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*regional initiative to sustainably increase the productivity of cereal-based cropping systems, thus improving food security and farmers' livelihoods in Bangladesh, India and Nepal. CSISA works with public and private partners to support the widespread adoption of resource-conserving and climate-resilient farming technologies and practices. The initiative is led by the International Maize and Wheat Improvement Center (CIMMYT), implemented jointly with the International Food Policy Research Institute (IFPRI) and the International Rice Research Institute (IRRI), and is funded by the US Agency for International Development (USAID) and the Bill & Melinda Gates Foundation.*

This work was undertaken as part of United States Agency for International Development (USAID) under its Feed the Future Nepal Seed and Fertilizer (NSAF) project, CGIAR Research Program Maize led by CIMMYT and the CGIAR Research Program Policies, Institutions and Markets, led by IFPRI.

## What is the true value of fertilizer? An assessment of farmers willingness-to-pay for fertilizers across the hill and Terai regions of Nepal

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March 2019

### Introduction

Agriculture in Nepal has historically suffered from low levels of productivity. Inadequate usage of fertilizer, poor fertilizer quality, and insufficient supply to satisfy demand have been identified among the major reasons behind this low productivity (Joshi, 2010). Other factors such as land fragmentation, lack of irrigation, lack of good quality seeds, inadequate public investment and more recently climate change (e.g., Niroula & Thapa; Joshi et al., 2012; Ghimire et al., 2015; Malla, 2008) also remain as challenges for Nepalese agriculture. Both the Agriculture Perspective Plan (APP, 1994-2014) and the Agriculture Development Strategy (ADS, 2015-2034) have recognized the deficiencies in the fertilizer supply chain and have prioritized the widespread distribution and utilization of fertilizers as essential elements in their development strategies (Bista et al., 2016). With continuation of the fertilizer distribution issues, a voucher system has been proposed in the ADS (2015-2035) but is yet to be implemented. As with any type of transfer policy, proper identification of intended beneficiaries and calibration of voucher payments is critical for its successful rollout. It is therefore imperative that all concerned stakeholders including government agencies garner a more complete understanding of the true demand of chemical fertilizers to optimize policy design. Through this study, we determine the implicit value farmers place on fertilizers as well as other perennial costs associated with obtaining fertilizers, such as travel costs and certainty premia.

### Methodology

This study relies on Becker-DeGroot-Marshak (Becker et al., 1964; hereafter BDM) valuation elicitation mechanisms to measure farmers' willingness-to-pay (WTP) for the two most commonly used fertilizers, urea and diammonium phosphate (DAP). In a BDM, individuals are asked to state a maximum monetary amount they would be willing to pay for a given product; in this case, fertilizer. After their valuations are recorded, a market price is selected randomly. If the participant's valuation exceeds the random market price, participants will be entitled to purchase the fertilizer at the market price. If their valuation is below the selected random market price, then no transaction occurs, nor is the farmer entitled to purchase the fertilizer at this market price. Consequently, farmers' optimal strategy is to state a value exactly equal to the true value of the fertilizer for them.

We conducted six different valuation elicitation scenarios, three each for both urea and DAP, to assess farmers' WTP with respect to fertilizer to be used for monsoon (*kharif*) 2018 basal application:

- Scenario 1: WTP for fertilizer with guaranteed delivery directly to their homestead in time for application ( $WTP_1$ )
- Scenario 2: WTP for fertilizers that will be guaranteed to be available at the cooperative, but farmers would have to travel to the cooperative to procure it ( $WTP_2$ )
- Scenario 3: WTP for fertilizers that will be delivered to their homestead, but only if there are available supplies at the cooperative ( $WTP_3$ ).

Using this series of BDM mechanisms, we aimed to decompose the intrinsic value of fertilizer into a measure of WTP for the productivity benefits of fertilizer, WTP for travelling from their homesteads to the cooperatives to purchase fertilizer, and the WTP for the certain availability of quality fertilizer. These exercises were conducted in the process of a primary survey (to gather data on production practices, consumption expenditure, and other relevant socio-economic indicators) conducted with farm households from eight districts (4 districts from the lowland region bordering India – called the Terai – and four districts from the hills) spanning across the country.<sup>1</sup> There were total of 12 Village Development Centers (VDCs) surveyed of which eight were from the Terai (2 from each selected district) and four VDCs from hill districts (one from each selected district). From each selected VDC randomly selected 50 households were surveyed making the initial sample size 600 households. However, for this analysis we restrict this initial sample to total of 482 rice-cultivating households. Actual fertilizer sale transactions occurred for those farmers whose WTP was higher than the randomly selected market price for their village.

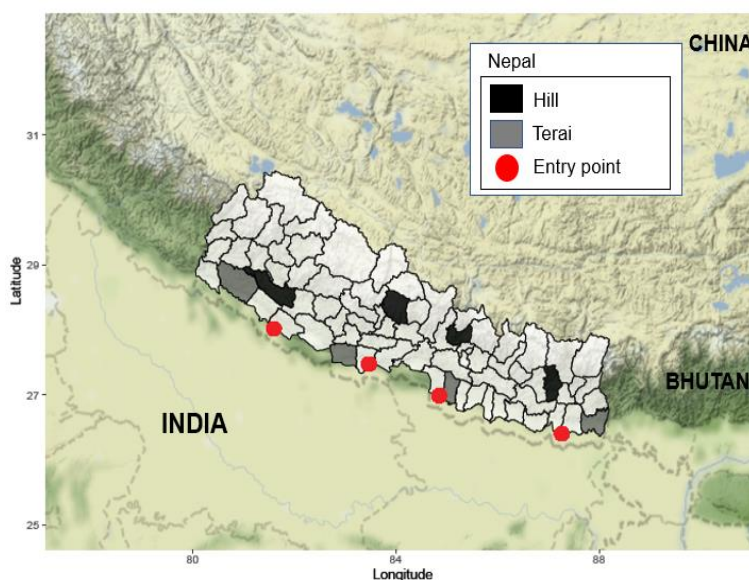


Figure 1. Location of survey districts in Terai and hill regions, and official fertilizer entry points along Indian border

## Results

The results suggest the WTP for fertilizers is highest under the scenario in which fertilizer is delivered directly to farmers' homes and guaranteed in time for *kharif* basal application. This scenario eliminates uncertainty as it pertains to both the availability and timeliness of access to fertilizer, as well as the opportunity cost of traveling to the cooperative to procure it. However, the average valuation under this best-case scenario in both the hill and Terai regions is virtually indistinguishable from the average prices farmers recalled paying in the previous *kharif* season in which farmers' had to travel to co-

<sup>1</sup> The districts were purposively selected ensuring at least one hill and Terai district in each market segment of the four fertilizer distribution points spread east to west along the Terai region (Biratnagar, Birgunj, Bhairahawa, and Nepalgunj) of the country. Most of the subsidized fertilizer is distributed these points to their respective market segments. The selection of districts took into account the area under the rice and agro-ecological (hill and Terai regions) as well as representation of all seven provinces.

operatives for fertilizer but without guaranteed availability (less optimal than the hypothetical Scenario 1).

By comparing the valuations under the three Scenarios 1 ( $WTP_1$ ), Scenario 2 ( $WTP_2$ ) and Scenario 3 ( $WTP_3$ ), we estimate each of these three dimensions of value. Results of this valuation decomposition<sup>2</sup> are presented in Table 1 below:

**Table 1. Total fertilizer valuation and value decomposition, by location and fertilizer type**

	(1)	(2)		(3)	(4)	(5)		(6)
	Hill	Urea		p-value	Hill	DAP		p-value
Total valuation	26.20	21.40		<0.0001***	44.33	45.58		0.2381
WTP for travel	2.61	1.81		0.0001***	3.51	2.73		0.0181**
WTP for certainty	5.64	3.16		<0.0001***	9.45	5.66		0.0012***
WTP for productivity benefits	17.94	16.43		0.0196**	35.17	39.71		0.0008***

\* Significant at 10 percent level; \*\* Significant at 5 percent level; \*\*\* Significant at 1 percent level. Reported p-values in column (3) and (6) are based on two-sided t-tests of sample means, with null hypothesis that sub-sample means are equal. In addition to the reported coefficients, all regressions control for respondent age (and its square), farming experience (and its square), marital status, gender, whether the respondent is the primary decisionmaker in the household, whether the household holds a formal title to the land they cultivate, and household expenditures (including both food and non-food expenditures).

To determine the drivers of total urea and DAP value, as well as these different value components, we test a tobit regression framework to control for the censored nature of our dependent variable, since it assumes that value cannot be negative. We find that the recalled price of urea in the previous season has a positive and statistically significant effect on the total value of urea, but the magnitude of correlation is very small. This suggests that to a small extent that values are anchored to the price farmers recall from actual transactions. One result that is particularly striking is the effect of distance from the nearest entry point along the Indian border. There is considerable anecdotal evidence to suggest that there are sizable flows of highly subsidized Indian fertilizers across the rather porous border into Nepal, though in our sample only 14 percent of farmers in the Terai and 2 percent of farmers in the hills reported purchasing fertilizers from sources in India. Once in Nepal, these fertilizers are widely traded through unregulated 'grey markets,' thereby providing a sort of backup fertilizer market that could be tapped if there are insufficient or untimely supplies of fertilizers available through the more formal retail channels. For both urea and DAP, farmers that are further away from the Indian border have a significantly higher WTP for fertilizers, though the underlying mechanism that drives the effect on total value is different for urea and DAP. For urea, this effect is largely driven by an effect on WTP for the productivity benefits of urea. For DAP, farmers further away from the Indian border are WTP more to travel to retailers to procure DAP.

Commercial farmers in the hills are willing to pay significantly more than their non-commercial counterparts to travel to procure urea. We believe that commercial farmers may have access to multiple fertilizer sources, and thus may be willing to travel greater distances (or incur greater costs) to procure urea. They are also likely to be well connected with cooperatives and have higher disposable income than other farmers. In the Terai, there is an opposite effect: commercial farmers are willing to pay significantly less than their non-commercial counterparts to travel to procure fertilizer (both urea and DAP). It is possible that like their commercial counterparts in the hills,

<sup>2</sup> An estimate of farmers' WTP to travel to the cooperative is given by taking the difference between  $WTP_1$  and  $WTP_2$ . An estimate for the certainty premium is given by taking the difference between  $WTP_1$  and  $WTP_3$ . If we take  $WTP_1$  – which is conflated with the value of certain availability and being delivered to the farmer's doorstep – and subtract off the willingness-to-pay for travel and the certainty premium, we arrive at our estimate for the value of these on-farm productivity benefits:  $WTP_2 + WTP_3 - WTP_1$ .

commercial farmers in the Terai have access to multiple sources of fertilizer including informal sources with limited cost and travel time, and thus are less willing to pay extra to travel for these purposes.

## Policy Implications

Fertilizer availability, access and application have remained as major hindrances towards agricultural productivity improvement in Nepal. The results of this valuation and value decomposition exercise have significant bearing on fertilizer procurement and distribution policies, as well as direct support policies that the Nepal government may consider. Farmers in the Terai – on average – value urea and DAP more than what they pay for these fertilizers in the market, and farmers in the hills value DAP less than what they pay in the market. Farmers' in Nepal have been relying on subsidized fertilizer for a long time. Because their total intrinsic value for fertilizer is typically less than the actual market price of fertilizers under the status quo scenario in which farmers incur travel and other transaction costs and face both uncertain quantities and qualities of fertilizers, an argument could be made that these farmers rely on subsidies. In this regard, there is a need for continued support from the government, at least in the short to medium term, to ensure that farmers can avail adequate fertilizer supplies and do not reduce the already low fertilizer application.

Relaxing travel and certainty constraints could have a desirable effect on farmers' perceptions of the overall benefits of fertilizer – specifically in terms of yield gains. A well-designed voucher program could provide the requisite support for increased access to fertilizer markets and quality fertilizers. Reducing the barriers to entry of the private sector will enhance this further. As the private market for fertilizers develops and increases competition for providing quality and timely availability of fertilizers to consumers, farmers will be able to avail the benefits of those using vouchers provided to them by the local administration. The value of vouchers can be determined by the amount of subsidy the government is willing to provide, per kg of the fertilizer. An appropriate targeting mechanism must also be derived to enhance the access of fertilizers to marginal and smallholders of land. As the fertilizer market becomes stronger and as competition increases, it should become easier and less costly for farmers to travel to acquire needed fertilizer supplies and encourage the uniformity of high-quality fertilizer supplies. In turn, less of the total value of fertilizers will be accounted for by travel and transaction costs, and more will be attributed to its intrinsic value. Over time, then, it is not difficult to imagine a scenario in which government support to farmers could be reduced if not wholly eliminated.

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