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INFLUENCE OF SOCIOECONOMIC, PRODUCT AND SERVICE QUALITY ATTRIBUTES ON CERTIFIED SWEETPOTATO SEED USE IN UGANDA

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ABSTRACT

The sweetpotato (*Ipomoea batatas* (L) Lam) seed system in Uganda is transiting from an informal to a formal setting, by integrating the use of certified sweetpotato seed (CSS) in the production system. Use of CSS enhances productivity by controlling the spread of the sweetpotato virus disease (SPVD) and seed degeneration. However, owing to the limited understanding of product and service quality attributes by farmers, the sustained use of CSS has remained dismal. The objective of this study was to investigate the contribution of farmer socioeconomic characteristics; product and service quality attributes to sustained use of CSS in Uganda. A total of 289 sweetpotato farmers from Central (Mpigi district) and Northern (Omoro district) Uganda, representing low and high SPVD prevalence zones, respectively, were interviewed to obtain information on product attributes (acceptability, accessibility, affordability and awareness) and service attributes (reliability, tangibility, assurance, responsiveness and empathy). Data were subjected to a Double Hurdle analysis. Results revealed that users of CSS scored more for product and service quality attributes, than their non-user counterparts. There was a highly positive correlation between use of CSS and education level in central; but a modestly positive in northern Uganda. Reliability ($\beta = 0.289, 12.612$) positively drove the use and extent of use of CSS; while for tangibility ($\beta = -0.302, -11.742$), the converse was true. Also, acceptability ($\beta = 0.469, 22.048$) increased the use and extent of use of CSS; yet accessibility increased only the use in both locations ($\beta = 0.268$). Thus, efforts to scale-out CSS use in the study areas should focus more on affordability, awareness, assurance and empathy based on location; putting into consideration education level and group membership differences.

Key Words: Accessibility, group membership, reliability, tangibility

RÉSUMÉ

Le système de semences de patate douce (*Ipomoea batatas* (L) Lam) en Ouganda est en train de passer d'un cadre informel à un cadre formel, en intégrant l'utilisation de semences certifiées de patate douce (CSS) dans le système de production. L'utilisation de la CSS améliore la productivité en contrôlant

la propagation de la maladie virale de la patate douce (SPVD) et la dégénérescence des semences. Cependant, en raison de la compréhension limitée des attributs de qualité des produits et services par les agriculteurs, l'utilisation durable de la CSS est restée lamentable. L'objectif de cette étude était d'examiner la contribution des caractéristiques socioéconomiques des agriculteurs et des attributs de qualité des produits et services à l'utilisation durable de la CSS en Ouganda. Un total de 289 producteurs de patate douce du district de Mpigi et district d' Omoro de l'Ouganda, représentant respectivement des zones de prévalence de SPVD faible et élevée, ont été interrogés pour obtenir des informations sur les attributs du produit (acceptabilité, accessibilité, abordabilité et sensibilisation) et les attributs du service (fiabilité, tangibilité, assurance, réactivité et empathie). Les données ont été soumises à une analyse de Double Hurdle. Les résultats ont révélé que les utilisateurs de CSS ont obtenu de meilleurs résultats pour les attributs de qualité des produits et des services que leurs homologues non utilisateurs. Il y avait une corrélation très positive entre l'utilisation de CSS et le niveau d'éducation dans le district de Mpigi, mais une corrélation légèrement positive dans le district d' Omoro. La fiabilité (b = 0,289, 12,612) a positivement influencé l'utilisation et l'étendue de l'utilisation de CSS, tandis que pour la tangibilité (b = -0,302, -11,742), l'inverse était vrai. De plus, l'acceptabilité (b = 0,469, 22,048) a augmenté l'utilisation et l'étendue de l'utilisation de CSS, alors que l'accessibilité n'a augmenté que l'utilisation dans les deux endroits (b = 0,268). Ainsi, les efforts visant à étendre l'utilisation de CSS dans les zones d'étude devraient se concentrer davantage sur l'accessibilité, la sensibilisation, l'assurance et l'empathie en fonction de l'emplacement, en tenant compte du niveau d'éducation et des différences d'appartenance à un groupe.

Mots Clés : Accessibilité, appartenance à un groupe, fiabilité, tangibilité

INTRODUCTION

Acquisition of sweetpotato (*Ipomoea batatas* (L) Lam) planting materials in Uganda is increasingly constrained, resulting in some elite varieties being lost due to devastating sweetpotato virus disease (SPVD); owing to repeated use of vines, without checking for quality status (Mukasa *et al.,* 2016). Generally, research in Uganda has revealed that high virus disease prevalence occurs in the western and central regions; and low in eastern and northern regions (Aritua *et al.,* 2007). The level of use of certified sweetpotato seed (CSS) in the country is still low, despite the associated yield advantages (Adikini *et al*., 2015) and the crop being increasingly grown for commercial purposes due to its early maturity, industrial quality and nutritive value (UBOS, 2019).

Certified seed refers to planting material of a given variety, produced under strictly approved standards, to maintain variety purity and freedom from pests and diseases (Mukasa *et al*., 2016). Certified sweetpotato seed, together with the actors involved in its production and delivery to farmers, constitute what is known as a formal CSS seed system. This contrasts with the farmers' own indigenous and less bureaucratic system, commonly known as the informal seed system (Clark *et al.,* 2012).

Among all vegetatively propagated food crops in Uganda, CSS represents growth trends due to efforts by stakeholders to promote its use, due to its associated yield and quality advantages. However, the purchase of vegetatively propagated seed in emerging market economies, is particularly difficult due to non-existence of service structures in the country (Almekinders *et al.,* 2019a). This emanates from their bulkiness and high perishability, plus farmers being unable to distinguish CSS from non-certified materials (FAO, 2010; Almekinders *et al.,* 2019b).

The limited role of the formal seed system in availing seed in Uganda is explained in various ways. Some studies point to constraints on the supply side, like high seed production costs and logistical problems (McGuire and Sperling, 2016); while others emphasise

constraints on the demand side, like information asymmetries and anti-cyclical demand (Almekinders *et al.,* 2019a). In addition, most farmers do not purchase seed from formal sources because they lack investment capacity and are invariably risk-averse (Almekinders *et al.,* 2019b). Also, farmers usually prefer local varieties because of their (local varieties) better adaptation to prevailing agroecological and socio-economic conditions; which often contrasts with most seed supplied by the formal CSS system.

Fortunately, in Uganda, the situation is gradually changing, as volumes of CSS become readily available, due existence of the necessary delivery, accompanied information dissemination pillars (Namanda *et al.,* 2019). This has provided an alternative to the informal seed system; but the farmers' purchasing power is still limiting (Namanda *et al.,* 2011).

The use and extent of use of CSS also seems to be affected by the socioeconomic characteristics of the sweetpotato farming communities and other stakeholders in the potato production value chain. As such, basing on purchaser characteristics, assessing for product and service quality attributes is crucial if effective market strategies are to be established (Mirza *et al*., 2021).

Parasuraman *et al.* (1988) identified the most important aspects of service quality elements; namely tangibility, assurance, empathy, responsiveness and reliability. They developed it into a scheme called SERVQUAL. Their work has been adapted to examine service quality in various environments; and positively influences satiety and use. The objective of this study was to investigate the contribution of farmer characteristic, product and service quality attributes in the sustained use of CSS in Uganda.

METHODOLOGY

Study area. This study was conducted in central and northern Uganda; in the districts of Mpigi and Omoro; which lie in the high and low SPVD prevalence zones, respectively. The study regions are characterised by annual average rainfall in the order of 1200 and 1414 mm. Mean annual temperatures are 24.73 and 22.2 ^{O}C, respectively. Although virtually all SW growers in Uganda depend on vegetative seed for production, some farmers in these districts had been previously exposed to CSS interventions; and with high levels of tuber yields for both home consumption and for the market.

Sampling techniques. A multistage sampling technique was adopted in this study; whereby three sub-counties in each study district were purposively selected. Within each sub-county, three villages were randomly selected to give a total of 18 study villages. With the help of local leaders (village chair persons) and farmer group leaders, all households and sweetpotato farmers in the respective villages, were identified and listed, leading to a total population of 1,103 farmers. Then, using Krejcie and Morgan's (1970) table of sample size determination, a sample of 289 farmers was derived for this study.

To arrive at the number of farmers to be studied per village, a proportionate-to-size sampling technique was used; and then respondents were selected using a randomiser computer programme (Graphpad QuickCalcs).

Data collection. The study independent variables included: product (acceptability, affordability, accessibility, and awareness), service quality (tangibility, assurance, empathy, responsiveness and reliability), and farmer socioeconomic characteristics (level of education, farm size, access to extension, and years in production). The dependent variables were use and extent of use of CSS.

All the variables in this study were measured on a scale of 1-5 (5 = strongly agree; 4 = agree; 3 = undecided; 2 = disagree; and 1 = strongly disagree). This approach of examining and measuring use and extent of use, using both a binary and continuous

indicators, has been widely used in studies of agricultural and non-agricultural technology adoption (Nasirumbi, 2017; Yigezu *et al.,* 2018; Sattler *et al.*, 2022).

Before data collection, a structured questionnaire was developed and reviewed for content validity, by a team of experts (five researchers and 5 extension staff). The questionnaire was then pre-tested for reliability and translated into local languages (Luganda for Mpigi district, and Acholi for Omoro district). This was done by language experts from the School of Languages at Makerere University. Thereafter, enumerators were recruited, trained and deployed to administer the tool.

To minimise the possibility of biased responses due to social desirability, acquiescence or consistency with 'assumed' research hypotheses, the respondents were guaranteed complete confidentiality, and repeatedly asked to be as honest as possible; following the Podsakoff *et al*. (2003) and Spector (2006) guidelines.

Data analysis. Data collected were subjected to general exploratory analysis, using STATA software. Pearson correlation analysis was used to check the collinearity of independent variables. Descriptive statistics involving cross-tabulations, were used to compare farmers in the low and high disease prevalence zones. Correlations were drawn between attributes of use and extent of use of CSS. In the analysis, we tested whether an agricultural technology's product attributes and the concomitant service attributes influence farmers' use and extent of use. This was tested on the high-quality CSS uptake in the two districts of Uganda, representing varying levels of SPVD incidence.

The key outcome in this analysis, which is the dependent variable for statistical analysis was uptake, which was measured with two indicators. Uptake in this analysis was measured both as a binary variable for uptake choice (i.e., the decision to use or not to use CSS); and as a continuous variable for the extent of uptake (i.e., the extent of use represented as the farmer's percentage share of sweetpotato area that is under CSS).

The analysis of use and extent of use was implemented as a two-stage decision-making process, within a Double-Hurdle analytical framework (Nasirumbi, 2017). The two stages of decision making were estimated using the widely used Double Hurdle Model approach, by estimating it with a Probit regression in the first stage uptake decision (Andrich, 1978), and a Tobit regression in the second stage uptake decision (Tobin, 1958). The Probit specification has an edge over the Logit model in cases of small sample sizes - less than 1000 observations. Thus, with a sample size of 287 farmers, the present study employed a Probit model to assess the determinants of farmers' decision to use or not to use CSS. Robust standard errors were used to overcome issues of heteroskedasticity of unknown form. Below is the Double Hurdle model specification.

Double Hurdle Model. Using the Double Hurdle estimation procedure (Cragg, 1971), it was presupposed that a farmer had to cross two hurdles to uptake CSS. First, a farmer becomes a "user" after crossing the "first hurdle". Given a positive use decision, the proportion of land allocated to CSS cultivation would then lead to the actual extent of use, termed the "second hurdle". A farmer's decision to use or not to use CSS is binary in nature and can be measured with two possibilities; namely, use (Y=1) or no use (Y=0). Therefore, the CSS use decision is a binary statistic.

The use equation can be presented in detail as Equation 1 (Wooldridge, 2009).

$$P(y = 1|x) = G(\beta_k x_k) \quad \text{..... Equation 1}$$

Where:

$P(y = 1|x)$ is the probability that one used CSS (*dependent variable*) given: farmers'

demographic characteristics, product, and service quality attributes (x_k). b_k is the vector for the coefficients.

A probit model was used to determine the probability that a farmer would use CSS (using all observations). From Equation 1, a probit model with a constant is specified as:

$$Y_i = \alpha_0 + \alpha_1 W_1 + \alpha_2 W_2 + \ldots\ldots\ldots + \alpha_{14} W_{14} + v_i \quad \text{Equation 2}$$

Where:

y_i = Dependent variable (Use =1 if the farmer uses CSS, 0 otherwise);

α_0 = Intercept;

$\alpha_1 \ldots\ldots\ldots \alpha_{14}$ = parameters to be estimated;

$W_1 \ldots\ldots\ldots W_{14}$ = Vector of independent variables;

v_i = Error term.

Specifically, the independent variables in the model were:

W_1 = Sex of farmer (1= Male, 0 = Female);

W_2 = Age of farmer (years);

W_3 = Marital status;

W_4 = Formal schooling of the farmer (number of years);

W_5 = Annual income;

W_6 = Total size of land under CSS (Acres);

W_7 = Respondent is household head;

W_8 = Primary occupation;

W_9 = Group membership;

W_{10} = Access to CSS extension service;

W_{11} = Duration using farmland;

W_{12} = CSS Product attributes (Accessibility, affordability, acceptability and awareness); and

W_{13} = CSS service attributes (Reliability, tangibility, assurance, responsiveness, empathy).

In the second hurdle, the dependent variable is the proportion of land allocated to CSS (out of the total land size allocated to sweetpotato production). The Tobit regression model was used to determine the extent of use (only on the non-zero observations) (Cragg, 1971), *viz*.:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + \beta_{13} X_{13} + \mu_i \quad \text{Equation 3}$$

Where:

y_i = Dependent variable (Extent of use of CSS measured by proportion of land allocated to CSS);

β_0 = Intercept;

$\beta_1 \ldots\ldots\ldots \beta_1$ = parameters to be estimated;

$X_1 \ldots\ldots\ldots X_{13}$ = Vector of independent variables; and

μ_i = Error term.

Since the Double-Hurdle model allows for the possibility that the same factors may impact each decision differently, the same set of independent variables were used in estimation of the extent of use model.

RESULTS AND DISCUSSION

Farmer socio-economics characteristics, product and service attributes. Table 1 presents t-tests of mean score across the individual measure questions on each social economic, product, and service quality variable

TaBLE 1. Farmer socio-economic characteristics, certified sweetpotato seed product and service attributes assessed in a study on use of CSS in central and northern Uganda

Factors	Overall (n=289)		
	Users (n=71)	Non-Users (n=218)	P-value t-test
Socioeconomic characteristics			
Sex (1= Male; 0= Female)	0.34	0.41	0.264
Age (Completed years)	45.14	45.94	0.662
Education (Completed years)	6.49	5.93	0.218
Group membership (1=Yes; 0=No)	0.85	0.71	0.025**
Primary Occupation (1= On-farm employment; 0= Otherwise)	0.9	0.81	0.067*
Wealth (1=<500,000; 2= 500,000-900,000; 3= 1M-2M; 4= 3M-4M; 5= 5M-10M; 6=>10M)	2.72	2.66	0.744
Location (1= Mpigi; 0= Omoro)	0.39	0.44	0.542
Services quality attributes			
Reliability: CSS system provides its services at the promised time	4.02	3.45	0.000***
Assurance: The behaviour of actors in the CSS systems instils confidence in me	4.12	3.6	0.000***
Tangibles: The CSS system has modern-looking equipment to carry out its functions	3.77	3.5	0.029**
Empathy: Multiplies/ sellers have convenient operating hours	3.69	3.16	0.000***
Responsiveness: Employees are never too busy to help you	3.52	3.01	0.000***
Product quality attributes			
Acceptability: I get more than what I have spent when I use CSS and its associated practices	4.12	3.66	0.000***
Affordability: The money I spend on CSS is worth it.	4.07	3.64	0.000***
Accessibility: It is easy to obtain CSS and associated services	3.84	3.06	0.000***
Awareness: We have clear product information	3.83	2.88	0.000***

***Significant at 1%, **Significant at 5%,*Significant at 10%. Attributes measured on a five-point Likert scale: 5 = strongly agree; 4 = Agree; 3 = Undecided; 2 = Disagree; 1= strongly disagree

item. Overall, irrespective of location, there were no significant socioeconomic differences between users and non-users of CSS, except for membership to organisations and primary occupation. The mean scores between users and non-users were statistically significant ($P<0.05$) for all service quality attributes, with users scoring more than their non-user counterparts. Similarly, for all product attribute items, the users' mean scores were greater than their non-users counterparts (Table 1).

The findings on product and service attributes imply that for those promoting CSS use, dissemination of information on services alone may not be sufficient to convert non-users into effective users. Product attributes should be addressed with emphasis on non-users. Rabello (2021), in a similar study, pointed out that need for targeted marketing for the non-users in order to increase use and extent of use of a product.

Mean scores for all product variables were significantly higher (P<0.05) for users than for non-users at both locations (Table 2). It is interesting to note that even for service attributes, users rated items significantly higher than their non-user counterparts. This implies that socioeconomic characteristics significantly accounted for CSS use *via* product and service quality attributes. CSS users ranked most attributes higher than non-users; suggesting that the users were more willing to put effort in managing challenges of CSS use. Since users scored attributes higher than the non-users, they could be used as change agents in promotion of CSS use in Uganda.

Factors influencing decision to use CSS. Table 3 presents the results of a Probit regression for factors that influenced the decision to use CSS by farmers. The three sets of factors used in the analysis, namely, socioeconomic, product and service quality attributes significantly influenced the use of CSS, albeit at different magnitudes. Among the socioeconomic attributes, education level had a strong significant effect on CSS use in the high disease prevalence zone (β =0.220, P< 0.01); while group membership had significant effects in the low disease prevalence zone (β =0.029: P<0.05).

High education levels have been reckoned to greatly influence early adoption of science based innovations, as opposed to low education levels. This could also be the case for central (Table 3, Education level, β = 0.220: P< 0.001) and northern Uganda (Table 3, Group membership, β = 0.029: P< 0.01). Communities with low education levels and/ or less exposure to an innovation tend to strongly follow the phenomenon of mass formation that normally leads to rapid change or adoption of new technologies in a community. Thus, we could propose that education drove use of CSS in central Uganda; while group membership (community mass formation) was likely the key driver for use of CSS in northern Uganda. Therefore, creation of awareness through extension education in central would be more efficient in promotion of CSS uptake; while in northern Uganda this would require targeting opinion leaders a farmer group since they are also agents of mass formation.

Primary occupation, unlike the other factors discussed above, drove CSS use in both positive (β = 0.897: P< 0.05, where primary occupation was on-farm employment) and negative directions (β = -1.121: P< 0.1, where primary occupation was not on-farm employment) (Table 2). Where the primary occupation was mainly on-farm employment, as observed in Omoro district, there was higher tendency to use CSS. However, where primary occupation was off-farm, in the case of Mpigi district, there was negative correlation between use of CSS and primary occupation. This could imply a greater opportunity cost in other activities than growing sweetpotato.

A similar observation was made by Olusayo *et al.* (2019,) where the degree of reliance on farming influenced their investment in agriculture. This implies that farmers may keep tied to the use of CSS and, therefore to production of sweetpotato, as long as they do not have competing sources of livelihood. This could further be supported by the observation that primary occupation could drive CSS use in both directions.

For the case of service quality attributes, reliability (β = 0.289: P< 0.05) positively drove CSS use in both study regions; while tangibility (β = -0.302: P< 0.05) negatively drove the use (Table 3). The negative sign could be an indicator of misconception about tangibility in previous studies on SERVQUAL model. Parasuraman *et al.* (1988) confirmed that all the five attributes of service quality must be at play, for an innovative product to capture mainstream markets, and hence investment in production. This implies that stakeholders, including seed growers, seed inspectors, and development agencies in the CSS ecosystem must put effort in making sure that assurance,

TABLE 2. Farmer socioeconomic characteristics, certified sweetpotato seed product, and service attribute item mean scores among users and non-users in central and northern Uganda

Factors	Central (n=123)			Northern (n=166)		
	Users (n=28)	Non-Users (n=43)	P-value	Users (n=123)	Non-users (n=95)	P-value
Socioeconomic characteristics						
Sex (1= Male; 0= Female)	0.43	0.52	0.421	0.28	0.33	0.514
Age (Completed years)	43.21	47.08	0.126	46.39	45.07	0.609
Education (Completed years)	7.5	6.53	0.132	5.84	5.47	0.554
Group membership (1 = Yes; 0 = No)	0.75	0.67	0.446	0.91	0.74	0.022**
Primary Occupation (1= On-farm employment; 0= Otherwise)	0.93	0.93	0.968	0.88	0.72	0.026**
Wealth (1= <500,000; 2= 500,000-900,000; 3= 1M-2M; 4= 3M-4M; 5= 5M-10M; 6= >10M)	3.29	3.26	0.937	2.35	2.19	0.422
Services quality attributes						
Reliability: CSS system provides its services at the promised time	4.14	3.51	0.003***	3.95	3.40	0.000***
Assurance: The behaviour of actors in the CSS systems instils confidence in me.	4.32	3.55	0.001***	4	3.63	0.001***
Tangibles: CSS system has modern-looking equipment to carry out its functions	3.75	3.66	0.647	3.79	3.39	0.019**
Empathy: Multiplies/ sellers have convenient operating hours	4.07	3.36	0.000***	3.44	3.03	0.024**
Responsiveness: Employees are never too busy to help you	3.64	3.26	0.111	3.45	3.83	0.001***
Product quality attributes						
Acceptability: I get more than what I have spent when I use CSS and its associated practices	4.14	3.62	0.009***	4.11	3.68	0.000***
Affordability: The money I spend on CSS is worth it.	4.07	3.67	0.036**	4.07	3.63	0.001***
Accessibility: It is easy to obtain CSS and associated services	4.21	3.25	0.000***	3.6	2.91	0.001***
Awareness: We have clear product information	4.03	2.65	0.000***	3.69	3.05	0.001***

***Significant at 1%, **Significant at 5%*Significant at 10%. Attributes measured on a five-point Likert scale: 5 = strongly agree; 4 = Agree; 3 = Undecided; 2 = Disagree; 1 = strongly disagree

TABLE 3. Factors influencing the decision to use and of CSS in low (Omoro) and high (Mpigi) disease prevalence zones of Uganda

Factors	Overall (n=245)		Omoro (n=153)		Mpigi (n=92)	
	Coefficients	Robust Std Errors	Coefficients	Robust Std Errors	Coefficients	Robust Std Errors
Socioeconomic characteristics						
Sex (1= Male; 0= Female)	-0.111	0.239	0.339	0.345	-0.308	0.430
Age (Completed years)	0.007	0.007	-0.001	0.010	-0.002	0.014
Education (Completed years)	0.037	0.030	-0.037	0.043	**0.220*** **	0.079
Group membership (1=Yes; 0=No)	0.212	0.260	**0.029** **	0.433	-0.698	0.536
Primary Occupation (1= On-farm employment; 0= Otherwise)	0.467	0.289	**0.897** **	0.350	**-1.121***	0.621
Wealth (Uganda shillings)	0.026	0.086	0.149	0.135	-0.123	0.154
Location (1= Mpigi; 0= Omoro)	-0.225	0.255	-	-	-	-
Services quality attributes						
Reliability: CSS system provides its services at the promised time	**0.289** **	0.140	**0.638** **	0.254	0.068	0.264
Assurance: The behaviour of actors in the CSS systems instils confidence in me	0.157	0.165	0.281	0.364	0.562	0.346
Tangibles: CSS system has modern-looking equipment to carry out its functions	**-0.302** **	0.121	-0.188	0.174	**-0.915*** **	0.312
Empathy: Multiplies/ sellers have convenient operating hours	0.018	0.126	0.051	0.170	0.268	0.237
Responsiveness: Employees are never too busy to help you	0.135	0.103	**0.246***	0.143	-0.001	0.177
Product quality attributes						
Acceptability: I get more than what I have spent when I use CSS and its associated practices	**0.469** **	0.191	**0.718***	0.433	0.094	0.267
Affordability: The money I spend on CSS is worth it	0.051	0.214	0.660	0.448	0.054	0.354
Accessibility: It is easy to obtain CSS and associated services	**0.268** **	0.136	0.276	0.198	0.194	0.303
Awareness: We have clear product information	0.085	0.150	-0.007	0.230	0.382	0.250
Constant	-6.040	0.939	-12.523	2.335	-2.555	1.544

Attributes measured on a five-point Likert scale (5 = Strongly agree; 4 = Agree; 3 = Undecided; 2 = Disagree; 1 = Strongly disagree; 99 = Not Applicable).
*Significant at 10%, ** Significant at 5%, *** Significant at 1%

empathy and responsiveness in the delivery of CSS in Uganda are addressed.

As regards product attributes, acceptability (β = 0.469: P< 0.05) and accessibility (β = 0.268: P< 0.05) positively drove CSS use in both study sites (Table 3). It would be expected accessibility to have more effect in high disease prevalence zone (central Uganda). The same area that also had more educated population would not be averse to CSS system. In line with the 4A model (Sheth and Sisodia, 2012), which stipulates that for any marketing campaign to succeed, it must achieve a high mark for all the 4As, our results showed that only two As (Acceptability and Accessibility) drove the use of CSS. This implies that the remaining two As (Affordability and Awareness) must be addressed in order to increase CSS use through more awareness creation about the benefits of CSS and cutting the cost CSS to a level affordable by farmers in central and in northern Uganda.

Factors influencing the extent of use of CSS. Results of a Tobit regression for factors that influence the extent of use of CSS (Table 4) indicated that, among social economic factors, education level was significant and positive in the high disease prevalence zone (β =6.941: P< 0.01); but not in the low disease prevalence zone. This could be attributed to the contrasting effects of education level, which was also observed by Nasirumbi (2017) in a study on actor interactions in the development and uptake of new banana hybrid banana varieties in Uganda.

This implies that generally low education levels, and its associated larger family sizes, could be affecting land allocation decision, where those in low disease prevalence zone may find it beneficial to allocate sufficient land to CSS to feed household numbers.

Primary occupation also had a significant and positive (β = 25.231: P< 0.1) effect on extent of use of CSS (Table 4); but with negative effects in low disease prevalence zone (Table 4). The other social economic attribute that affected extent of use of CSS was group membership, which was positive and significant only in low disease prevalence zone (β = 42.584: P< 0.05). This implies that belonging to groups in high disease prevalence areas may limit allocation of more land to CSS, and this could reduce the advantage of using groups during scaling up interventions. These findings suggest that although similar farmer socioeconomic characteristics, drove both use and extent of use of CSS, they did so differently depending on disease prevalence zones, hence the need for promoters of CSS to be aware of these critical factors. Group membership was critically important in northern Uganda, where awareness creation would be more important in promoting use of CSS.

Service quality attributes influenced the extent of use of CSS differently from the cases of the socioeconomic factors. Overall, reliability (β = 12.612: P< 0.1) significantly and positively drove the extent of use of CSS (Table 4). This reveals the importance of timely availability of CSS at planting time. A similar observation was reported by Clark *et al*. (2012) on sweetpotato, and Kassem *et al*. (2021) on other consumer products like apparels and electronics.

Conversely, tangibility significantly (β = -11.742: P< 0.05) and negatively drove extent of CSS use, in only the high disease prevalence zone (Table 4). This is rather surprising since earlier studies indicated greater need for CSS in high disease prevalence zones (Adikini *et al*., 2015). Probably, there is a need to present the entire CSS production system is a more simplistic manner. For example, the highly technical aspects of CSS production, like screenhouse production, should be done by specialised actors in this value chain.

As regards product attributes, acceptability (β = 22.048: P< 0.05) significantly and positively drove extent of use in both disease prevalence zones (Table 4). This conforms to the conclusion reached by Sheth and Sisodia (2012), that when clients get more than what

TABLE 4. Socioeconomic, service quality and product attributes influencing the extent of use of CSS in central and northern regions in Uganda

Factors	Overall (n=245)		Omoro (n=153)		Mpigi (n=92)	
	Coefficients	Robust Std Errors	Coefficients	Robust Std Errors	Coefficients	Robust Std Errors
Socioeconomic characteristics						
Sex (1= Male; 0= Female)	-6.787	11.026	9.145	13.225	-14.348	16.216
Age (Completed years)	0.413	0.346	0.129	0.447	-0.252	0.574
Education (Completed years)	1.651	1.360	-1.325	1.733	**6.941*** **	2.396
Group membership (1=Yes; 0=No)	10.740	12.420	**42.584** **	18.665	-24.929	19.835
Primary Occupation (1= On-farm employment; 0= Otherwise)	**25.231***	14.141	**41.488*** **	14.219	**-42.334***	22.680
Wealth (US$)	1.001	3.962	6.120	5.235	-3.860	6.256
Location (1= Mpigi; 0= Omoro)	-8.111	11.787	-	-	-	-
Services quality attributes						
Reliability: CSS system provides its services at the promised time	**12.612***	6.744	**26.870** **	10.618	-2.372	10.250
Assurance: The behaviour of actors in the CSS systems instils confidence in me	8.370	7.954	6.388	14.558	17.512	13.412
Tangibles: CSS system has modern-looking equipment to carry out its functions	**-11.742** **	5.051	-5.562	6.554	**-29.524*** **	9.998
Empathy: Multiplies/ sellers have convenient operating hours	2.004	5.747	4.964	6.345	9.730	9.386
Responsiveness: Employees are never too busy to help you	4.785	4.833	8.754	5.952	-1.184	6.562
Product quality attributes						
Acceptability: I get more than what I have spent when I use CSS and its associated practices	**22.048** **	8.737	20.813	14.657	11.062	12.265
Affordability: The money I spend on CSS is worth it.	5.185	10.191	**30.497***	16.305	4.231	14.420
Accessibility: It is easy to obtain CSS and associated services	11.199	7.025	7.055	9.258	6.301	11.018
Awareness: We have clear product information	3.971	7.496	0.714	10.066	15.563	10.091
Constant	-301.190	40.466	-487.299	65.317	-98.104	62.957

Code used on five Likert scale: (5 = strongly agree; 4 = Agree; 3 = Undecided; 2 = Disagree; 1 = strongly disagree; 99 = Not Applicable). *Significant at 10%,

** Significant at 5%, *** Significant at 1%

they have spent when using a product, they express high acceptability. On the other hand, affordability significantly and positively (β = 30.497: P< 0.1) drove extent of use in low disease prevalence zone. This implies that farmers in the low disease prevalence zone can expand use of CSS at affordable costs; while those in high disease zone may need acceptable (quality) attributes to increase use of CSS.

CONCLUSION

The study sought to establish social economic, product and service quality attributes that contribute to use and extent of use of CSS in Uganda. Results revealed that the users of certified sweetpotato seed scored more for product and service quality attributes than their non-user counterparts. Education level, primary occupation and group memberships drove both use and extent of use of CSS, albeit at different levels and in different directions. Reliability significantly and positively drove both use and extent of use in both zones; while tangibility negatively drove the use and extent of use of CSS. Acceptability and accessibility also significantly and positively influenced use and extent of use of CSS in both locations; yet affordability only influenced extent of use in low disease prevalent zone. Efforts to scale-out CSS use should focus more on interventions that promote affordability, awareness about CSS, while the service providers should invest more in assurance and being empathetic while taking in consideration location specificity.

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