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DETERMINANTS OF SMALLHOLDER FARMERS' WILLINGNESS -TO -PAY FOR SOYABEAN PRODUCTION INPUTS IN NORTHERN GHANA

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ABSTRACT

Farmers in northern Ghana have been cultivating soyabean with very little or no agro-inputs due to cost and limited accessibility. Use of quality agro-inputs can significantly improve the productivity of soyabean. This study assesses farmers' current use of soyabean production agro-inputs, identifies challenges faced by smallholder farmers in soyabean cultivation and assesses factors influencing farmers' willingness-to-pay (WTP) for soyabean inputs (determinants) in northern Ghana. Four hundred (400) smallholder soyabean farmers were sampled using a multi-stage sampling method. In stage one, the study area was stratified into three regions, northern, upper east and upper west regions. Stage two encompassed purposive sampling of eight (8) districts across the three northern regions famed for soyabean production. Data was collected using a semi-structured questionnaire, key informant interviews and focus group discussions were conducted.. Descriptive statistics were performed and a contingency valuation method (CVM) was used to assess key determinants that influence farmers' WTP for soyabean inputs. The results show that 74 % of the respondents were willing to pay for the soyabean inputs. However, 43, 47.3, 39.5 and 49.5 % of respondents were willing to pay at the bid price of 1.06/kg, 3.98/litre, 31.91/50kg bag and USD 5.32/100g sachet for certified seeds, herbicide (glyphosate), TSP fertiliser and inoculants, respectively. Age, household size, access to credit, participation and gains made from on-farm demonstrations significantly influenced farmers' willingness to purchase certified soyabean seeds. Factors that significantly influenced farmers' willingness to purchase glyphosate included household size, purpose and experience in soyabean production. In the case of triple superphosphaste fertiliser (TSP), access to extension services, participation and gains from farm demonstrations and distance to the nearest agro-input shop were identified as key determinants. Farmers' willingness to purchase inoculants markedly correlated with age, credit, participation in on-field demonstrations, membership of farmer-based organisation and experience in soyabean production. The results of this study form a basis for making a business case for agro-input companies to invest in the distribution and sale of the newly introduced soyabean production inputs in northern Ghana. Development and promotion of early maturing and drought tolerant soyabean varieties by the National Agricultural Research Institutes are required to enable farmers to cope with the changing climatic conditions which pose a threat to soyabean production in northern Ghana.

Key words: Grain legumes, savanna, purchasing power, agricultural inputs, farmers

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INTRODUCTION

Soyabean (Glycine max (L.) Merril) has become an important cash crop in Northern Ghana over the past decade, where it is grown mainly by smallholder farmers. Under Ghana's Medium-Term Agricultural Sector Investment Plan (METASIP), soyabean has been selected by the government as a key strategic pillar for increasing the incomes of farmers because of its potential to provide income for many rural smallholders [1]. Soyabean is an excellent source of protein, amino acids and micro-nutrients. It contains about 40 % protein, which is comparable to the protein content of animals and 20 % higher than the protein content of common beans [2-4]. Soyabean can also contribute to improving soil fertility owing to its ability to fix atmospheric nitrogen (N) in symbiotic association with rhizobia (a group of bacteria) into a form that can be utilised by plants [5]. Soyabean could be rotated with cereals with the additional benefit of reducing the need for mineral N fertiliser in the subsequent cereal crop grown in rotation. Rotating cereals with soyabeans can also control Striga, a parasitic weed that constrains cereal production in the Guinea savannas of West Africa [6,7].

The estimated annual national demand of over 297,000 tonnes for cooking oil, seasoning and animal feed cake exceeds the current supply of about 170,000 tonnes [8] www.resourcetrade.earth]. To meet the country's domestic oil and soya meal requirements for the fish and poultry industries, the country imports large quantities of soyabean oil and soya meal annually. In 2017 for instance, about 85,238 tonnes of soyabean in grain equivalent were imported into the country [2, 9].

Despite its importance, soyabean yields in Ghana are extremely low, averaging less than one tonne per hectare although yields in northern Ghana could be as high as 3 tonnes per hectare [10]. The generally poor yields of soyabean in northern Ghana are due to limited use of inputs, especially phosphorus (P) fertilisers, rhizobium inoculants and certified seeds of improved soyabean varieties [11]. Soyabean yields could be improved by inoculating the seeds with rhizobium inoculants and applying 20-30 kg/ha P. Yield increase in soyabean as high as 452 and 447 kg/ha have been obtained by applying P fertiliser and rhizobium inoculants, respectively in northern Nigeria [7]. The additive effect of both P fertiliser and inoculant resulted in a yield increase of 777 kg/ha [7]. Also, in northern Ghana, inoculating soyabean seeds with rhizobium inoculant alone resulted in a grain yield increase of about 22 % while inoculating soyabean seeds and applying 30 kg/ha P fertiliser resulted in about 122 % increase in grain yield [12].

Farmers' limited use of inputs is partly due to the lack of access to inputs from agro-input dealers: farmers are not able to find the inputs they need, and agro-dealers are not stocking inputs because of a lack of information about demand. This study was therefore undertaken to identify and evaluate key determinants of smallholder farmers' willingness to purchase newly introduced soyabean inputs in northern Ghana. Specifically, this study sought to (i) assess farmers' adoption and current use of newly introduced soyabean agro-inputs and (ii) assess factors influencing farmers' willingness to pay for soyabean inputs in northern Ghana. The results of this study form a basis for encouraging agro-input companies to invest in the distribution and sale of newly introduced soyabean agro-inputs in northern Ghana.

MATERIALS AND METHODS

The study was conducted in the Northern, Upper East and Upper West Regions of Ghana. A sample size of 400 smallholder soyabean farmers was used for the study. Multi-stage sampling was employed. In stage one, the study area was stratified into regions. Stage two involved purposive sampling of eight (8) districts across the three northern regions famed for soyabean production. This was done in consultation with the Ministry of Food and Agriculture (MoFA), the N2Africa Project (www.n2Africa.org) and ACDI-VOCA/ADVANCE II project (key informants) who are key stakeholders in the promotion of soyabean production and technology transfer in northern Ghana. Four districts were selected from the northern region while two each were selected from the Upper East and Upper West regions. The third stage involved random sampling of 16 communities and 400 respondents. Data was collected using a semi-structured questionnaire, key informant interviews and focus group discussions involving farmer-based organisations. Data collected included household characteristics, farmers' awareness of newly introduced inputs and use, farmers' constraints to soyabean production and farmers' willingness to purchase inputs. Data were analysed by both descriptive and inferential statistics such as percentages, frequency distribution table, Contingent Valuation Method (CVM) and binary logistic regression model using the Stata software (StataCorp, USA).

The Contingent Valuation Method (CVM) is a well-established technique to measure the benefit from changes in the quality of technology, intervention, or the environment [13]. Instead of inferring Willingness-To-Pay (WTP) for a specified good or Willingness-To-Accept (WTA) a specified good from observed behaviour in regular market places, this approach asks people to directly report their WTP for a

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specified good or WTA a specified good [14]. The "Yes/No" response to the WTP questions, the offered amount and the additional information about the respondents' characteristics are used to fit binary response models such as Probit/Logit [15]. Farmers' decision to pay or not to pay for better use of agro-inputs at any time is influenced by a complex set of socio-economic, socio-demographic, institutional and biophysical factors. Modelling farmers' response to agro-inputs use is important both theoretically and empirically [7, 13].

Willingness-To-Pay value is in the form of a binary choice dependent variable, either 1 for the 'YES' response or 0 for the 'NO' response. Also, the bid amount is varied across respondents and the only information obtained from each individual is whether their maximum WTP is above or below the bid offered. In this study, a logistic regression model was employed to evaluate factors influencing WTP [15]. Considering the WTP estimation in the logistic distribution function, the probability of WTP for the offered bid is estimated as:

$$p_i = \frac{e^{z_i}}{1+e^{z_i}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where p_i is the probability of WTP for the offered bid was estimated as:

$$Z_i = \beta_0 + \sum \beta_i x_i + \varepsilon_i \dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where, Z_i is the probability of WTP for the price; x_i is a vector of explanatory variables including the bid offered, socio-economic variables, β_0 is the intercept, β_i is the unknown coefficient of estimated parameters and ε_i is the random error.

RESULTS AND DISCUSSION

Farmers' socio-demographic characteristics and awareness of production inputs

Results of the gender distribution of respondents show that about 69 % of respondents were male farmers and 31 % were females (Table 1). Age is an important socio-demographic variable as it relates to labour input in smallholder agriculture. The mean age obtained for the study was 42 years, with a maximum and minimum of 81 and 16 years, respectively. The results indicate that the average household size in the survey was nine (9) people, with a minimum of one person and a maximum of twenty (20) people (Table 1). In terms of experience in the cultivation of soyabeans, the results show that farmers in the study areas had a minimum of one (1) year, a maximum of 25 years with an average of 5 years of

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experience in soyabean cultivation (Table 3). This indicates that soyabean production assumed commercial status two decades ago due to its promotion by development initiatives and the Ministry of Food and Agriculture in northern Ghana.

Certified seeds of improved varieties used by respondents was the highest (74 %) known agro-input for soyabean production followed by herbicides (glyphosate) and insecticide was the least (22 %) known input (Figure 1). The major inputs used by farmers during the 2015 cropping season include certified seeds (45.5 %), herbicides (46.8 %), triple superphosphate fertilisers (TSP) (35.5 %) and inoculants (29 %) (Figure S1). About 96 % of the respondents used their own seeds (the majority of which were improved seeds) saved from previous harvests for planting. It is a common practice among farmers in Ghana to use 'own seeds' saved from the previous harvest for planting. The herbicide commonly used in soyabean production is glyphosate which has different trade names, but farmers in Ghana popularly call them "kondem" meaning complete/total weed killer. It is applied as a pre-emergence herbicide in soyabean fields to control weeds which can compete with the crops for water, sunlight and nutrients at the early stages.

Characteristics of farmers such as culture and ethnicity, wealth, education and gender play a significant role in the adoption of technology [16]. The mean age of 42 years of respondents suggests that the majority of the farmers were youth which is very important in soyabean cultivation due to the labour-intensive nature of the enterprise. Hassen *et al*. [17] found age as an important determinant for the adoption of technology as young farmers are less averse to taking risks and have more years to plan and stay in farming than the aged [18]. The study revealed that the average years of experience in the cultivation of soyabean by farmers in northern Ghana was five years. Although soyabean has been introduced in Ghana since 1909 [19], it was only recently (from 2010) that its production assumed commercial prominence as a result of its promotion by development initiatives and the N2Africa project backed by the Ministry of Food and Agriculture (MoFA). Martey *et al.* [20] hypothesised that farmers having more years of experience are expected to adopt improved maize varieties. About 50 % of the respondents had no formal education suggesting that soyabean cultivation in northern Ghana is done mainly by farmers with a very minimal level of formal education, which has severe implications for technology adoption.

The higher degree of awareness of improved seeds and herbicides among the soyabean farmers could be ascribed to farmers' familiarity with similar inputs and modes of application for other crops, particularly maize and rice. According to Rogers [21] and Mugwe *et al.* [22], adopters' initial exposure to innovation enables

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them to form some attitudes toward it by seeking more information about how it works, its benefits and the costs associated with it. Although farmers were highly aware of the use of improved seeds for planting, the majority of them relied on seeds saved from the previous harvest for planting. This was not surprising since, in cowpea, MoFA reported about 75 % of farmers used saved seeds while about 25 % of farmers purchased seeds from the grain market or from other farmers [23]. Reasons farmers adduced for using saved seeds include the high cost of certified seeds. The most frequently used improved variety by farmers was Jenguma, an improved dual-purpose soyabean variety developed by the Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research (CSIR) in Ghana and it is very popular among soyabean farmers in northern Ghana. Its popularity emanates from its ability to withstand shattering. In northern Ghana, soyabean is the last crop to be harvested by farmers and so farmers prefer non-shattering varieties, so they can have enough time to harvest their other crops such as maize, sorghum and cowpea which are considered as food security crops before they harvest the soyabean. The relatively low awareness among farmers on insecticides as input for soyabean production could be ascribed to soyabean's less susceptibility to insect pest attack. Soyabean is a relatively new crop cultivated in commercial quantities in northern Ghana and is less susceptible to insect attack and therefore it is hardly sprayed with insecticide.

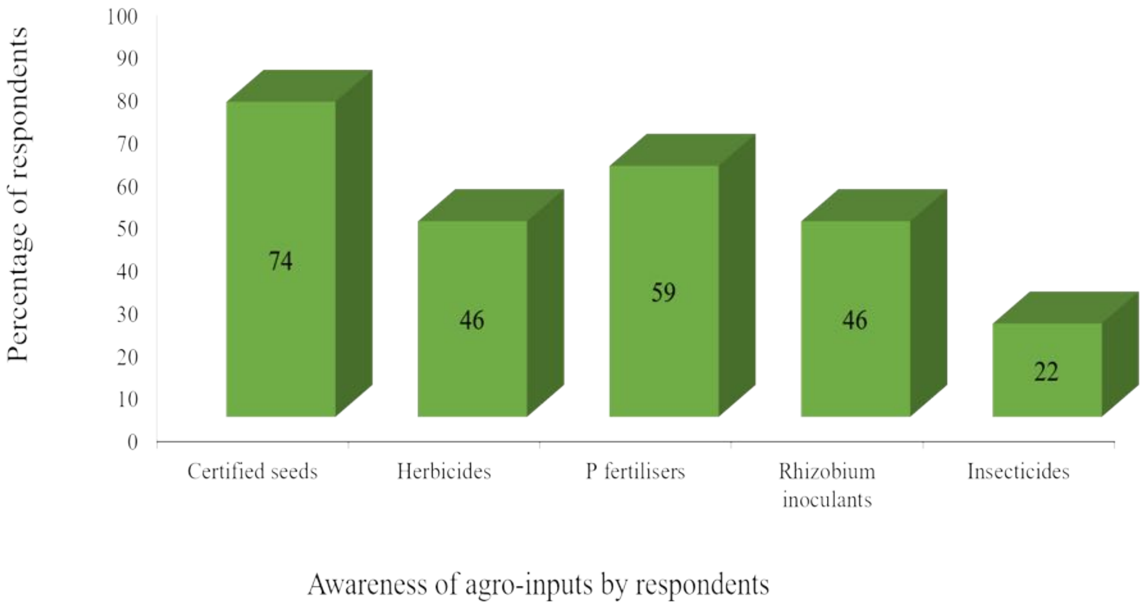

Figure 1: Farmers awareness of soyabean inputs

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Farmers' sources of information on soyabean production inputs and challenges

The study revealed that, MoFA was the major (20.8 %) source of farmers' information on fertiliser use while non-governmental organisations (NGOs) topped as the major source of information on improved seeds (21.8 %) and inoculants (15 %). Agro-input dealers and local radio stations were major sources of farmers' information on herbicides. Agro-input dealers are also major stakeholders in the delivery of agricultural information to farmers especially in most rural areas where agricultural extension agents are rare (Figure 2). The study revealed that, out of the 400 respondents, 268 representing (67 %) had ever attended or participated in a soyabean on-field demonstration activity (Figure S2). The main challenges confronting farmers were frequent droughts, difficulties in harvesting and threshing and access to tractor for ploughing their fields. Scarcity of labour, high cost of agro-inputs, lack of remunerative market for produce, pod shattering, difficulty in planting, access to land, pest and diseases ranked in a respective manner as key challenges to farmers (Table S1).

Source of information is critical for adoption of agricultural inputs by farmers. Agro-input dealers are the major source of information for most agro-inputs, particularly herbicides in the study areas. In rural communities, agro-input dealers are the first people farmers encounter whenever they need any information on agricultural inputs as found in the study areas. Radio as a major source of information by farmers on herbicides is not surprising because herbicides utilisation is being promoted by private agro-input businesses who normally advertise on local radios. This is consistent with reports by Oti-Agyekum *et al.* [24], who suggests local media as the main source of farmers' information in the use of faecal compost as organic fertiliser in crop production. The Ministry of Food and Agriculture was cited as a major source of information on fertiliser use by farmers and this can be linked to the fact that agricultural development is markedly spearheaded by the state and agro-inputs including mineral fertilisers by MoFA. In northern Ghana, NGOs are major stakeholders in the promotion and utilisation of agro-inputs including the use of improved varieties and inoculants through field demonstrations. It was, therefore, not surprising that they were cited by farmers as the major source of information on the use of improved seeds and inoculants.

The farmers ranked frequent drought as a key production challenge and this may be attributed to the adverse effect frequent droughts have on soyabean yield as the crop is grown under rain-fed conditions. Fluctuating rainfall under changing climate seriously affects yields. Planting of seeds is dependent on adequate soil moisture for germination at the right time. Therefore, urgent attention needs to be

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paid to time of planting. Meda Grow [25] reported threshing of soyabean as a major challenge faced by soyabean farmers which sometimes makes its cultivation less attractive to farmers. The very low levels of mechanisation in the production of soyabean from production to post-harvest processing makes small- and medium-scale soyabean production unattractive to the youth who constitute the majority of the smallholder farmer population.

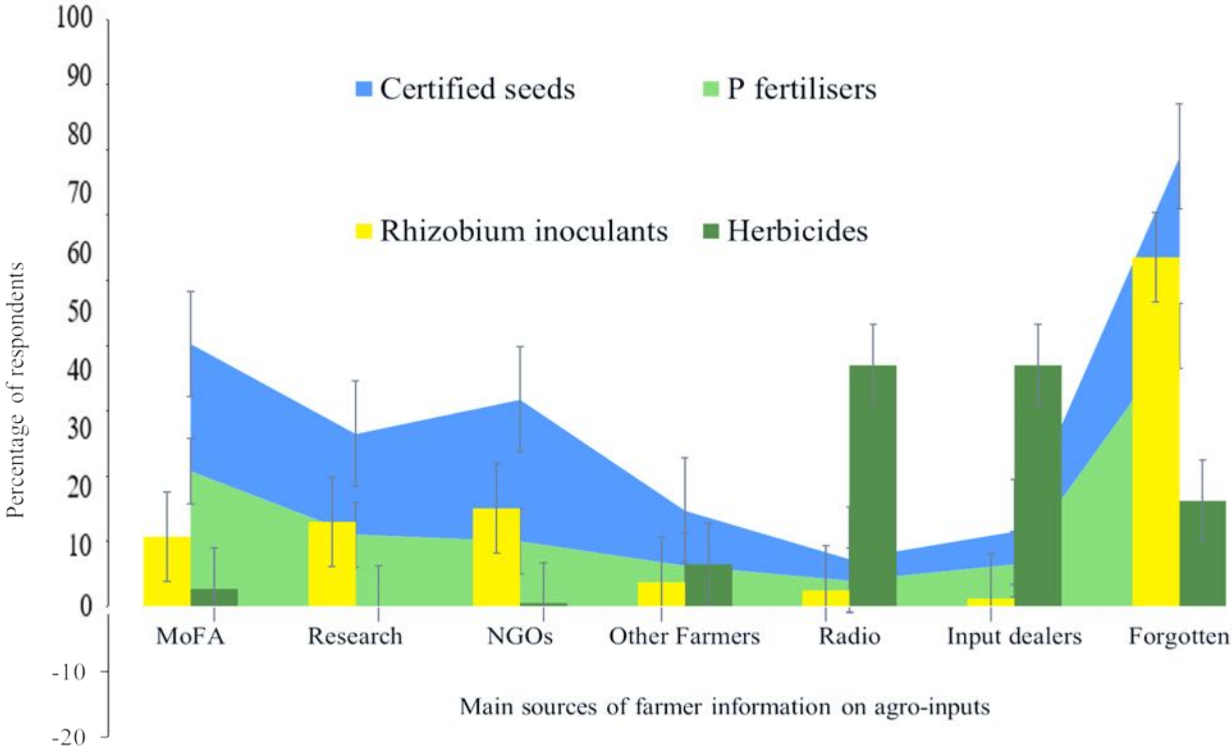

Figure 2: Farmers sources of agro-inputs information

Determinants of farmers' willingness to pay for soyabean inputs

The results show that, nearly three quarters (74 %) of the respondents were willing to pay for the newly introduced soyabean inputs, while 26 % were not willing to pay for soyabean inputs (Figure 3). In a similar study, Gockowski and Ndoumb [16] reported that, most farmers were willing to pay for water use in irrigation scheme than those who were unwilling to pay. The results also show that, more people (83 %) in the Upper East and Upper West regions were willing to pay for soyabean inputs than in the Northern region where only 66 % of the respondents indicated they were willing to pay for soyabean inputs. The willingness of more farmers in the Upper East and Upper West regions to pay for the inputs may be attributable to farmers' understanding of the poor nature of soils and erratic rainfall pattern in the area which results in lower yields than in the Northern Region where better soils and rainfall pattern often result in higher yields [8]. Male and female farmers'

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willingness to pay did not differ much (Table 2) with responses of 72 and 75 %, respectively for male and female farmers.

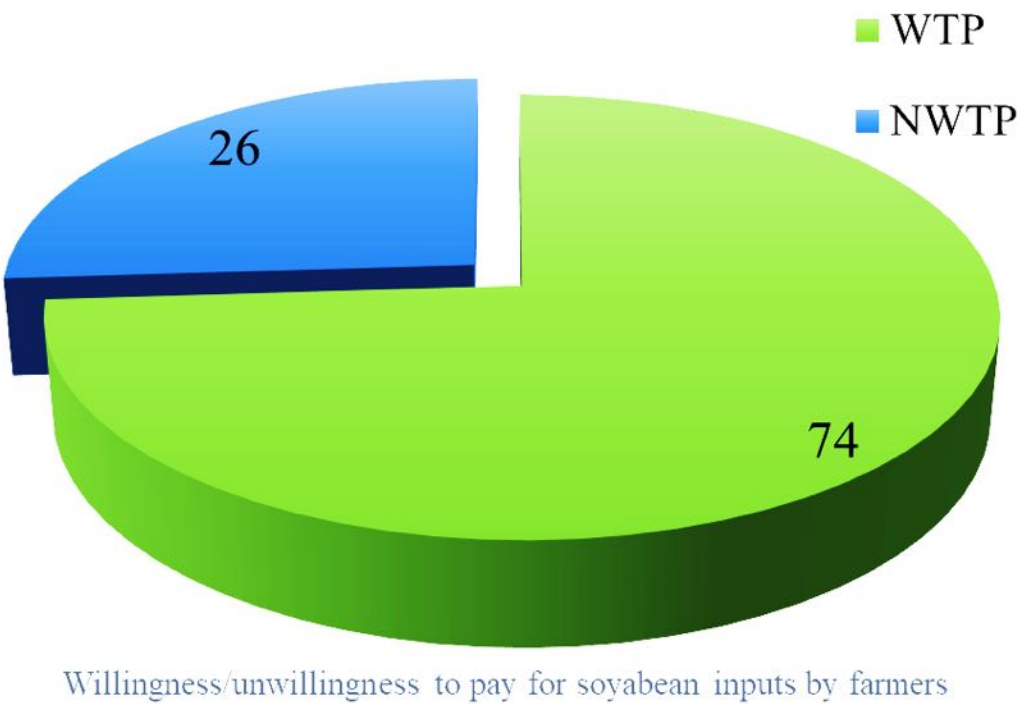

Figure 3: Farmers' willingness to pay for soyabean inputs. Values are measured in percentage (%)

Also, results show 43, 47.25, 39.5 and 49.5 % of the respondents were willing to pay at the bid prices of USD 1.06/kg, USD 3.98/litre, USD 31.91/50kg bag and USD 5.32/100g sachet for certified seed, herbicides, TSP fertiliser and inoculants, respectively. At the same time, 3, 4, 21.25 and 8.75 % of farmers interviewed were not willing to pay any amount at all for certified seeds, TSP fertiliser, herbicides and inoculants, respectively (Table S2). The result shows that the mean amount that the farmers were WTP for certified seeds was $213.30, for glyphosate $189.03, for TSP fertiliser $232.45 and for inoculants was $178.05 per hectare.

Further, the study probed the reasons why some respondents were unwilling to pay for soyabean inputs (Figure S3). The main reason for their unwillingness was the high price of the inputs. However, for inoculants, lack of knowledge in their application and storage were additional reasons adduced by farmers for their unwillingness to purchase them. Rhizobium inoculants require a cold chain for their handling and storage, posing a challenge for smallholder farmers in the most rural part of northern Ghana where the crop is cultivated since most farmers in these areas do not have access to cold storage. Also, being a relatively new input, farmers require training in their handling, storage and application before they can be confidently handled by them. Cash constraints, non-availability in the market and the ability of soyabean to grow without fertiliser were the additional reasons respondents gave for not willing to pay for TSP fertiliser (Figure S3).

The dependent variable used in this model was a dummy variable that respondents stated their WTP (by Yes or No responses). Ten (10) independent variables were used to determine farmers' WTP for four agro-inputs including certified seeds, glyphosate, TSP fertiliser and inoculants (Table 3). For certified seeds, the significant variables were the age of the farmer (10 %), access to credit (10 %), household size (5 %) and participation in soyabean on-field demonstrations and the gains made from them (1 %). Experience in soyabean production (5 %), household size (1 %) and purpose of soyabean production (1 %) were key determinants of willingness to pay for glyphosate. Access to agricultural extension services (10 %), participation in soyabean on-field demonstrations (5 %), farmers' years of experience in soyabean production (5 %), lessons learnt from the demonstrations (1 %) and distance to the nearest agro-input dealers influence their overall WTP for triple super phosphate (TSP)-blended fertiliser. Age (10%), membership of farmer-based organisation (FBO) (5 %), access to credit (1%) and farmers' years of experience in soyabean production (5%) were found to significantly influence WTP for inoculants.

Access to extension service and credit, household size, participation in the demonstration, membership in FBO and nearness to an agro-input store among others were found as key determinants of farmers' WTP for soyabean inputs. Yu and Nin-Pratt [26], studying fertiliser adoption in Ethiopia's cereal production found extension services as a key determinant of fertiliser adoption among smallholder farmers. Motuma *et al.* [27] reported that participation in on-field demonstration trials and farmer field schools facilitate diffusion of knowledge and information about new agricultural technologies among farmers, resulting in their wider diffusion and adoption. Studies by Olwande and Mathenge [28] and Mercer-Quarshie and Nsowah [29], reported that proximity to agro-input market/dealer and poor road network increase transaction and transport costs of acquiring farm inputs which can limit their usage among smallholders. Swanby [30] also found membership in FBOs has a strong positive effect on the adoption of chemical fertilisers among smallholder farmers. Thus, being a member of an FBO, having access to extension services and agro-input market are likely to increase farmers' WTP for agro-inputs.

Access to credit is one of the major challenges faced by smallholder farmers, which limits farmers' ability to purchase agro-inputs due to lack of collateral

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security [1, 31]. Whitaker *et al.* [32] and N'Banan *et al.* [33] indicated that, credit as an institutional factor provides the necessary capital to facilitate farmers' potential to afford a given technology and maintain its usage. Farmers with large household sizes are less likely to use herbicides as they have easy access to family labour to assist in weeding and manual pest control. N'Banan *et al.* [33] reported that, household size determines agricultural labour, farm size and amount of produce retained for household consumption.

Farmers' unwillingness to pay for agro-inputs like inoculants and phosphorus fertiliser in soyabean production varied across the study areas ranging from high cost to availability and knowledge of their use. Soyabean in the past has been promoted as a crop which requires relatively little input. However, while soyabean like any other grain legume can access atmospheric nitrogen through symbiosis with soil-inhabiting bacteria-rhizobia and therefore requires minimal nitrogen fertiliser input, this process can be limited by deficiency of other nutrients, particularly phosphorus fertilizer [8, 34]. Farmers' unwillingness to purchase herbicides for soyabean cultivation stems from their preference for manual weeding (with a hoe) which simultaneously loosens the soil, increases the soil volume and enhances moisture retention [35]. Other reasons are the availability of family labour and the fear of the adverse effect of chemicals on soil health and farm produce. Some farmers attributed their unwillingness to purchase certified seeds to their 'no need for new variety'; thus, as long as they could select good seeds from their previous harvests, they are unwilling to purchase new seeds. This thinking is not peculiar to soyabean farmers in northern Ghana as Karikari *et al.* [36] similarly reported that about 75 % of farmers who used modern cowpea varieties used 'saved seeds' from their previous harvests while 25 % procured their seeds from the grain market and family members.

CONCLUSION

The study suggests that, previous participation in soyabean on-field demonstration and application of similar inputs such as certified seeds, fertilisers and herbicides could play a major role in creating awareness and interest in the use of soyabean inputs such as certified seed, TSP, inoculants and herbicides. Membership of FBOs was found to be a significant determinant of WTP for soyabean inputs, suggesting the need for MoFA and other NGOs involved in the dissemination of soyabean technologies to encourage membership of FBOs among farmers to enhance information sharing especially on soyabean inputs. Membership of FBO will also facilitate farmers' access to agricultural extension services and credit to purchase soyabean inputs and labour-saving tools such as tractors and threshers where group members collateralise for each other and render services at a fee.

Although farmers were WTP for soyabean inputs as a result of their previous participation in on-field demonstrations by the N2Africa and other projects, their low response at the bid price implies they consider the bid prices to be too high due to limited access to credit, suggesting the need for government to subsidise soyabean inputs to boost production as is being done for other crops.

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Author Contribution

Samuel Adjei-Nsiah conceptualised the study design, proposed the methodology and paid for the software. Kwasi Gyan led the field data collection, collation and drafted the manuscript. John K. Ahiakpa cleaned and analysed the data, revised the manuscript and served as the corresponding author. Dessalegn Anshiso Debo and Theresah Ampadu-Boakye validated the econometric model and performed the econometric analysis. All authors read and reviewed the final manuscript.

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Table 1: Socio-economic/demographic characteristics of respondents

Description of variable	Frequency		Percentage
Sex of respondents			
Male	277		69.25
Female	123		30.75
Educational status			
No formal education	230		57.5
Basic	98		24.5
Secondary	50		12.5
Tertiary	22		5.5
Marital status			
Married	355		88.75
Single	34		8.50
Divorced/ separated	3		0.75
Widowed	8		2.00
Variable description	Maximum	Minimum	Mean
Age (number of years)	81	16	42
Household size	20	1	9
Experience in soyabean production (years)	25	1	5
Distance to nearest agro-input market (km)	35	0.5	5

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Table 2: Willingness to pay for soyabean inputs by region and sex

Region	Yes		No		
	Frequency	%	Frequency	%	Total (%)
Northern	140	66	72	34	100
Upper East	93	83	19	17	100
Upper West	63	83	13	17	100
Gender					
Male	208	75	69	25	100
Female	88	72	35	28	100

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Table 3: Key determinants of farmers' Willingness to pay for soyabean agro-inputs in northern Ghana by contingency valuation

Variables	Certified seeds		Glyphosate		TSP fertiliser		Inoculants	
	Coefficient (St.Dev)	Dy/dx (ME)	Coefficient (St.Dev)	Dy/dx (ME)	Coefficient (St.Dev)	Dy/dx (ME)	Coefficient (St.Dev)	Dy/dx (ME)
Age	.0260* (.0205)	.0423	.0013 (.0064)	.0686	-.0074 (.0061)	-.0838	-.0255* (.0064)	-.0218
Household size	-.0713*** (.0211)	-.0683	-.0701** (.0342)	-.0119	-.0023 (.0155)	.0027	.02404 (.0430)	.0433
Group membership	.1417 (.2961)	.1064	.2778 (.2303)	.1650	.33225 (.2212)	.1297	.5625** (.2228)	.1908
Access to extension	.0761 (.2718)	-.0475	0.0254 (0.2186)	.0627	-.3726* (.2100)	.1102	.0692 (.2149)	.0186
Access to credit	-.3071* (.1807)	.0513	-.2063 (.1297)	-.0194	-.0702 (.1231)	-.0417	-.3563*** (.1332)	-.0722
Purpose of soyabean production	.0558 (.0784)	.1308	.1372** (.0604)	.0879	.0827 (.0594)	-.0245	-.0515 (.0605)	.0657
Participation in soyabean demo	1.187*** (3407)	.0888	.0781 (.2632)	.1732	-.6981*** (.2609)	.0314	.4584 (.2641)	.0455
Gains from demo participation	-.3079*** (.0919)	-.0804	-.0107 (.0780)	.0209	2533*** (.0758)	.06 15	.0758 (.0752)	.0546
Distance to input market	-.0151 (.0267)	-.0680	-.0099 (.0204)	.065 7	-.0526** (.0226)	- .03 02	.0089 (.0205)	0.234
Soya farming experience	.0183 (.0290)	.047 5	.1027*** (.0236)	- 0.12 51	.0158 (.0217)	.05 57	.0489** (.0226)	0.123
Constant	11.348***		8.234***		5.323***		10.095*** (.0778)	

	(0.0622)	(.0344)	(.0567)	
Log likelihood	-101.814	-79.2585	-98.443	-93.567
Pseudo R2	.1934	.2613	.2093	.2345
LR chi2(10)	83.06	109.45	99.08	112.06
Prob > chi2	0.0000	0.0000	0.0000	0.0000
N	400	400	400	400

*, **, and *** indicates 10 %, 5 %, and 1 % significant levels; N is number of observations. Dy/dx (ME) refers to the marginal effect

Table S1: Ranking of challenges in Soyabean production in northern Ghana

Challenges	Mean	Rank
Frequent droughts	4.63	1
Difficulties in harvesting and threshing	4.67	2
Access to tractor services	4.98	3
Unavailability of labour	5.03	4
High cost of soyabean inputs	5.19	5
Low marketing price	5.31	6
Pods shattering	5.48	7
Difficulties in planting	6.34	8
Access to land	6.49	9
Diseases and pest	6.89	10

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Table S2: Willingness to pay for agro-inputs at bid price

Inputs	Bid price (USD)	Frequency	Percentage
Certified seed (per kg)	1.06 (4)*	172	43.0
Herbicides (per litre)	3.98 (15) *	189	47.3
TSP (per 50kg)	31.91 (120) *	158	39.5
Inoculants (100g)	5.32 (20) *	198	49.5

* Ghana Cedis (GHS) equivalent. 1 USD equivalent to 3.76 GHS (October, 2015 exchange rate, Bank of Ghana)

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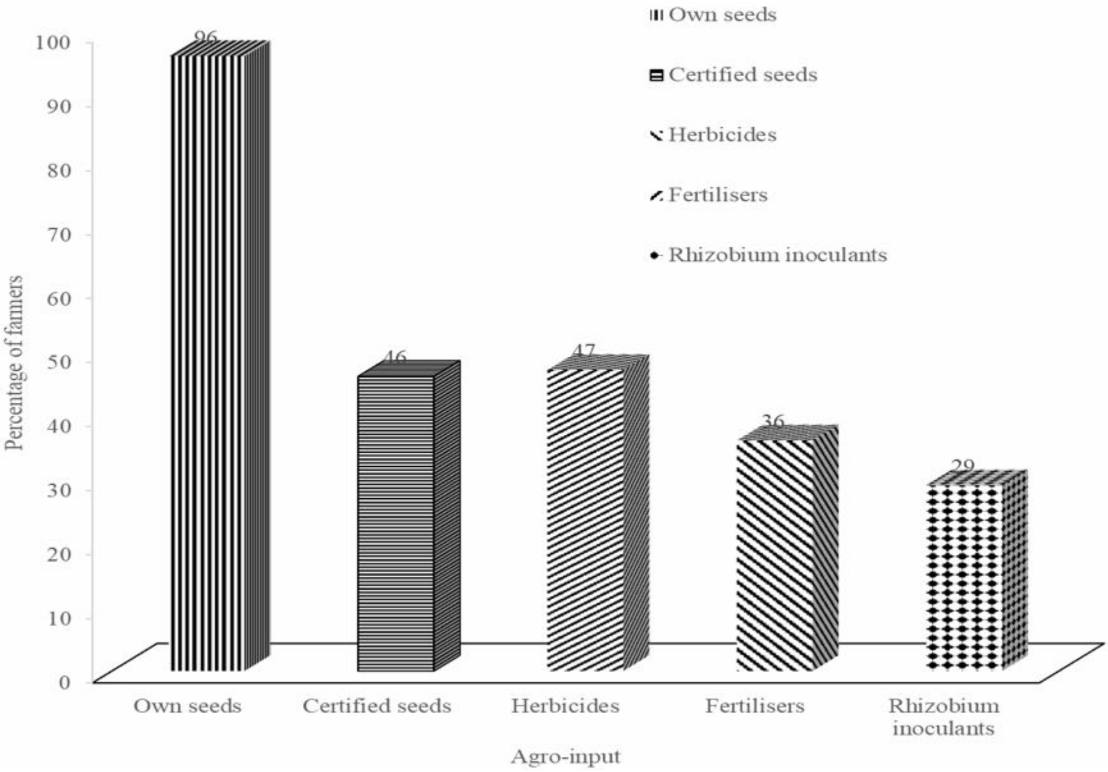

Figure S1: Agro-inputs used in soyabean production

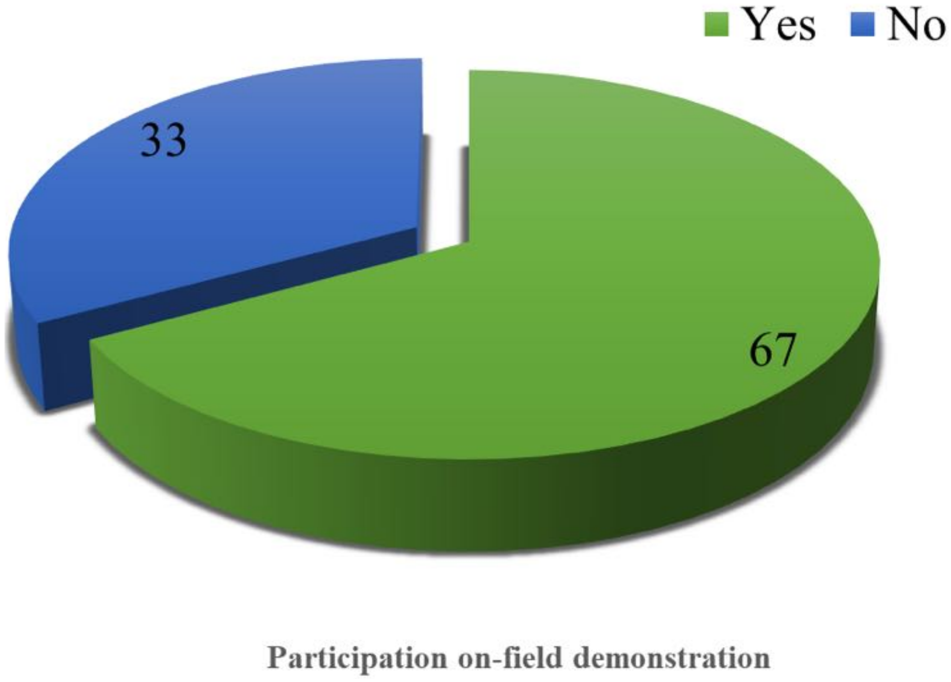

Figure S2: Respondents participation in soyabean on-field demonstration. Values are measured in percentage (%)

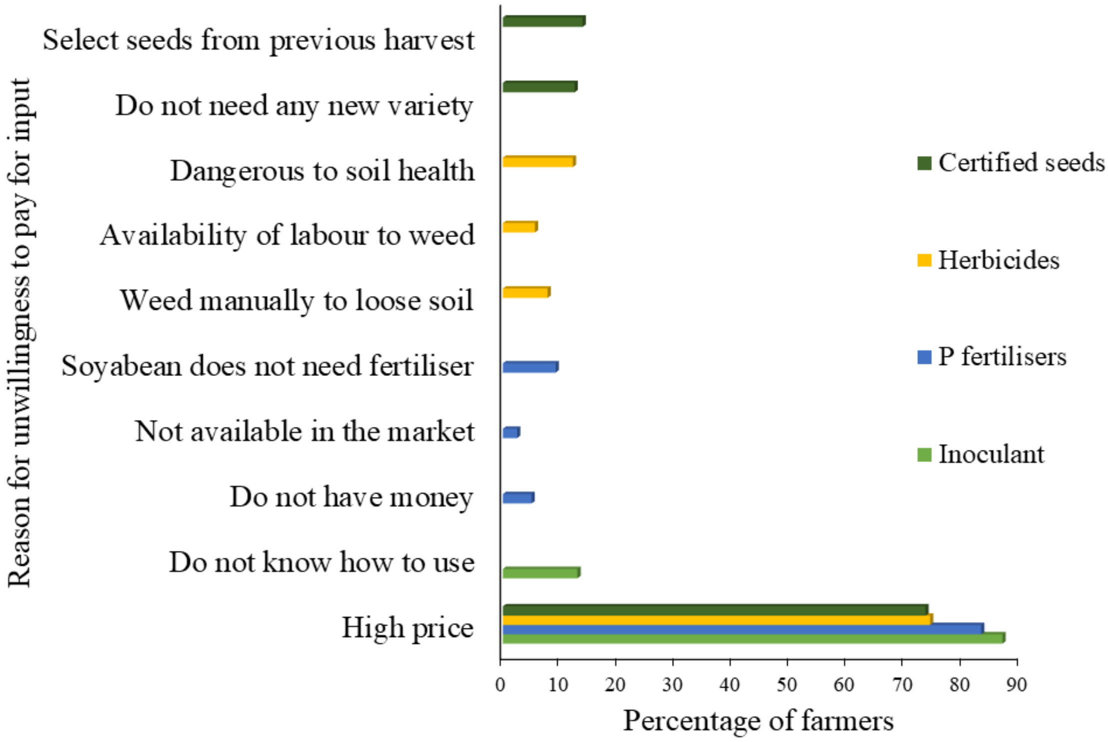

Figure S3: Reasons for unwillingness to pay for agro-inputs

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