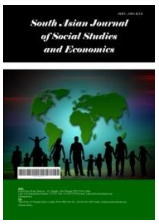

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Farmers as Consumers of Quality Fertilizers: Willingness to Pay and Empirical Evidences from Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study investigated farmer's willingness to pay for getting quality fertilizers by employing probit and ordered probit models as the quality of fertilizers were often adulterated in Bangladesh. Primary data collected from 300 farm households were utilized. Results indicated that an average farmer's willingness to pay was influenced significantly by the farm size group, annual income, off-farm income, product prices and financial constraints. All farmers except marginal farmers were more likely to be willing to pay more than market prices for urea and MoP. The findings suggested for adjusting the farm size group specific subsidy policies. More off-farm employment opportunities could be created in the farming regions to strengthen farmer's financial capability.

Keywords: Willingness-to-pay; stated preference method; adulteration; farm size group; subsidy policy.

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1. INTRODUCTION

Since introduction, the use of chemical fertilizers in Bangladesh agriculture continues an increasing trend which reached 55.79 million metric tons in 2018-2019 from 22.18 million metric tons in 1993-94 [1]. This is justified for Bangladesh agriculture as the country has virtually no possibility of increasing its cultivable land area but at the same it has to increase crop yield and production for an increasing population. The total contribution of three major nutrient fertilizers (urea, triple super phosphate and muriate of potash) to crop production is about 37 percent [2]. Given this backdrop, the quality of different fertilizers is often tempered by the traders in the market. The application of adulterated fertilizers reduces crop yields significantly because of their low nutrient contents [3]. The Ministry of Agriculture is responsible for fertilizer quality control throughout the country and it undertakes various measures to control for adulteration of fertilizers. Although there is a Fertilizer Management Act [4], field level monitoring and controlling of fertilizer adulteration is inadequate in the country. Extension agents are involved in the marketing of fertilizers paying less attention on providing extension services to farmers and conducting quality checks [4]. Profit seeking traders including manufacturers, dishonest importers and dealers become active in altering various types of fertilizers during plantation seasons. Besides, some dealers mix low standard fertilizers with quality products and supply it to the market for higher profits. Usually, fertilizers are contaminated through mixing of substances of particular fertilizer in such a way that is practically inseparable by the farmers from actual one. In addition to tampering with genuine product, many unregistered dealers are marketing expired products also. This happens mainly for urea fertilizer. In case of TSP and DAP, red contaminants like cracked bricks and different micro-granules containing sulphur (Magnesium Sulphate, Sodium Sulphate) are mixed with original one. Brick chips, powder of broken glasses, finely ground stones play the role of major contaminants in case of MoP [4,5].

Mixing of harmful substances degrades fertility of the soil and also lowers production. Farmers in the northern and southern regions are already experiencing decline in crop production and soil fertility due to excessive use of adulterated fertilizers [6]. One of the leading newspapers of Bangladesh reported that nearly 40 per cent of all fertilizers used by farmers are adulterated according to the tests conducted by Soil Research Development Institute (SRDI) [7]. Adulteration of urea increased from 2 per cent in 2010-11 to 3 per cent in 2011-12 while for MoP it has been decreased to 7 per cent in 2011-12 from 11 per cent in 2010-11. Adulteration of TSP remained at the same level of 25 per cent and in case of DAP, adulteration raised from 21 per cent in 2010-11 to 22 per cent in 2011-12 [8]. While the supply of fertilizers is generally sufficient to meet the demand in the country and prices are affordable to the farmers, quality became an issue. Adulteration or contamination of fertilizers at the farm level becomes one of the major problems regarding the fertilizer marketing in the country. Ensuring that Bangladeshi farmers have access to high quality and unadulterated fertilizers is critical to the country's journey of improving productivity, achieving food security and generating higher incomes [9]. Government needs and should take into consideration the farmer's willingness to pay for quality fertilizers in the pricing and subsidy policies.

In this perspective, it is necessary that producers' willingness to pay for quality fertilizers to be measured. Several studies were found on the literature regarding the estimation of willingness-to-pay (WTP) for producers. Horna *et al.* estimated farmers' willingness-to-pay for seed-related information in Nigeria and Benin following contingent valuation methods [10]. The economic value of tank irrigation water was determined by Chandrasekaran *et al.* through contingent valuation method in south India [11]. A similar research was conducted by Basarir *et al.* in Bulgeria where they analyzed the producer's willingness-to-pay for higher quality irrigation water and the factors that were affecting their payment decisions by applying Tobit and Heckman sample selection model [12]. Barkat et al. examined, as a part of their research on fertilizer market, whether farmers were willing to pay more than the market price of urea fertilizer in Bangladesh or not. However, they did not empirically measure farmers' WTP for fertilizers [13]. Casselbrant and Stahle [14] determine farmer's WTP for Di-ammonium Phosphate (DAP) fertilizer following payment card method in Kenya. By using same method, Lenksjo and Nordzell [15] estimated WTP for improved maize seeds among smallholder Kenyan farmers. Uddin et al. [16] investigated farmer's WTP for extension services by using contingent valuation method as agricultural extension in Bangladesh

was experiencing chronic fund crisis. Tsigou and Klonaris [17] has conducted a study for the purpose of examining the determinants of farmers' willingness to pay for two packages of an innovative anti-salinity fertilizer, which does not yet exist in the market, in the regions of southwest Greece by applying both contingent and inferred valuation method. The regression analysis showed that the size of cultivated land, the level of education, the knowledge scale about salinity, the package of liquid fertilizer that farmers usually buy and the consequentiality script have a positive effect on willingness to pay, whilst hypothetical bias and inferred valuation method have a negative effect. Shee et al. [18] measured farmers' willingness to pay (WTP) for hybrid maize seed and local inorganic fertilizer using a contingent valuation experiment in Northern Tanzania. Results showed that the average WTP was 61% higher for hybrid maize seed and 15% lower for inorganic fertilizer than their average local market prices during the reference period, suggesting that farmers were willing to pay a premium for hybrid maize seed, while they did not seem to be interested in fertilizer purchase at current market price.

Till date, little empirical research has been conducted in the country to deal with the issues raised in this study. This research is an endeavor to extend the literature which will benefit producers, policy makers and government as a whole. This part of information will contribute to the debate of fertilizer subsidy policy and appropriate price decisions by the policy makers. The study has the following specific objectives with an aim to contribute to the national policy analysis:

i. To analyze the farmer's willingness-to-pay for fertilizers with ensured quality; and
ii. To assess the factors those are affecting mostly farmer's willingness to pay for quality fertilizers.

2. MATERIALS AND METHODS

The research was conducted at farm household level which was considered as the sampling unit. The primary data and information had been collected from the sampling units which were identified through a multi-stage sampling procedure based on purposive selection. The study covered three districts namely, Dinajpur, Mymensingh and Tangail from northern part of Bangladesh on the basis of farming concentration and fertilizer usage. From each district, several sub-districts were selected again on the same basis. In total, 300 farm households belonging to different farm size groups (i.e., marginal, small, medium and large [1]) were interviewed. Farmers were selected with the help of sub assistant agricultural officers from each sub-district. Some focus group discussions and key informant interviews were also conducted to cross check the data. The stated preference method was used for revealing farmer's WTP for quality fertilizers. This method has been employed to a wide range of applied research for measuring WTP for both marketed and non-marketed products and inputs. Probit and ordered probit models within the context of the double hurdle model were developed to analyze empirically the farmer's WTP for quality fertilizer and the factors which influence their WTP. This allows for a more flexible framework to model a producer's WTP as a simultaneous choice of two decisions instead of a single decision as proposed by [19]. The farmers first decide whether they will pay more or less than the current market price and then they decide the amount that they will be ready to pay. Arthur *et al.* argued that if the respondents are not asked first if they will pay more than the current price or not, many respondents may presupposes that they should pay more than the market price and hence, overstate their willingness [20].

2.1 Empirical Model for Identifying the Factors Affecting Farmer's Willingness to Pay More Than the Market Price for Quality Fertilizer

Probit regression model was employed for estimating the influence of factors that affect farmer's willingness to pay more than existing market prices for three major fertilizers (urea, TSP and MoP). The dependent variable used in the model has only two outcomes: will the farmers pay more than market price or not? Therefore, limited dependent variable regression model (probit model) was applied instead of ordinary Least Square (OLS) method. The model takes the following form [21]:

$$Pr\ (Y=1|\ X_{1i}\ldots\ X_{ni}) = F(\beta_1\ X_{1i} + \beta_2\ X_{2i} + \beta_3\ X_{3i} + \ldots + \beta_n X_{ni} + \varepsilon_i) \quad (1)$$

Where, Pr is probability; Y is farmer's willingness to pay more than market price (1: Yes, if farmer

[1] *Marginal farmers operate between 0.02 and 0.2 ha of land; small farmers operate between 0.2 and 1.0 ha of land; medium farmers operate between 1.0 and 3.0 ha of land and large farmers operate above 3.0 ha of land [21].*

is willing to pay more; O: otherwise); F is cumulative distribution function (CDF) which follows standard normal distribution; X_{1i}… X_{ni} are factors that affect farmer's willingness to pay more; β_1… β_n are the parameters estimated using maximum likelihood estimation (MLE) procedure; and ε_i is random component.

2.2 Econometric Model for Investigating Farmers' Willingness to Pay Amount for Quality Fertilizers

The utility of preference or WTP is an ordinal measure [22]. Given the ordinal ranking of the WTP dependent variable, the ordered version of probit regression model was applied. In this study as WTP took the form of a multiple response variable that has intrinsic order, the WTP model can be written using a latent variable as follows:

$$WTP^* = \beta_i X_i + \varepsilon_i \quad (2)$$

Where, WTP^* is the farmer's unobserved willingness to pay; X_i is a vector of variables thought to influence willingness to pay; β_i is a vector of parameters reflecting the relationship between willingness to pay and variables in X; and ε_i is an independently and identically distributed error term with mean zero and variance one. If a farmer's WTP^* falls within a certain range, their WTP is assigned a numerical value that reflects the category in which their unobserved willingness to pay lies. Therefore, If $\gamma_{j-1} < WTP^* \leq \gamma_j$ then, WTP = j -1 for all j = 1,..., J. Where, j is the WTP category and γ are unknown threshold parameters associated with WTP categories. These unknown threshold parameters were estimated along with β_i assuming $\gamma_{-1} = -\infty$, $\gamma_0 = 0$ and $\gamma_j = \infty$ [23]. Theoretically, willingness to pay is determined by the changes in utility from the choice made by an individual [24]. Also WTP is likely to vary across individuals. Therefore, it was rational to use the relationship between WTP and factors affecting WTP to predict the probability of a farmer's WTP within a certain range. The difference in these probabilities indicates the chance of that consumer's WTP being between the defined levels. Specifically, the probability of having a WTP between two defined WTP levels is:

$$Pr(WTP_1 < WTP < WTP_2) = Pr(X_i\beta_i + \varepsilon_i \leq \gamma_1) - Pr(X_i\beta_i + \varepsilon_i \leq \gamma_2) \quad (3)$$

Where, Pr is the probability; WTP_1 and WTP_2 are two limits of WTP; and γ_1 and γ_2 are threshold changes in utility consistent with the WTP limits. Further, the probability of a farmer's WTP being in one of j finite WTP categories can be expressed as follows [24]:

$$Pr(WTP = j - 1) = \Phi(\gamma_j - X_i\beta_i) - \Phi(\gamma_{j-1} - X_i\beta_i) \quad (4)$$

Where, Φ is the cumulative density function (CDF) which measures the probability of WTP being in one of the WTP category. The ordered probit model allows for the calculation of predicted probabilities for each WTP category and marginal effects like other probability models. When calculated at the means of the data, predicted probabilities indicate the chance of an individual being willing to pay a price falling within each of the categorical WTP levels. These can be used to measure the level of farmer's WTP for different fertilizers. Marginal effect for the considered variable shows the change in predicted probability for each WTP category for an average farmer.

3. RESULTS AND DISCUSSION

3.1 Measurement of Dependent Variables

The dependent variable used in the probit model was a binary response variable taking the value of 1 if the farmer was willing to pay more than existing market price for an upgradation of fertilizer quality considering their financial condition and crop prices and 0 if the farmer was not willing to pay more.

For ordered probit model, the dependent variable was a range of WTP categories. The respondents were asked to indicate their WTP in actual monetary amounts instead of percentage amount, which helps them to avoid mental calculations and to be reflective of a real market situation. The responses were then classified into six groups of WTP and were coded as WTP=1 for first category, 2 for the second WTP category, 3 for the third category, 4 for the fourth category, 5 for the fifth category and 6 for the sixth category. The ranges of possible WTP categories (as a percent of the base value i.e., market price) and the distribution of WTP responses were presented for urea and MoP in Table 1 and for TSP in Table 2. Here, the classification criteria of WTP categories are different for TSP which was done to incorporate all the responses.

Table 1. Distribution of WTP responses for urea and MoP

WTP category	Code	Urea		MoP	
		Frequency	%	Frequency	%
Willing to pay 11- 20 % less	1	45	15.00	36	12.00
Willing to pay 01-10 % less	2	47	15.67	38	12.67
Not willing to pay more or less	3	24	8.00	47	15.67
Willing to pay 01-10 % more	4	82	27.33	73	24.33
Willing to pay 11- 20 % more	5	55	18.33	83	27.67
Willing to pay >20 %more	6	47	15.67	23	7.67

Source: Author's calculation

Table 2. Distribution of WTP responses for TSP

WTP category	Code	Frequency	Proportion
Willing to pay 16- 30 percent less	1	53	17.67
Willing to pay 01-15 percent less	2	105	35.00
Not willing to pay more or less	3	55	18.33
Willing to pay 01-15 percent more	4	36	12.00
Willing to pay 16- 30 percent more	5	32	10.67
Willing to pay >30 percent more	6	19	6.33

Source: Author's calculation

3.2 Predictor Variables Used in Empirical Models

Economic theory and literature indicated that farmer's stated WTP for quality fertilizer was a function of their individual preferences and expectation regarding product yield and prices, income and financial capabilities to bear input cost, satisfaction with fertilizer subsidy policies, as well as household and demographic characteristics. Changes or differences in these factors had a bearing on the actual willingness to pay and probability associated with a certain WTP range. Therefore, a number of different observable explanatory variables were included in both probit and ordered probit models (Table 3).

Actual amount of cultivable land (decimal), a farmer own, was entered as a quantitative variable in the probit model. However, this variable entered as a qualitative variable representing four farm size categories (marginal, small, medium and large[2]) in the ordered probit model. Following the rule of using dummy variable in the regression, three dummies for marginal, small and medium farm size category were included omitting the large farm category which was the base category in this situation. The omitted reference variable was selected arbitrarily. Nevertheless, interpretation of results was relative to the omitted reference variable for that category of question. The dummy variable off-farm employment opportunity was used in probit model taking the value of 1, if the farmer had alternative sources of income rather than farming and 0, otherwise. On the other hand, share of off-farm income in total income, which was a quantitative variable, was entered in ordered probit model.

Summary statistics of cultivable land showed that on average, farmers have 214 decimal of cultivable land. Majority were small farm households (52 percent) while 14 percent were marginal, 28 percent were medium and only 5 percent were large farms. The spread amongst the average size of household's homestead area was 18 decimal. About 45 percent of farmers had no involvement in off-farm income generating activities which restricted their sources of getting an additional income besides farming. Farm household's off-farm income share in total income was only about 13 percent. The households earned about BDT 175 thousand per year. The annual income differed among the farm households very much. Majority of the farmers (69 percent) were either dissatisfied with subsidy policy or did not express any views. About 73 percent farmers faced difficulties while buying fertilizer in time and in right quantities due to monetary crisis. Among them, 56 percent managed the liquidity problem by taking loan from different credit institutes. Among sampled farmers, 49 percent got their expected yield from paddy cultivation while 54 percent did not get expected market price for the produce (Table 3).

[2]*Medium and large farm groups are merged together for e better econometric estimation as the sample size for large farms is too small which is a common phenomenon in Bangladesh.*

Table 3. Measurement of explanatory variables used in econometric models

Variables	Measurement unit	Mean	Standard deviation
Cultivable land	Decimal/household	213.86	205.07
Dummy of cultivable land			
Marginal farm group	1= marginal farm, 0= otherwise	0.14	0.35
Small farm group	1= small farm, 0= otherwise	0.52	0.50
Medium farm group	1= medium farm, 0= otherwise	0.28	0.45
Large farm group[a]	1= large farm, 0= otherwise	0.05	0.22
Homestead area	Decimal/household	21.73	18.31
Off-farm employment opportunity	Dummy: 1= yes, 0= no	0.55	0.49
Off-farm income share	Ratio	13.31	15.87
Annual income	BDT[b]/household/year	175,626.11	136,371.20
Product yield	Ton/hectare	6.05	1.56
Product price received	BDT/Kg	17.63	2.09
Satisfaction with subsidy policy	Dummy: 1= yes, 0= no	0.31	0.64
Fertilizer purchasing capability	Dummy: 1= yes, 0= no	0.27	0.69
Credit access	Dummy: 1= yes, 0= no	0.44	0.49
Getting expected yield	Dummy: 1= yes, 0= no	0.49	0.50
Getting expected product price	Dummy: 1= yes, 0= no	0.46	0.49

Source: Author's calculation
[a]The variable was dropped during estimation
[b] Bangladeshi Taka

Table 4. Factors influencing the probability of farmer's willingness to pay more than market price for different fertilizers

Variables	Urea Marginal effect	SE	TSP Marginal effect	SE	MoP Marginal effect	SE
Cultivable land (decimal)	0.067***	0.024	0.035**	0.012	0.081**	0.026
Off-farm employment opportunity (1=yes)	0.086	0.141	0.127**	0.023	0.152**	0.061
Annual income (BDT)	0.009***	0.067	0.002**	0.052	0.006***	0.106
Product yield (ton/ha)	0.033	0.085	0.020	0.049	0.044	0.057
Product price (BDT/kg)	0.023**	0.014	0.015**	0.003	0.030**	0.008
Satisfaction with subsidy policy (1=yes)	0.082*	0.032	0.061	0.139	0.105**	0.063
Fertilizer purchasing capability (1=yes)	0.055	0.056	0.063**	0.017	0.098	0.055
Model summary						
LR chi^2 (7)	53.31		30.91		37.62	
Prob > chi^2	0.000		0.000		.000	
Pseudo R^2	0.14		0.09		0.11	
Log likelihood	-168.35		-161.15		-188.07	

Source: Author's estimation
*Note: ***, ** and * represent statistical significance at 1%, 5% and 10% level, respectively*
SE = Standard Error

3.3 Factors Influencing the Probability of Farmer's Willingness to Pay More Than Market Price for Getting Quality Fertilizers

Table 4 reported the marginal effects of probit estimation. The estimated coefficient for the farm size was positive valued and statistically significant for three fertilizer type. On average, a 100 decimal increase in farm size increased the probability of a farmer's willingness-to-pay more than the market price by about 7 percent, 4 percent and 8 percent for urea, TSP and MoP, respectively, other factors remaining unchanged. Higher probability associated with higher farm size was in line with the findings of [13]. Medium and large farmers could actually afford and willing to pay a higher price for quality fertilizers as compared to marginal and small farmers.

Off-farm employment opportunity had positive and significant impact on farmers' willingness-to-pay more for unadulterated TSP and MoP but insignificant impact for unadulterated urea. In particular, farmers who had alternative employment sources outside agriculture were likely to pay more than market price as compared to those who depended only on farming income. The positive and significant coefficients associated with household's annual income implied that farmers with higher income could afford higher market prices to have ensured quality. As revealed from field survey, farmers kept more attention on paddy price than fertilizer market prices. With increased output return they could offset the input cost which raises the probability of paying more. This fact may contribute towards the significant impact of product price variable. If the farmers were satisfied with current subsidy policy and market prices, this would increase the probability of willing-to-pay more than market prices by 8 percent, 6 percent and 11 percent for urea, TSP and MoP, respectively as compared with their counterparts. The magnitude of coefficient was lower and insignificant for TSP because farmers treated this as a relatively expensive fertilizer and they wished a lower price even for ensured quality. Farmer's WTP was also positively influenced by fertilizer purchasing capability. The estimated coefficient turned out significant for TSP (Table 4). During production stages, farmers first tried to ensure the adequate use of urea as it has immediate visible effects. The use of TSP depended to an extent on farmers purchasing capability after the use of urea.

3.4 Farmer's Willingness to Pay Amount for Quality Fertilizers

The estimated predicted probability for the six WTP categories, evaluated at the sample means of the data, has been estimated and presented in Table 5 for urea, TSP and MoP. The higher predicted probability for a category indicates a strong likelihood that the average producer was willing-to-pay within that range of price. It had been revealed that the predicted probability was highest (0.283) for fourth WTP category for urea. That means farmers, in general, were willing-to-pay one to ten percent more than the market price for urea. For TSP and MoP, the maximum predicted probability was observed in second and fifth WTP category, respectively. This indicated that farmers had the most likelihood of paying in between one to fifteen percent less than market price for TSP and eleven to twenty percent more than the market price for MoP. For TSP, similar result was found by Shee et al. where farmers were willing to pay 15% lower than the current market price for local inorganic fertilizer [18].

The marginal effects of the explanatory variables on the probability of selecting a willingness-to-pay category were presented in Tables 6, 7 and 8 for urea, TSP and MoP, respectively. The sum of the marginal probabilities for six WTP categories was equal to zero (since the sum of the probabilities for the WTP categories is one, the change in probabilities for WTP categories is equal to zero) because an increase in the probability in one category could be equated by a corresponding decrease in the probability in another category.

A farmer, falling in marginal farm category, was likely to pay less than market price for all three nutrients. An average marginal farmer had the most likelihood of paying one to ten percent less than market price for urea and MoP and 16 to 30 percent less than market price for TSP. The results point to the fact that they couldn't actually afford current market prices of nutrients as relative to large farmers and wanted to pay less even for quality nutrients. Small farm category increased the probability of farmers' willingness-to-pay more than market price for quality urea and MoP while reduced the probability of willing-to-pay more than market price for quality TSP. On the other hand, medium farmer's likelihoods tended to be stronger for paying one to fifteen percent more than market price for TSP and eleven to twenty percent more than urea and MoP market price, respectively. That is, farmer's WTP for quality fertilizers vary along with the land holding class. Tsigou and Klonaris also found a positive impact of size of cultivated land on farmer's WTP [17].

Diversity in the sources of income had an impact on farmers' decision of WTP for a particular quality changes as it gives some secure income to avoid occasional financial crisis for buying fertilizers. As the ratio of off-farm income to total income increased, the probability of being willing to pay less than market prices decreased while the probability of being willing to pay an amount more than market prices for having unadulterated fertilizer increases, all other things being unchanged (Tables 6, 7 and 8). A similar result was noted for annual income of the households. To the extent that higher income households had the ability and could afford to pay more, it was expectable that they would be willing to pay a

higher price in order to receive improved attributes of inputs from the government. As contrast to product yield, product price received by the farmers had a positive significant impact on WTP levels for urea and MoP but insignificant impact on WTP level for TSP.

As the subsidy policy of Bangladesh is realized through market prices, farmer's satisfaction with subsidy is important in making the decision of WTP. This dummy variable showed significant marginal effects for urea while having insignificant marginal effects for TSP and MoP. These marginal effects for urea and MoP could be interpreted as farmer's satisfaction with subsidy policy increase the chance of being willing to pay a higher price while reduce the chance for willing-to-pay lower prices. On the other hand, in case of TSP, one plausible explanation of negative signs for higher WTP categories could be that the farmers who were satisfied with subsidy policy and current market price still wanted a lower price for unadulterated TSP. This increased their likelihood of paying first two WTP categories.

Table 5. Predicted probability of willingness-to-pay categories for fertilizers

Fertilizers	Willingness to pay categories					
	WTP=1	WTP=2	WTP=3	WTP=4	WTP=5	WTP=6
Urea	0.073	0.155	0.156	0.283	0.184	0.073
TSP	0.176	0.358	0.184	0.121	0.106	0.056
MoP	0.146	0.127	0.124	0.259	0.275	0.067

Source: Author's estimation

Table 6. Marginal effects of the factors influencing the amount of farmer' willingness-to-pay for urea fertilizer

Variables	Willingness-to-pay categories					
	WTP=1	WTP=2	WTP=3	WTP=4	WTP=5	WTP=6
Marginal farm (dummy)	0.115** (0.033)	0.289*** (0.039)	0.149*** (0.029)	-0.124** (0.045)	-0.154*** (0.046)	-0.275*** (0.039)
Small farm (dummy)	-0.120*** (0.025)	-0.107*** (0.032)	-0.059** (0.028)	0.183*** (0.053)	0.091*** (0.042)	0.013*** (004)
Medium farm (dummy)	-0.085*** (0.011)	-0.073*** (0.015)	-0.033** (0.013)	0.070*** (0.027)	0.107*** (0.049)	0.014*** (0.007)
Homestead area (decimal)	-0.003 (0.005)	-0.002 (0.006)	-0.002 (0.006)	0.004 (0.008)	0.002 (0.005)	0.001 (0.001)
Off-farm income share	-0.056*** (0.012)	-0.046*** (0.007)	-0.032*** (0.004)	0.065*** (0.030)	0.053*** (0.015)	0.016*** (0.004)
Annual income (BDT)	-0.0062** (0.0019)	-0.0037*** (0.0012)	-0.0028*** (0.0010)	0.0034*** (0.0016)	0.0075*** (0.0018)	0.0018*** (0.0005)
Product yield (ton/ha)	-0.019 (0.019)	-0.015 (0.023)	-0.009 (0.011)	0.019 (0.033)	0.013 (0.018)	0.010 (0.032)
Product price (BDT/kg)	-0.025** (0.004)	-0.022*** (0.005)	-0.013*** (0.002)	0.031*** (0.004)	0.018*** (0.006)	0.011*** (0.004)
Satisfaction with subsidy policy (1=yes)	-0.027* (0.005)	-0.031** (0.012)	-0.015** (0.005)	0.041* (0.005)	0.022** (0.082)	0.010** (0.029)
Fertilizer purchasing capability (1=yes)	-0.042 (0.036)	-0.024 (0.019)	-0.057 (0.092)	0.038 (0.026)	0.051 (0.015)	0.033 (0.027)
Credit access (1=yes)	-0.016 (0.018)	-0.018 (0.021)	-0.009 (0.020)	0.026 (0.035)	0.015 (0.017)	0.002 (0.029)
Getting expected yield (1=yes)	-0.022 (0.018)	-0.025 (0.021)	-0.012 (0.023)	0.020 (0.036)	0.026 (0.271)	0.013 (0.030)
Getting expected product price (1=yes)	-0.016** (0.003)	-0.017** (0.008)	-0.012** (0.004)	0.019** (0.004)	0.018** (0.002)	0.008** (0.003)

Source: Author's estimation

*Note: ***, ** and * represent statistical significance at 1%, 5% and 10% level, respectively; Figures within the parentheses indicate standard errors*

Table 7. Marginal effects of the factors influenced the amount of farmer' willingness-to-pay for TSP fertilizer

Variables	Willingness-to-pay categories					
	WTP=1	WTP=2	WTP=3	WTP=4	WTP=5	WTP=6
Marginal farm (dummy)	0.117***	0.042***	-0.020***	-0.042**	-0.037***	-0.059***
	(0.037)	(0.014)	(0.005)	(0.011)	(0.007)	(0.023)
Small farm (dummy)	0.033***	0.060***	-0.014***	-0.022***	-0.031***	-0.027***
	(0.015)	(0.022)	(0.002)	(0.003)	(0.014)	(0.011)
Medium farm (dummy)	-0.068***	-0.091***	0.037***	0.064***	0.032***	0.026**
	(0.022)	(0.038)	(0.005)	(0.014)	(0.005)	(0.009)
Homestead area (decimal)	-0.001	-0.006	0.002	0.002	0.001	0.001
	(0.001)	(0.053)	(0.023)	(0.035)	(0.051)	(0.043)
Off-farm income share	-0.011**	-0.057***	0.012***	0.026***	0.023***	0.006**
	(0.003)	(0.009)	(0.002)	(0.010)	(0.005)	(0.003)
Annual income (BDT)	-0.0060*	-0.0032**	0.0021**	0.0031**	0.0026**	0.0014*
	(0.0015)	(0.0012)	(0.0009)	(0.0005)	(0.0011)	(0.0004)
Product yield (ton/ha)	-0.011**	-0.048**	0.025**	0.021**	0.012**	0.001*
	(0.003)	(0.013)	(0.011)	(0.06)	(0.004)	(0.0003)
Product price (BDT/kg)	-0.018	-0.009	0.011	0.009	0.004	0.002
	(0.080)	(0.043)	(0.019)	(0.029)	(0.014)	(0.013)
Satisfaction with subsidy policy (1=yes)	0.056	0.118	-0.004	-0.022	-0.031	-0.117
	(0.037)	(0.018)	(0.001)	(0.004)	(0.019)	(0.146)
Fertilizer purchasing capability (1=yes)	-0.031**	-0.016**	0.007**	0.016*	0.013**	0.011**
	(0.007)	(0.006)	(0.002)	(0.005)	(0.006)	(0.003)
Credit access (1=yes)	-0.029**	-0.015**	0.015**	0.012**	0.010*	0.007*
	(0.013)	(0.005)	(0.007)	(0.004)	(0.004)	(0.003)
Getting expected yield (1=yes)	-0.014	-0.008	0.003	0.005	0.007	0.006
	(0.058)	(0.018)	(0.058)	(0.027)	(0.018)	(0.042)
Getting expected product price (1=yes)	-0.042	-0.022	0.021	0.018	0.015	0.010
	(0.086)	(0.028)	(0.060)	(0.054)	(0.048)	(0.035)

Source: Author's estimation

*Note: ***, ** and * represent statistical significance at 1%, 5% and 10% level, respectively; Figures within the parentheses indicate standard errors*

Table 8. Marginal effects of the factors influenced the amount of farmer' willingness-to-pay for MoP fertilizer

Variables	Willingness-to-pay categories					
	WTP=1	WTP=2	WTP=3	WTP=4	WTP=5	WTP=6
Marginal farm (dummy)	0.002**	0.168***	0.066***	-0.039***	-0.109***	-0.088***
	(0.001)	(0.036)	(0.022)	(0.006)	(0.027)	(0.023)
Small farm (dummy)	-0.155***	-0.080***	-0.042***	0.162***	0.107***	0.008**
	(0.043)	(0.034)	(0.019)	(0.054)	(0.024)	(0.006)
Medium farm (dummy)	-0.142***	-0.052***	-0.021**	0.028***	0.128***	0.059***
	(0.039)	(0.015)	(0.010)	(0.007)	(0.019)	(0.015)
Homestead area (decimal)	-0.005	-0.002	-0.001	0.004	0.002	0.003
	(0.085)	(0.038)	(0.028)	(0.068)	(0.087)	(0.047)
Off-farm income share	-0.073***	-0.044***	-0.023**	0.076***	0.035***	0.029***
	(0.013)	(0.011)	(0.008)	(0.013)	(0.007)	(0.005)
Annual income (BDT)	-0.0145***	-0.0065***	-0.0034***	0.0060***	0.0169***	0.0011**
	(0.0031)	(0.0014)	(0.0006)	(0.0017)	(0.0032)	(0.0003)
Product yield (ton/ha)	-0.013	-0.005	-0.002	0.005	0.011	0.004
	(0.032)	(0.014)	(0.002)	(0.025)	(0.032)	(0.018)

Variables	Willingness-to-pay categories					
	WTP=1	WTP=2	WTP=3	WTP=4	WTP=5	WTP=6
Product price (BDT/kg)	-0.012*** (0.003)	-0.004*** (0.001)	-0.007*** (0.002)	0.006*** (0.002)	0.013*** (0.006)	0.004*** (0.002)
Satisfaction with subsidy policy (1=yes)	-0.129 (0.131)	-0.059 (0.427)	-0.026 (0.069)	0.054 (0.055)	0.130 (0.311)	0.032 (0.016)
Fertilizer purchasing capability (1=yes)	-0.072** (0.077)	-0.054** (0.123)	-0.017** (0.064)	0.052** (0.036)	0.068** (0.130)	0.024* (0.031)
Credit access (1=yes)	-0.043 (0.029)	-0.019 (0.013)	-0.010 (0.057)	0.005 (0.042)	0.044 (0.043)	0.023 (0.258)
Getting expected yield (1=yes)	-0.051 (0.030)	-0.023 (0.035)	-0.012 (0.073)	0.004 (0.013)	0.053 (0.051)	0.028 (0.172)
Getting expected product price (1=yes)	-0.126 (0.089)	-0.066 (0.086)	-0.016 (0.029)	0.031 (0.026)	0.102 (0.305)	0.074 (0.165)

Source: Author's estimation

*Note: ***, ** and * represent statistical significance at 1%, 5% and 10% level, respectively; Figures within the parentheses indicate standard errors*

An average farmer, having the capability to purchase fertilizer during on-season was more likely to pay a higher price for all quality fertilizers. A similar pattern emerged with respect to the credit access by farmers. Credit from local, specialized banks and microfinance institutions supported the farmers to buy fertilizer in time. Farmer's expected yield and market price for output depended on many factors. When their expectation met with realty, it represents a normal production period and market situation. In that situation, they might quote their maximum willingness to pay amount as price which could be higher than market prices. In contrast, when farmers got their expected product price this also increased their probability of being willing to pay more for getting better quality fertilizers. The reverse was true for farmers who got a lower market price for product than their expectations.

4. CONCLUSION

An average farmer's WTP is influenced significantly by the farm size group which a particular farmer belongs to, annual income as well as off-farm income, product prices and financial constraints. The probability of a farmer to be willing to pay a certain price range for quality fertilizers was found to be closely associated with its' landholding class category. All farmers except marginal farmers had the most probability of being willing to pay more than market prices for unadulterated urea and MoP. But for TSP, both marginal and small farmers were likely to be willing to pay less than market price as compared with medium and large farmers. These findings have implications for farm size group specific support polices as well as subsidy on different nutrients can be re-adjusted to accommodate the extra costs for ensuring quality of fertilizers at the farm level. As off-farm income has significant impact on farmer's WTP for quality fertilizers, alternative off-farm employment opportunities should be created in the farming regions to strengthen farmer's financial capability. Moreover, Ministry of Agriculture (MoA) should separate extension workers from the fertilizer marketing by recruiting new employees for that responsibility. Instead, they should be responsible for checking the qualities of fertilizers at farm level and for providing training to farmers on how to recognize the originality of fertilizers by some indigenous ways.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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