some cases has resulted in an overuse that has a negative impact on yields. Thus, overall the relationship between fertilizer use and rice yields is best described as an inverted U-relationship, supporting the existence of an optimum level of fertilizer use, beyond which additional consumption has an adverse effect on output. The maximum level of urea use, at which the relationship with yields reverses from positive to negative, is in line to that recommended by the MoA. However, most farmers report that they use higher than recommended levels of fertilizer. Finally, the findings of this paper suggest that the costs associated with the fertilizer subsidy program, both fiscal and economic, outweigh the benefits from achieving higher rice yields.

Given the problems with the fertilizer subsidy system discussed in previous sections, the agriculture sector would be better served if a considerable amount of resources are reallocated. The GoI could improve the provision of public services for agriculture by investing in other agriculture public goods, which yield higher returns,[19] while keeping two specific objectives in mind: increasing the productivity of the agriculture sector, and increasing the welfare of farmers. There is an array of options for using newly freed resources, as fertilizer is just one of many determinants of yields and agriculture productivity that complement, but do not substitute, investments in: irrigation, extension services, improved agriculture marketing (particularly in the outer islands off-Java) and research and development in agriculture.

There may be a rationale for subsidizing the purchase of agriculture inputs by small farmers who may be credit-constrained, in light of the MoA's goal to improve farmers' welfare. However, fertilizer subsidies are only one of many options to do so and they may not be the most cost-effective instrument. A more cost-effective alternative to support small farmers and overcome potential credit-market constraints would be to establish a system of cash transfers, an area in which Indonesia already has extensive experience. With a well-targeted system of cash transfers for agriculture, farmers would be in a better position to determine the level and combination of inputs best suited to their needs. Fertilizer would be

19 Spending on public goods is likely to have higher returns than private goods, as discussed in the policy note Agriculture Public Spending and Growth, Indonesia Public Expenditure Review, World Bank.

one of many inputs to which farmers would have greater access to increase their productivity. Also, a cash transfer system is a more effective way to increase farmers' welfare in the form of income support.

Deregulation of fertilizer supply would ensure better quality and availability of the input by enforcing market competition. The production and distribution of fertilizer is highly regulated, following several decades of government intervention to promote the use of fertilizer. The current structure and subsidy system may be contributing to the limited capacity utilization in the industry and stifling the entrance of private sector actors, limiting competition among fertilizer producers and distributors. This contributes to fertilizer shortages, with very few farmers paying at the regulated price (HET). It is not clear whether the current system (in which the MoA, in coordination with other central government agencies, determines the fertilizer needs, production and prices on a yearly basis) provides the necessary flexibility to respond to changes in the demand and supply for fertilizer. Deregulation of the supply of fertilizer should be combined with monitoring the availability of fertilizer at affordable prices in more remote areas, where low demand for agricultural inputs and low profits may prevent the private sector from becoming involved.

ANNEXES

Annex I. Methodology

1. The market price, the "cost of goods sold" (CoGS), includes: production costs, profit margins of 10 percent, distribution costs from the plants to the retailer, and a value-added tax of 10 percent. The subsidy was calculated as the difference between the CoGs price and the actual price paid by the farmer, while the total subsidy spending per quintile used the formula:

$$\sum \text{(CoGs – Farmer's price) x quantity used by the farmer.}$$

2. The ceiling price (HET) for urea in 2003 was Rp 1,050 per kg up to July and the MoA revised the figure to Rp 1,150 for August. Therefore, the analysis takes the ceiling price of urea for 2003 as Rp 1,150 to better capture higher fertilizer consumption during the rainy season months (from September to December). The ceiling price of urea in 2007 was Rp 1,200 per kg, while for SP-36 was Rp 1,500 per kg in 2003 and Rp 1,550 per kg in 2007.
4. The source for the CoGS for urea in 2007 is the State Audit Agency Report 2008 (BPK). This analysis uses a weighted average of the CoGs prices from the four domestic producers, while the CoGS per kg = total CoGS/amount of subsidized fertilizer. These are reported below.

Producer	Production	CoGS	Weighted CoGS
PETRO GRESIK	318,959	1,850	136.6
PUSRI	1,395,009	2,068	668.1
KUJANG	753,870	2,217	387.0
KALTIM	1,850,505	2,284	978.7
CoGS of urea per Kg (Rp)			**2,170.5**

Source: World Bank staff calculations.

5. The CoGS of urea for 2003 was unavailable in the State Audit Agency and is an estimate. The CoGS prices of urea in 2006 and 2007 were available, as well as the CoGS of SP36 in 2003, 2006 and 2007 from the PT Petrokimia Gresik State Audit Agency Reports (which is the sole producer). Therefore, the calculation of the CoGS for urea in 2003 maintains the price ratio of urea to SP36 (using an average of the observed ratios for 2006 and 2007) times the CoGS of SP36 in 2003. This preserves the price relationship between both fertilizers, as SP-36 was historically sold at higher prices than urea.

Year	CoGS of Urea (Rp/kg)	CoGS of SP-36 [b] (Rp/kg)	Ratio (a/b)
2007	2,170.5	2,395	0.906
2006	2,054	2,227.8	0.921
2003	**1,489**	1,628.8	**0.9135**

Source: World Bank staff calculations.

a. The non-subsidy group represents farmers that paid above or equal to the CoGS prices.
b. The partial-subsidy group captures farmers paying above the HET, but below the CoGS prices.
c. The full-subsidy group takes farmers paying at or below the HET price.

Annex II. Other Fertilizers: Which Farmer Groups Received the Subsidized SP36?

As in the case of urea, there was no targeting of benefits for the subsidized SP36 and public spending was mostly captured by the larger farmers. While in 2003, larger shares of small farmers were receiving subsidized SP36, by 2007 these differences across quintiles disappeared (Figures II.1 and II.2). As in the case of urea, the share of farmers that received the subsidy increased significantly from 43 percent (2003) to 68 percent (2007), but it remains lower than the share of farmers (96 percent) capturing subsidized urea in 2007. Still, larger producers in quintiles 4 and 5 capture 57 percent (2003) and 62 percent (2007).

Figure II.1. Farmers receiving subsidized SP36 by quintiles of land size 2003

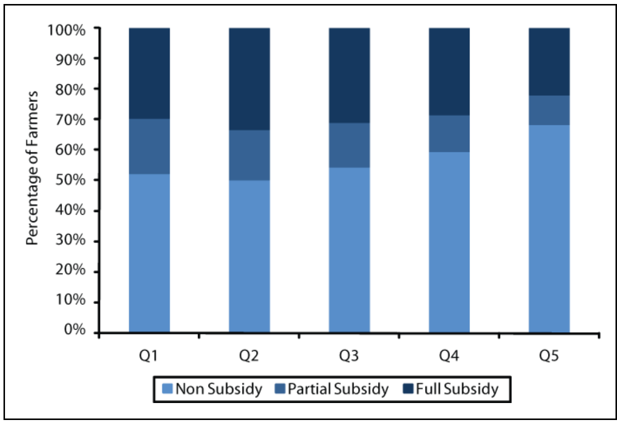
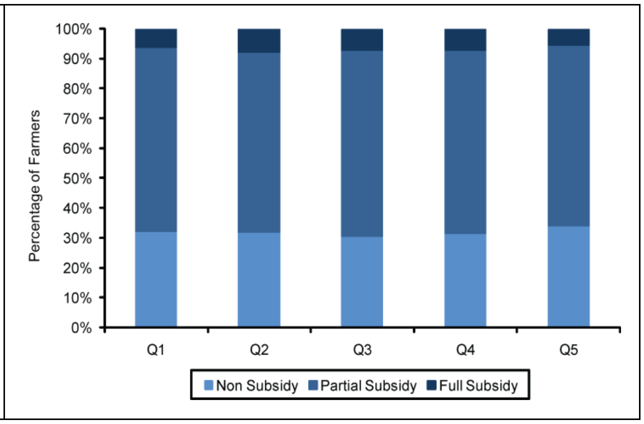


Figure II.2. Farmers receiving subsidized SP36 by quintiles of land size 2007



Source: World Bank staff calculations.

Subsidies for SP36 were regressive and larger rice producers captured a large share of the benefits. In 2007, the quintile with the largest land size captured 38 percent of the total subsidy, while smaller farmers in quintiles 1 and 2 only received 7 percent and 14 percent of the total resources, respectively (Figures II.3 and II.4 and Figures II.5 & II.6 illustrate the total subsidy captured per quintiles). As with urea, the analysis suggests that large fiscal savings are possible through a better targeting mechanism that limits the benefits of the subsidy to the smaller farmers in quintiles 1-3.

Figure II.3. Distribution of SP36 subsidy spending by quintiles of land size, 2003

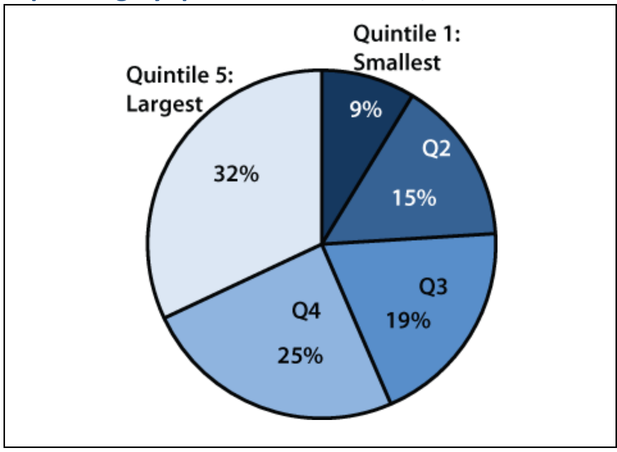
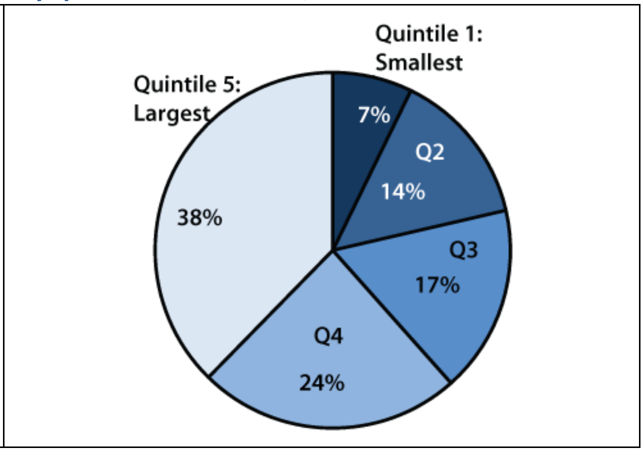


Figure II.4. Distribution of SP36 subsidy spending by quintiles of land size, 2007



Source: World Bank staff calculations.

Figure II.5. SP36 subsidy spending by land size, 2003

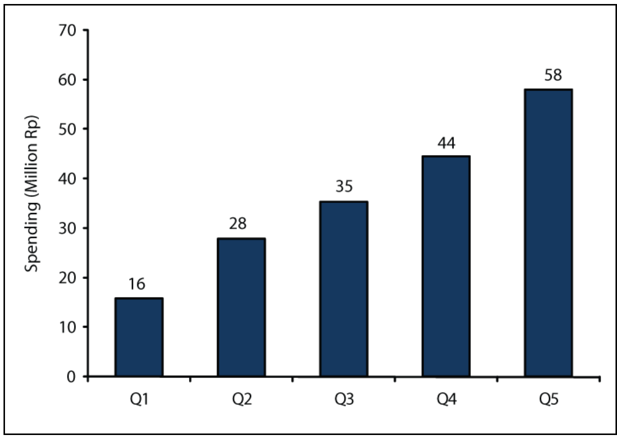
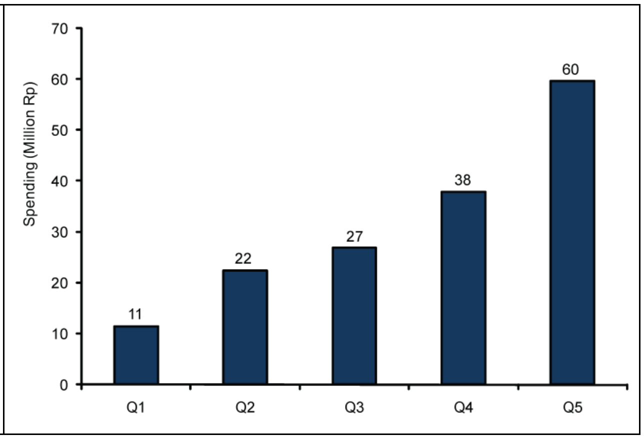


Figure II.6. SP36 subsidy spending by land size, 2007



Source: World Bank staff calculations.

Annex III. Incidence Analysis for Urea by Quintiles of Rice Gross Revenue

This section conducts the incidence analysis for subsidized urea by grouping farmers according to the size of their rice gross revenues. In the absence of household income reported in the surveys, one can examine whether gross revenues from rice production are a good proxy for a farmer's income, and through it attempt to capture differences in fertilizer consumption that relate to farmers' wealth. Annex IV provides further insights into the adequacy of gross revenues from rice as a proxy for farmers' income.

The benefit incidence analysis by gross revenues from rice shows a similar picture as the analysis by land size. Benefits captured by the farmers with the highest rice gross revenues stood at 68 percent for both surveys (in contrast to 60 percent when grouping farmers' by their land size, Figures III.3 and III.4). However, the differences in gross revenues across quintiles were wide and the individuals in quintile 5 earned 8 times more than those in quintile 1. In addition, very few farmers paid for the input at the HET regulated price. This is evident from Figure III.2, where most farmers report receiving partial urea subsidy and paying above the ceiling price.

Figure III.1. Farmers receiving subsidized urea by quintiles of gross revenue 2003

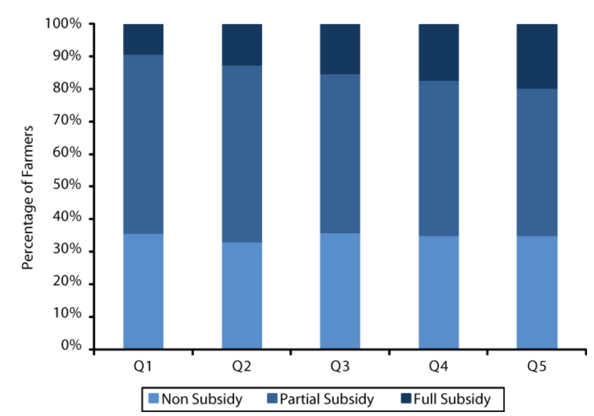
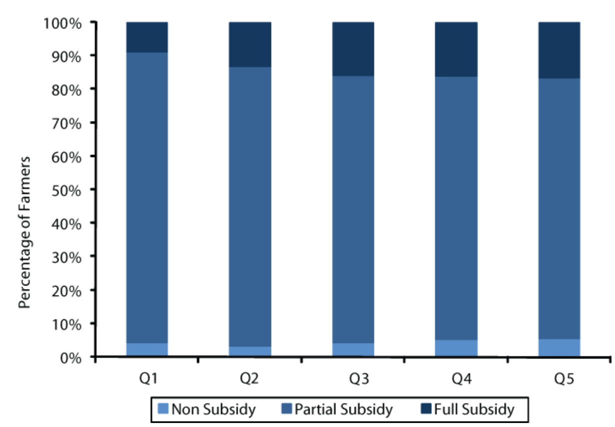


Figure III.2. Farmers receiving subsidized urea by quintiles of gross revenue 2007



Source: World Bank staff calculations.

Figure III.3. Distribution of urea subsidy by quintiles of gross revenue, 2003

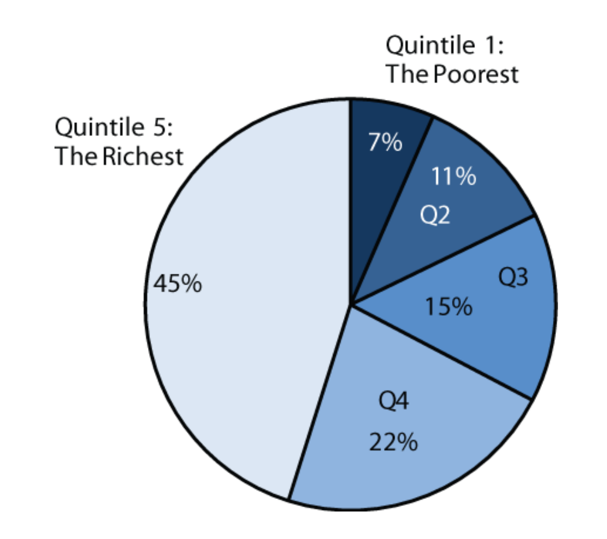
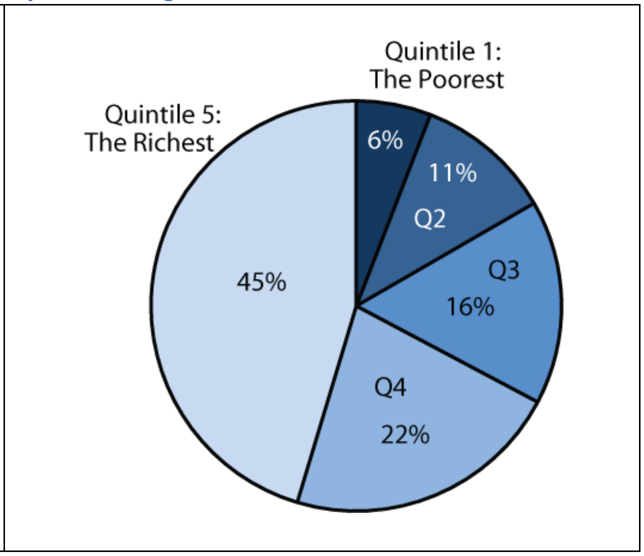


Figure III.4. Distribution of urea subsidy by quintiles of gross revenue, 2007



Source: World Bank staff calculations.

The analysis by rice gross revenues shows larger fiscal savings for the GoI from improving the targeting of the urea subsidy. If the distribution of benefits in 2007 holds (Figure III.6), while providing subsidies only to 60 percent of the farmers with the lowest gross revenues, then the GoI would have saved Rp 10.3 trillion in the 2008 budget.

Figure III.5. Urea subsidy spending by gross revenue, 2003

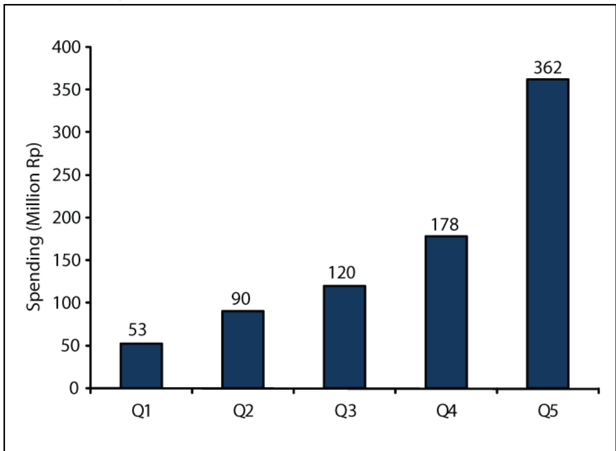
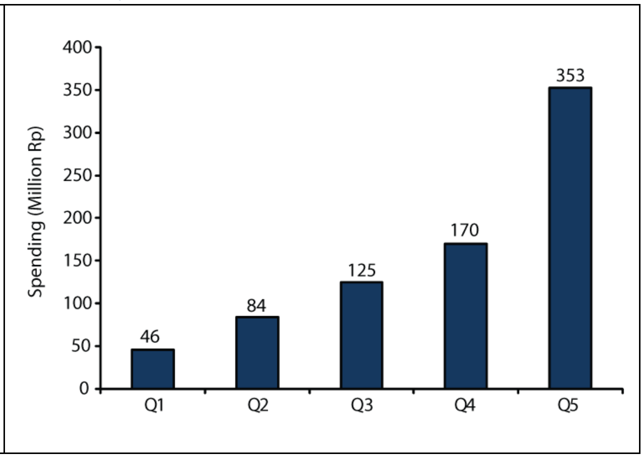


Figure III.6. Urea subsidy spending by gross revenue, 2007



Source: World Bank staff calculations.

Annex IV. Are Gross Revenues from Rice a Good Proxy for Rural Income?

This policy note assumes that farmers with smaller plots or lower gross revenues from rice are worse off. This is because there are limited alternative activities (off-farm or beyond rice) that would compensate for small land size or low rice revenues. Although this is clearly an over-simplification, the evidence suggests that the assumption holds when looking at asset variables (e.g. quality of housing) in the survey and farmers with smaller plots of land or lower gross income from rice are worse off.

In the absence of an income variable from both surveys, the approach to determine if gross revenues from rice are a good proxy for wealth is two-fold: (i) use asset variables in the 2003 and 2007 surveys (the building materials of the farmers' houses, the quality of the walls and flooring), and (ii) draw a sub-sample in 2003 that is limited to those respondents where rice accounts for a larger share of their income (50 percent or more) and look at assets in this sub-sample only. In both cases, there is evidence showing that farmers with small paddy fields and lower gross revenues are less well-off.[20]

The findings from both 2003 and 2007 surveys suggest gross revenue from rice is a good proxy for rural income. Farmers in the poorer quintiles 1 and 2 report having houses of inferior quality materials, with soil floors and bamboo walls, as opposed to the higher quintiles 4 and 5, having non-soil floors and wooden walls. In both 2003 and 2007 surveys, half of those farmers with soil-floor houses belong to quintiles 1 and 2 (respectively, 27 percent and 24 percent in 2003 and 2007, see Tables IV.1-6). Likewise, 33 percent and 37 percent of the farmers in quintile 1 had bamboo walled housing, while 48 percent and 45 percent of the farmers having wood-walled houses belong to higher revenue quintiles 4 and 5.

Gross Revenue Quintiles

Table IV.1. Type of floor, 2003

Quintile	Non soil	Soil
1	18%	27%
2	19%	24%
3	20%	19%
4	21%	17%
5	22%	13%
Total	100%	100%
Total	36,226	9,886

Table IV.2. Type of wall, 2003

Quintile	Brick (batako)	Wood	Bamboo
1	21%	16%	33%
2	21%	17%	26%
3	21%	20%	19%
4	20%	22%	14%
5	18%	26%	9%
Total	100%	100%	100%
Total	21,928	17,896	5,392

Table IV.3. Type of floor, 2007

Quintile	Non soil	Soil
1	19%	23%
2	19%	23%
3	20%	18%
4	21%	18%
5	21%	18%
Total	100%	100%
Total	9,224	2,052

Table IV.4. Type of wall, 2007

Quintile	Brick	Wood	Bamboo
1	18%	15%	37%
2	20%	19%	22%
3	20%	20%	18%
4	21%	21%	14%
5	21%	24%	10%
Total	100%	100%	100%
Total	5,746	3,686	1,663

20 The assessment of farmers that sow rice more intensively can only be carried out in the 2003 survey that includes a variable determining the size of a farmer's income derived from rice.

Annex IV.1. Drawing a Sub-Sample: Farmers Deriving 50 Percent or More of their Gross Revenues from Rice

This section draws new gross revenue quintiles from a sub-sample of farmers reporting that rice production accounted for 50 percent or more of their household income. As before, the findings indicate that farmers in the lower quintiles are less well-off according to the same asset variables (quality of housing). Most farmers with inferior housing, those living with soil floors and bamboo walls, belong to the "poorer" 1 and 2 quintiles, while farmers with better building materials, such as non-soil floors, fall in the quintiles 4 and 5. Because these farmers show a similar profile in terms of housing quality, one can conclude that using gross revenues from rice is a good way to classify "poorer" farmers in the lower quintiles and "wealthier" farmers in the higher quintiles 4 and 5

Gross Revenue Quintiles

Table IV.5. Type of floor, 2003

Quintile	Non soil	Soil
1	18%	28%
2	19%	23%
3	20%	19%
4	21%	17%
5	22%	13%
Total	100%	100%
Total	18,924	5,953

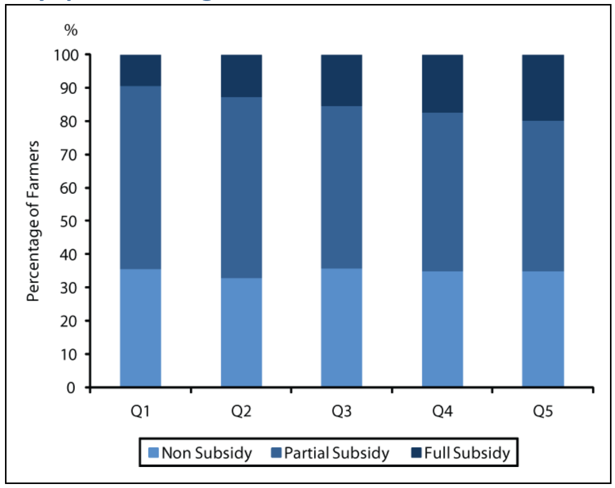
Table IV.6. Type of wall,2003

Quintile	Brick	Wood	Bamboo
1	19%	17%	34%
2	21%	18%	26%
3	21%	20%	18%
4	20%	21%	13%
5	19%	25%	9%
Total	100%	100%	100%
Total	10,908	10,443	3,056

Annex V. Sub-Sample: Only Farmers Deriving 50 Percent or More of Their GrossRevenues from Rice

The results corroborate the findings that there is no targeting of subsidized urea benefits and the regressive nature of the fertilizer subsidy. As in the case of the larger gross revenue sample, on average 66 percent of farmers report receiving subsidy benefits. This was independent of the size of their rice gross revenues, which suggests that the urea subsidy did not target only the needier farmers (Figure V.1). The leakage of subsidized urea benefits that supported the wealthier quintiles 4 and 5 stood at 67 percent. This represented Rp 348 million, which was significantly more than the combined share received by the lower quintiles 1, 2, and 3. (Figures V.2 and V.3)

Figure V.1. Farmers receiving subsidized urea by quintiles of gross revenue, 2003



Source: World Bank staff calculations.

Figure V.2. Distribution of urea subsidy spending, 2003

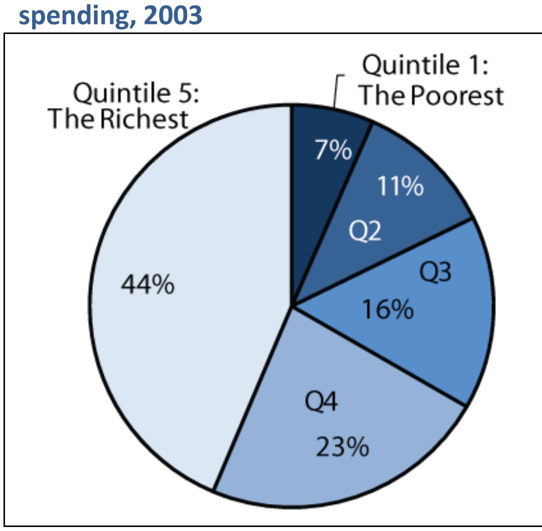
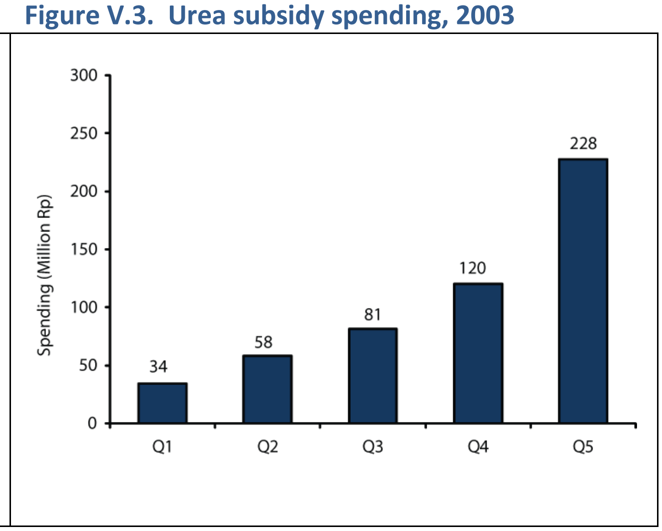


Figure V.3. Urea subsidy spending, 2003

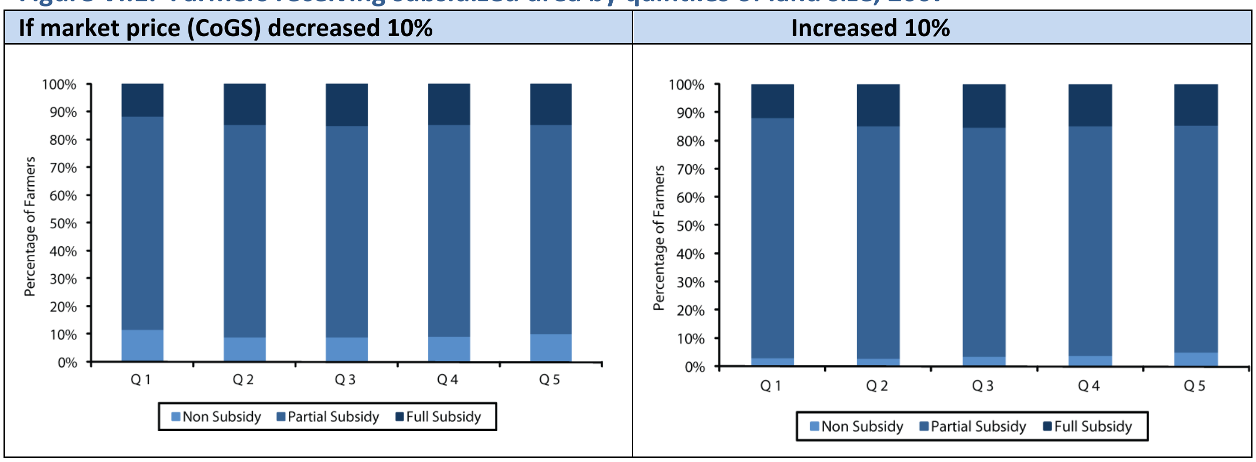


Source: World Bank staff calculations.

Annex VI. Sensitivity Analysis. What if Market Prices Decreased or Increased by 10 percent?

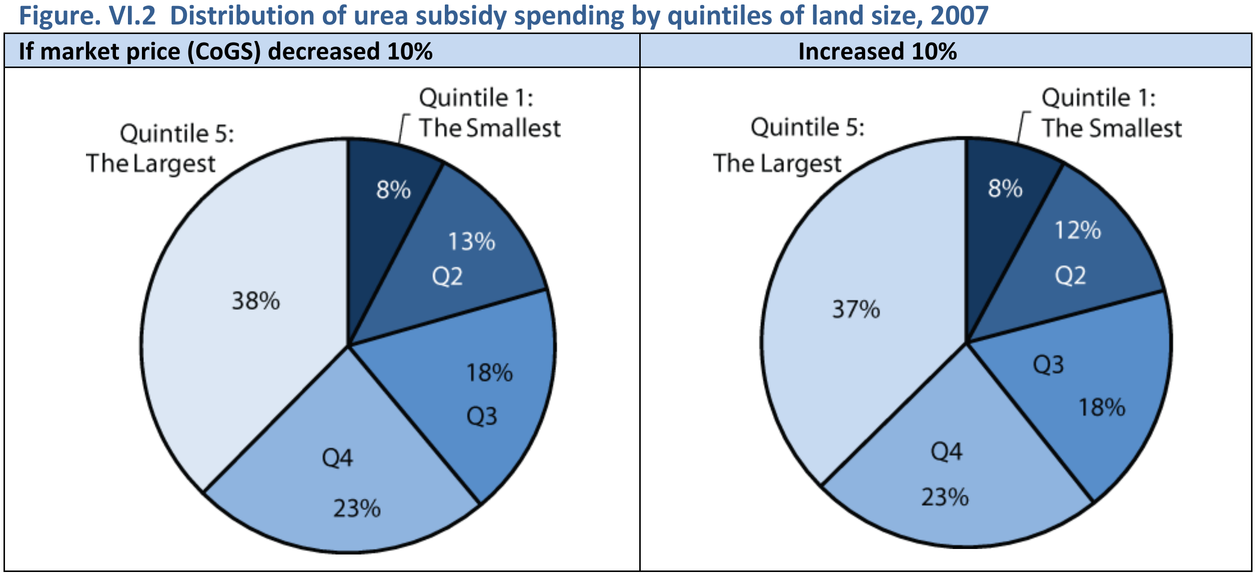
A sensitivity analysis is conducted to explore whether increasing or decreasing the estimation of the market price (CoGS) can be a driver of the findings. However, our results are validated by the fact that changes to the CoGS prices yield the same outcome for the incidence analysis. Thus, while the number of farmers receiving benefits changes, whether more or less farmers receive partial and/or total subsidy support, it does not alter the distribution of benefits across quintiles. Therefore, the evidence of leakage is clear and the fact that the subsidy is regressive persists because it is captured mostly by the larger farmers (and by the richer according to their reported rice gross revenues). (Figures VI.1 –VI.3)

Figure VI.1. Farmers receiving subsidized urea by quintiles of land size, 2007



Source: World Bank staff calculations.

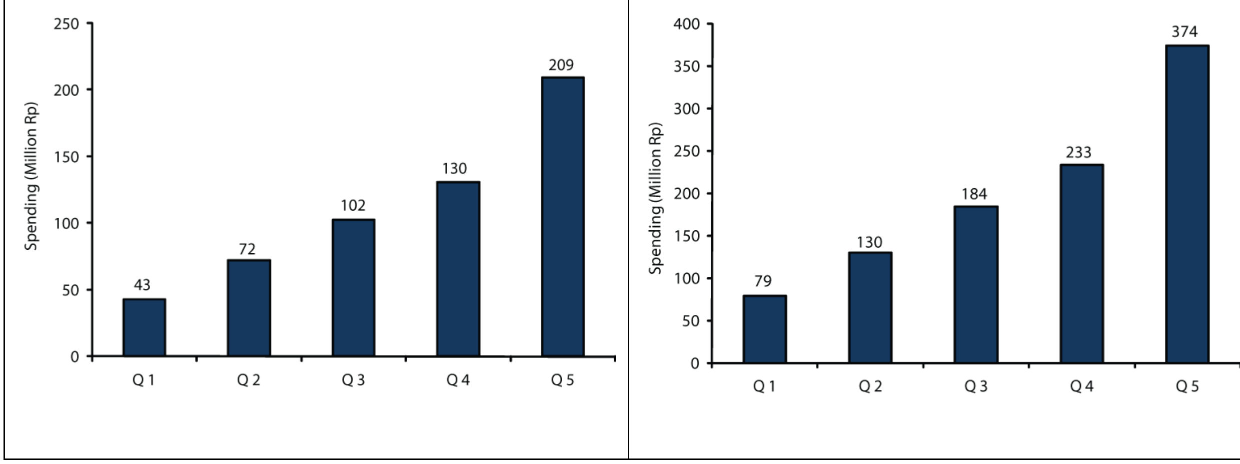
Figure. VI.2 Distribution of urea subsidy spending by quintiles of land size, 2007



Source: World Bank staff calculations.

Figure. VI.3. Urea subsidy spending by land size, 2007

If market price (CoGS) decreased 10%	Increased 10%



Source: World Bank staff calculations.

Annex VII. Two-Stage Least Squares (2SLS) and OLS

The model in Section 3 was estimated with instrumental variables (2SLS) because of the correlation between urea usage and the error term in the yields equation that would render OLS inconsistent. This correlation is most likely the result of omitted variable bias, but can also stem from various sources, such as (i) measurement error in the urea variable from the survey; or (ii) simultaneity, if the relationship is one of reverse causality, where the yields determine urea used through income, but urea usage is a driver of rice production.

In the absence of endogeneity, OLS will always produce more efficient estimates. Therefore, this section compares the results of 2SLS and an estimation using OLS. By construction, the first-stage regression of the 2SLS and OLS are the same, it is in the second-stage regression that the endogeneity is present. Thus, the Table VII. 1 below shows the output of the model estimated without using instrumental variables. These findings suggest that the model estimates under OLS are in line with the 2SLS estimation. While the impact from urea varies in magnitude, the direction and significance is similar and almost the same for the non-fertilizer inputs.

Table VII.1. Estimation results using 2SLS (second stage regression results) and OLS

Dependent variable: Rice yields	Overall (2SLS)*)	Overall (OLS)
(1)	(2)	(3)
Urea use	4.2098	0.3426
	(2.26)*	(9.12)**
Urea use squared	-0.3882	-0.0016
	(-2.08)*	(-0.79)
Land size	-0.0959	-0.1237
	(-5.86)**	(-24.85)**
Labor cost	0.0431	0.0656
	(3.08)**	(18.34)**
Dummy irrigation	0.0339	0.0136
	(2.76)**	(1.77)+
HH's head education	-0.0006	0.0030
	(-0.32)	(2.93)**
HH's head age	-0.001	-0.0002
	(-1.82)+	(-0.67)
Dummy for Java- Bali	-0.0937	-0.0680
	(-4.49)**	(-7.81)**
Constant	-2.3646	7.0767
	(-0.52)	(69.19)**
R-squared	.	0.34

z statistics in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

All variables are estimated in natural logarithm

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