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FERTILIZER DEMAND-SUPPLY GAP AND AVENUES FOR POLICY REVISITS IN NEPAL

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ABSTRACT

Nepal's farmers report fertilizer shortages yearly, especially for rice, wheat, and maize production. A reliable and established approach to estimating the actual demand for fertilizers for different crops and cropping seasons is lacking. Therefore, it is difficult to project the types and quantity of fertilizer to import and allocate across various regions in the country. With the direct involvement of the Government of Nepal (GoN) in fertilizer import, price (subsidy), and distribution, together with the high affinity of farmers for the subsidy, there is no incentive for the private sector to import and distribute fertilizers. Thus, farmers' access to fertilizers in the country depends primarily on the subsidy budget, quantity and types of fertilizers imported, and their distribution management. In this study, the fertilizer demands, both at the national and sub-national levels, were estimated through a survey of cooperatives that distribute subsidized fertilizers in the country. Our estimate suggests that the fertilizer supplied in 2018/19 was only 60% of the total effective demand in the country. With this estimate of the demand-supply gap and the price variability across provinces, short, medium, and long-term policy recommendations are made to improve the supply of chemical fertilizer in the country.

Keywords: Fertilizer import, Subsidy policy, Demand-supply gap, Fertilizer distribution, Nepal.

INTRODUCTION

Chemical fertilizer is considered one of the most reliable productivity-enhancing inputs (Ezeh et al., 2008). One-third of the increase in cereal production worldwide is

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associated with using fertilizers (FAO and IFA, 1999). However, the rates of fertilizer use in developing countries are much lower compared to developed countries. During the 1960s, more than 70% of the total chemical fertilizers were consumed by the industrialized countries (Heisey and Norton, 2007), while in 2013, the share of developing countries rose to 70.2%, and the consumption of developed countries reduced to less than 30% (Reetz, 2016). However, the average fertilizer application rate in South Asia is still lower (160.3 kg/ha) than in other developed countries but higher compared with Sub-Saharan Africa (16.2 kg/ha) (World Bank, 2020). The productivity of cereals in Nepal is one of the lowest in South Asia (FAOSTAT, 2020), mainly due to poor access of farmers to agricultural inputs such as improved seeds, fertilizers, irrigation, low mechanization, and fragmented smallholdings (Takeshima and Bhattarai, 2019; Sarom, 2014). Although the use of chemical fertilizer has increased in Nepal in the past few decades, the overall intensity of use lags compared to that of many other Asian countries (World Bank 2020).

In Nepal, the low use of chemical fertilizers is associated with inadequate supply and a lack of farmers' awareness of improved fertilizer management practices (APROSC, 1995; MoAD, 2017). In addition to availability, the fertilizer application rate at the farm level is determined by price, fertilizer yield response, irrigation, and commodity prices, among others (Denbaly and Vroomen, 1993). It is difficult for subsistence farmers to afford the high price of fertilizers, particularly in developing countries. Thus, subsidies have been widely used to promote the use of fertilizers (FAO and IFA, 1999). However, the effectiveness of subsidies on agricultural inputs, including fertilizers, to a targeted group of farmers remains debatable (Wiggins and Brooks, 2012; Hemming et al., 2018; Druilhe and Barreiro-Hurle, 2012). In Nepal, while subsidy has increased farmers' access to fertilizers, it has not been an effective instrument for meeting fertilizer demand and its timely supply (Takeshima et al., 2017). The subsidy for fertilizers provided by the government was NRs (Nepalese Rupees) 11.00 billion which is roughly 30% of the total agricultural budget (NRs. 34.8 billion) in 2019/20 (MoF, 2020). The Agricultural Development Strategy-ADS (2015-2035) has suggested a comprehensive subsidy assessment to improve the supply system in the short term and withdraw subsidies in the long term (MoAD, 2014; MoAD, 2017).

The formal government import of chemical fertilizers in Nepal started with the Agriculture Input Corporation (AIC) establishment in 1965. The Government of Nepal (GoN) introduced a fertilizer subsidy policy in 1973. The government, however, eliminated the subsidies on DAP and MOP in 1997 and removed the subsidy on Urea in 1999 in a phased manner. However, the chemical fertilizer supply gradually decreased with subsidy removal, primarily due to increasing global fertilizer prices (Takeshima et al., 2016), and the government reintroduced the fertilizer subsidy in 2009.

Nepal does not have any domestic production of chemical fertilizer. Two government parastatal companies-Agriculture Inputs Company Limited (AICL) and the Salt Trading Corporation Limited (STCL)- import and distribute subsidized fertilizers primarily through cooperatives and a small proportion through other registered dealers in the country. Three main fertilizers [Urea, diammonium phosphate (DAP), and Muriate of Potash (MoP)] are imported legally only through the subsidy program. However, subsidized supply is estimated to meet half of the total demand, though there is no documentation on how such estimate is made. A considerable quantity of fertilizer is reported to be entering the country informally (not legally) through the porous Indian border (Singh, 2018). This informal import from the Indian border meets part of the unmet demand (MoAD, 2014; Panta, 2018; Singh, 2018). In addition to the short supply in quantity, another problem is the government's inability to import and make fertilizer timely available to farmers. There is a delay in the import of fertilizers during the major crop-growing seasons most of the years, and this problem is more evident during rice season.

Every year, particularly during the primary cropping seasons, fertilizer shortages are reported by farmers across the country (Pant, 2018). The supply of subsidized fertilizer does not meet farmers' demand. Still, there is a lack of a reliable way to estimate the actual demand for fertilizers at the national and regional levels. As the county relies on subsidies to import fertilizers, a proper estimate of the fertilizer demand across different regions and crops is of great significance for their effective import and distribution planning. An actual assessment of the fertilizer demand could help to project the total budget required for procurement, and timely supply of fertilizers by season and crops, to estimate the volume of buffer stock needed and to increase efficiency in distribution.

Against the above backdrop, this study was conducted to estimate the effective demand for three subsidized fertilizers (Urea, DAP, and MoP) at the national and sub-national levels and to provide recommendations to manage the supply and distribution of fertilizer in the country.

MATERIALS AND METHODS

Data collection

About seven and a half thousand cooperatives (dealers of AICL and STCL) in 77 districts distribute three subsidized fertilizers to farmers. The survey purposively selected 33 districts, covering all seven provinces and three agroecological regions-Mountain, Hills, and Terai. Of the 33 districts, 20 were from Terai, 12 were from Hill, and one was from the Mountain (High Hill) region (Fig. 1). However, the mountain district was grouped as the Hill district for our analysis in this study. This is because less than 2% of total subsidized fertilizer was allocated for the Mountain region in 2018/19. Most of the pockets that use fertilizers in the Mountain regions are like those of the Hill districts. A total of 79% of the fertilizer is distributed in Terai

districts (GoN, 2017). Therefore, we selected 79% of the cooperatives (n=645) from the Terai region, and the other 21% of cooperatives (n=183) were taken from the Hill/ Mountain region for data collection.

The survey was conducted between October 2019 and January 2020 from 828 cooperatives focusing mainly on the demand and supply of three subsidized fertilizers for 12 months (from April 2018 to March 2019).

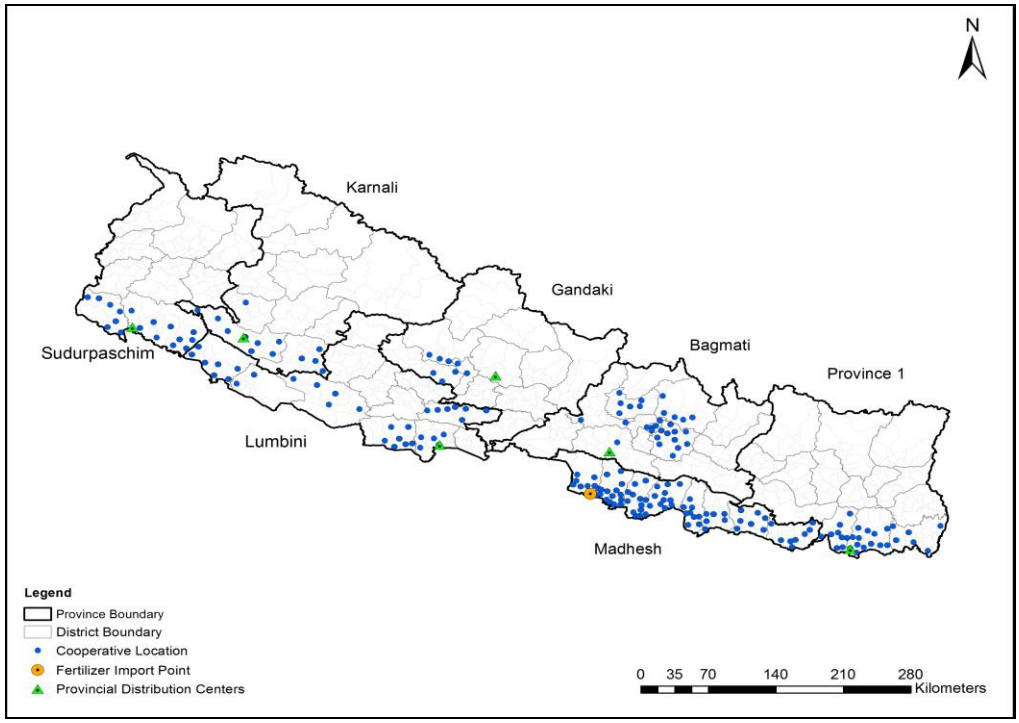

Figure 1. Location of surveyed cooperatives across different provinces of Nepal

Estimation of the total effective demand (TED)

The total effective demand (TED) is the quantity of fertilizer that farmers would be willing to purchase if available in time and quantity (Kelly et al., 2001). From all the surveyed cooperatives, we obtained the total reported supply (hereafter called TRS) based on their fertilizer sale inventories. As the quantity of subsidized fertilizer has always been in short supply, the cooperatives were asked to estimate what would be the actual demand for fertilizer from farmers in their area, based on which we estimated the total reported demand (hereafter called TRD) for all three subsidized fertilizers for 12 months. Using the TRS and TRD from each of the cooperatives surveyed, we calculated the Demand-Supply Ratio (DSR) for co-operative '*i*' for fertilizer '*j*' as in equation (1) as follows:

$$DSR_{ij} = \frac{TRS_{ij}}{TRD_{ij}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (equation\ 1)$$

DSR estimates the proportion of the total demand met by the current supply for each of the surveyed cooperatives for Urea, DAP, and MoP. However, our interest here is to estimate the Demand-Supply Gap at the national as well as provincial and regional (Hill and Terai regions) levels. So, we calculate the DSR of each province and at the regional level (Hill/ Mountain and Terai) by taking the average DSR for all the cooperatives in each of the seven provinces, regions, and at the national level by taking an average of all 828 cooperatives surveyed as follows:

$$DSR_{pj} = \frac{\sum DSR_{ij}\ \ in\ province\ p}{N_p} \quad \ldots\ldots\ldots\ldots\ldots\ldots \ldots\ (equation\ 2)$$

where Np is the number of cooperatives surveyed in each province and '*j'* is one of the three fertilizers

$$DSR_{rj} = \frac{\sum DSR_{ij}\ \ in\ region\ r}{N_r} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (equation\ 3)$$

Where *Nr* is the number of cooperatives surveyed in each region, and '*j'* is one of the three fertilizers.

$$DSR_{cj} = \frac{\sum DSR_{ij}}{N_c} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (equation\ 4)$$

where Nc is the number of cooperatives surveyed in the country (i.e., n= 828), and 'j' is one of the three fertilizers

The total actual supply (TAS) of chemical fertilizers is available from government sources at the national and district level (GoN, 2017), which can be calculated by summing the quantity supplied to all districts that fall in a given province or region. Then, the supply as the DSR estimates in equations 2, 3, and 4 can be used to estimate the total effective demand (TED) of the fertilizer 'j' at province 'p', region 'r' and at an overall country- level 'c' as follows for each of the three fertilizers:

At the province level: $TED_{pj} = \frac{TAS_{p}j}{DSR_{pj}}$--------------------------------------- *(equation 5)*

At the regional level: $TED_{rj} = \frac{TAS_{rj}}{DSR_{rj}}$-- *(equation 6)*

At the country level: $TED_{cj} = \frac{TAS_{cj}}{DSR_{c}j}$-- *(equation 7)*

Price of fertilizers

The government applies price subsidy at the point of import; thus, the unit price of the subsidized fertilizer is fixed at the port of entry (Birgunj city). For example, the retail price for one kilogram of Urea, DAP, and MoP in Birgunj is NRs 14, 43, and

31, respectively, in 2019. The distributing companies AICL and STCL transport them to four different regional facilities (along the Terai region) from where the districts and cooperatives source their fertilizers supply. As fertilizers are subsidized at source, the price of fertilizer paid by the farmers at a given cooperative is the price at the port of entry plus the function of the distance (transportation cost) from the point of import and other logistic expenses (staffing, loading/unloading, warehouse, etc.) incurred by the cooperatives. A simple regression analysis was conducted to see the impact of distance on the selling price of the three fertilizers at different cooperative locations as follows:

$$Price = \beta + \partial Distance + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

where *'Price'* is the selling price of fertilizer, *'Distance'* is the distance to the selling point (location of cooperatives) from the point of entry (i.e., Birgunj), β and parameters to be estimated, and the ε is the error term.

RESULTS AND DISCUSSION

Fertilizer supply and use at the farm level

On average, the surveyed cooperatives have been trading fertilizer for the past seven years. When fertilizer is not available at these cooperatives, farmers must travel, on average, 13 km (Hill: 18.2 km; Terai: 12.7 km) which is equivalent to an average travel time of 75 minutes (Hill: 98 minutes; Terai 72 minutes; overall standard deviation: 73 minutes) using the most common means of travel available. But there were some extremes in some districts (maximum: 8 hours) without motorable roads to some of the areas surveyed, which increased the travel time.

On average, a typical surveyed cooperative received around 84 MT of Urea, 64.1 MT of DAP, and 13.3 MT of MoP. The average volume was higher in cooperatives across Terai than in the Hill region, as shown in Table 1. Almost 85% of the surveyed cooperatives reported that the fertilizer supply was less than the demand in their area. Still, the size of the supply-demand gap varies across provinces and regions. Besides subsidized fertilizers, about 45% of cooperatives reported selling unsubsidized fertilizers, including Single Super Phosphate (SSP) and Ammonium Sulphate (AS). Still, the sales volume of these fertilizers is considerably lower than the subsidized ones. The STCL and some other private firms import these unsubsidized fertilizers sold by cooperatives and private agri-input retailers called agrovets. The use of unsubsidized fertilizers was reported more in the provinces that shared a border with India and were the highest in Sudurpashchim province, the province with the highest number of cooperatives reporting a shortage of subsidized fertilizers (91% cooperatives).

Table 1. Actual supply of subsidized fertilizer as reported by surveyed cooperatives in the fiscal year 2018/19 (April-March)

Region or Province	Cooperatives surveyed (n=828)	Mean supply to surveyed cooperatives in MT (SD in parentheses)			Percentage of cooperatives reporting short supply
		Urea	DAP	MOP	
Region					
Hill	183	71 (127)	44.2 (92)	5.2 (11)	74.9
Terai	645	87.8 (115)	69.8 (104)	15.9 (68)	87.6
Province*					
Province P1	71	114 (118)	63 (60)	14.4 (47)	70.4
Madhesh	344	82.5 (108)	72.7 (109)	14.5 (36)	89.0
Bagmati	102	103.2 (155)	61.8 (90)	7.3 (14)	82.4
Gandaki	54	87.5 (176)	31.8 (65)	7.8 (14)	83.3
Lumbini	158	71 (84)	50.5 (66)	10.8 (74)	84.8
Karnali	44	34.9 (78)	32.9 (124)	2.4 (5)	75.0
Sudurpashchim	55	101.6 (123)	117.9 (172)	41 (166)	90.9
National	828	84 (118)	64.1 (102)	13.3 (60)	84.8

* There are seven provinces in the country. Until recently they were called P1, P2, P3, P4, P5, P6, and P7. Now six provinces have been given a name except Province P1, as indicated in Table 1. We have used the notations and the names of the provinces as relevant in this paper.

Farmers generally use subsidized fertilizers mainly for rice, maize, and wheat. However, significant amounts of DAP and MoP were used for commercial crops, including vegetables, potatoes, bananas, and cash crops such as sugarcane (Fig. 2). Out of the 828 cooperatives surveyed, 17 (2.1%) from the Terai region reported using chemical fertilizers for non-agricultural purposes, such as in plywood production. Still, they needed to provide information on the source and quantity of fertilizer for these non-agricultural users.

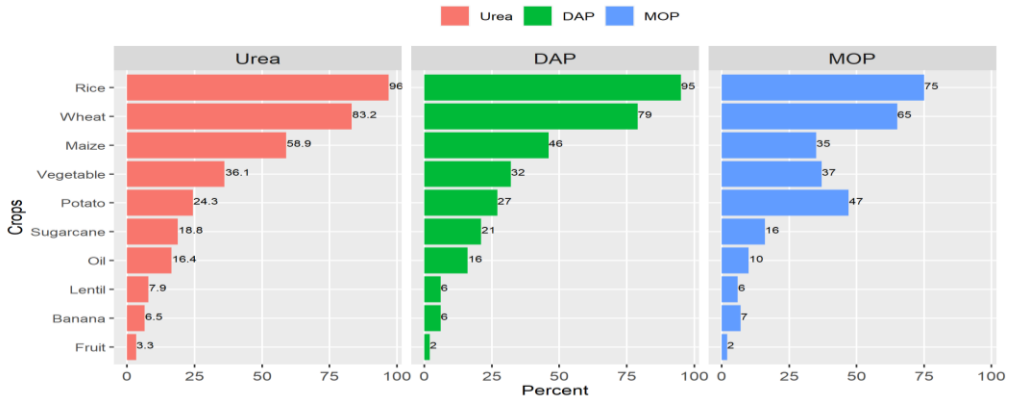

Figure 2. Percent of cooperatives reporting fertilizer application for different crops

The total amount of imported fertilizers in the fiscal year 2017/18 was 364 thousand MT. The Madhesh province received the highest amount (115 Mt) of fertilizer, followed by the Lumbini province (85 Mt), while Karnali province received the least (4 Mt) (Table 2). However, when we calculate the use of fertilizer per hectare.

Table 2. Actual supply, total effective demand (TED), and supply as a percentage of TED at provincial/regional and national levels (based on actual supply of 2017/18)

Region/ Province	Actual Supply (AS) in '000 MT				Total Effective Demand (TED) in '000 MT				Supply as percentage of TED				Fertilizer supply (kg/ha)
	Urea	DAP	MoP	Total	Urea	DAP	MOP	Total	Urea	DAP	MOP	Total	
Region													
Hill	54.3	20.3	1.5	76.1	79.0	28.1	1.5	108.6	68.7	72.2	100.0	70.1	49
Terai	190.3	90.9	6.7	287.9	327.3	157.3	10.2	494.9	58.1	57.8	65.7	58.2	180
Province													
Province P1	40.6	15.4	1.8	57.8	66.6	25.7	2.7	95	61.0	59.9	66.7	60.8	87
Madhesh	74.1	38.3	2.2	114.6	121.8	63.4	3.9	189.1	60.8	60.4	56.4	60.6	189
Bagmati	41.9	16.8	1.9	60.6	64.6	22.4	2	89	64.9	75.0	95.0	68.1	155
Gandaki	9.6	4.2	0.4	14.1	13.1	5.9	0.5	19.5	73.3	71.2	80.0	72.3	47
Lumbini	56.8	26.6	1.2	84.6	98.5	49.9	1.9	150.3	57.7	53.3	63.2	56.3	140
Karnali	2.5	1.3	0.1	3.9	3.8	2.3	0.1	6.2	65.8	56.5	100.0	62.9	18
Sudurpashchim	19.1	8.7	0.5	28.4	38	15.8	0.6	54.4	50.3	55.1	83.3	52.2	78
National	244.7	111.2	8.2	364.0	406.4	185.4	11.7	603.5	60.2	60.0	70.1	60.3	116

Source: The actual supply figures are from MoAD, 2017

(considering the area under three crops rice, maize, and wheat), Madhesh province received the highest quantity (189 kg/ha) followed by Bagmati province (155 kg/ha) and Karnali province received the least (18kg/ha).

Effective demand at the provincial and regional level

As per the actual supply and extrapolated effective demand of fertilizers (Urea, DAP, MoP) in the country, the actual supply in 2017/18 was about 60% of the TED (Table 2). However, when disaggregating for three subsidized fertilizers, the supply was around 60% of the TED for Urea and DAP, while it was about 70% for the MoP. Among the provinces, the highest supply (72%) was in Gandaki province, followed by Bagmati province (68%); the lowest (52%) was in Sudurpashchim province. The reason for variation in the demand at the regional and provincial level is related to crops grown and cropped acreage and, to some extent, knowledge about specific nutrients at the farmers' level.

Price variation across provinces

The Urea, DAP, and MOP prices in Birgunj port (port of entry in Nepal) were NRs 14, NRs 43, and NRs 31, respectively (Fig. 3). Each cooperative calculated its retail price based on transportation and logistics costs. The farmers in the hills paid more, primarily due to the added cost of transportation (from regional depots of AICL and STCL to distribution locations).

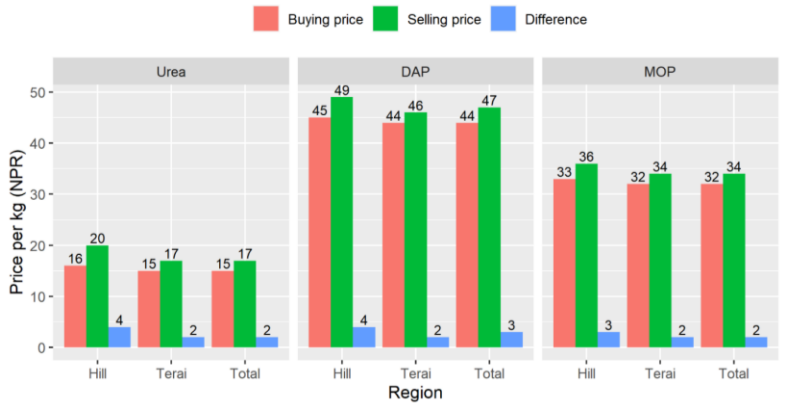

Figure 3. Average buying and selling price and difference by region (in NPR/ kg). The cooperatives in provinces further away from Birgunj tend to sell at higher prices than those closer to Birgunj. The average price paid by farmers in different provinces ranged from NRs 16-21 per kg for Urea, NRs 45-50 for DAP, and NRs 33–37 for MoP, respectively. The average price of all three subsidized fertilizers was highest in the Karnali province and lowest in Province 1 and Madhesh.

The distance from the port of entry (city of Birgunj in Madhesh province) to each cooperative was significant in explaining the price variation across the country as per the empirical results from the simple linear regression model. A kilometer increase in distance from Birgunj is associated with an increase in NRs 4.01/MT of Urea, NRs 4.62/MT of DAP, and NRs 4.43/MT of MoP (Table 3).

Table 3. Relationship between the distance from the port of import (Birgunj) and price of fertilizers at different cooperatives

	Urea	DAP	MOP
(Intercept)	16453.40 ***	45489.76 ***	33414.79 ***
	(95.51)	(117.21)	(141.39)
Distance from import custom point	4.01 ***	4.62 ***	4.43 ***
	(0.32)	(0.39)	(0.47)
N	787	796	719
R^2	0.17	0.15	0.11

*** p< 0.001; ** p< 0.01; * p< 0.05.

CONCLUSION

Fertilizer supply in Nepal depends completely on imports as there is no domestic production. The timely supply of fertilizer is a chronic problem and farmers are not able to get fertilizers as per their requirements. GoN has limitations in resources (subsidy budget and logistic facilities) to increase imports to meet the current demand. GoN could address part of the fertilizer problems by maintaining a buffer stock. Further, in addition to global tender process of fertilizer purchase, we suggest a more reliable and longer-term Government to Government (G_2G) purchasing of fertilizer arrangement to ensure around 50% of the current supply to ensure a smooth supply during the peak growing season. The current fertilizer policy does not allow the private sector to participate in the subsidy program. One option to increase the supply is to allow private firms involve in the subsidy program. For this GoN could adopt a nutrient-based subsidy scheme rather than the current product-based subsidy.

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