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DETERMINANTS OF SMALLHOLDER FARMERS' DECISION TO INVEST AND TO INTENSIFY INVESTMENT IN SEED POTATO PRODUCTION IN SOUTH WESTERN UGANDA

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ABSTRACT

Whereas several national and international efforts to increase seed potato production have been promoted in Uganda in the last decade, few farmers are participating in seed potato production despite the higher returns on investment from it. Existing studies relate farmer low investment to economic reasoning and as such limited empirical evidence exists on the importance of socio- psychological factors in influencing potato farmers' decisions and the level of investment in seed potato production. This paper utilizes data from a cross -sectional study of 227 randomly selected potato farmers drawn from Kabale and Kanungu districts of southwestern Uganda, to analyse the empirical determinants of farmers' decision to invest and their level of investment in seed potato production. The findings reveal that only 44% of the potato farmers had invested in seed potato production. Further, the results revealed that institutional factors largely influenced farmers' decision to invest while socio -economic factors significantly influenced farmers' level of investment level in seed potato production. Similarly, psychological factors affected both the decision and level of investment in seed potato production. We conclude that investing in seed potato production is an individual farmer's encounter enhanced by supportive cognitive environment accompanied by soft and hard production assets affluence. Therefore, promotion programs and policies on seed potato production should focus on enrolling resource able farmers and enhancing their capacity through training via peer learning strategies. This study contributes to the body of knowledge by incorporating psychological factors in modelling farmers' decision and level of investment in seed potato production. Thus, the study recommends the intensification of the utility of socio-psychological theories in studies investigating investment behaviour in the context of the smallholder farmers.

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INTRODUCTION

In Uganda, Potato is mainly grown by small-scale farmers in highland areas for food and income (de Vries et al. 2016). The national production of the potato in 2019 was

recorded at 327,300 MT (UBOS, 2020) but it is still far below the country's demand for potato. Recently in Uganda, there has been growth in potato value chains connecting farmers to the growing local and international

fast-food restaurants, which has triggered high demand for the crop (Chalwe et al. 2015). The production of the crop registered an upward trend of 272,000 MT between 2006 and 2018 (UBOS, 2020). However, the increase in production has been due to increase in cultivated area. At 2.9 MT/ Ha, Uganda's potato productivity is still low given that a yield of 22 MT/ha is attainable on farm (FAO, 2014). The low productivity is attributed to pests such as whiteflies; common diseases such as bacterial wilt and early blights, the use of poor-quality seed and the existent inefficient seed system, regulatory and policy framework (CIP, 2011; Kroschel et al. 2020; Janssen et al. 1992; Gildemarcher et al., 2009).

Use of poor-quality seed is by far the most limiting factor in food production, since it can cause 100% yield loss (Bertin et al. 2012). In addition, the quality of seed interacts with and determines the utilization of other farming inputs, such as water, fertilizers and the optimization of the pedigree of the variety grown (Lukonge et al., 2015). Seed quality also determines the crop's ability to out vigor weeds and pests and to cope with harsh climatic conditions (Ogunbameru and Idrisa 2013). Therefore, quality seed when regularly accessed by farmers across seasons could contribute to improved potato yields and attainment of food security.

Progress to improve farmers' access to quality seed potato has been intensified in recent years. National and international efforts to increase seed potato production (SPP) in Uganda include the development of SPP technologies - seed plot, positive seed selection (selecting good- and healthy-looking potato for seed); developing farmer capacity on Good Agronomic Practices (GAP), infrastructure development (building screen houses and stores by Non-Governmental Organizations (NGOs)). Despite these efforts, the prevailing seed production system that is led by private seed potato multipliers after acquiring the foundation seed from the research station Kachwekano Zonal Agricultural Research and Development Institute (KaZARDI) seems to be inefficient. On the other hand, the interest of business-oriented seed companies in seed business for crops that viably regenerate through vegetative methods (e.g., vines, stem cuttings and suckers) is considerably low (ISSD-Uganda, 2012). As a result, formal companies have ceded ground to the informal systems where the smallholders continue to use own-farm saved seed potato, also called ware potato (Gildermacher, et al. 2009; CIP, 2011) which, however, is known to be prone to systematic disease that

are major cause of low yields in potato (Kinyua, et al. 2008).

Several scholars of seed distribution (e.g., Maredia et al. 1999; Kinyua, et al. 2008; Louwaars and De Boef 2016) posit that if smallholder farmers are supported to produce quality seed, it is possible to increase their intensity of use of quality seed. This is so, because by locally producing the seed, the transaction costs can be minimized for producers involved in seed supply and for the farmers. Local seed systems also deliver seeds that are highly adapted to the conditions of the farmer; hence, they are likely to be preferred by the farmers (ISSD-Uganda 2012). However, despite the well-argued case for farmers' involvement in the production of quality seed and efforts invested by Government of the Republic of Uganda (GoU) and NGOs in promoting seed potato production interventions in Uganda's potato producing regions, the use of ware potato for seed remains widespread. For example, a report by UBOS (2020) shows that only 10% of the farmers used quality seed in 2019 which is in agreement with Mbowa and Mwesigye (2016) who found that Ninety percent of the farmers in South western Uganda use recycled seed potato. It can be argued that farmers' use of quality seed potato is driven by the level of seed potato production given that only 13% of the demanded seed is produced (Mbowa and Mwesigye, 2016). Thus, farmers' participation in seed production will contribute to closing the seed demand-supply gap, but also increase use of quality seed since it will be available (Welelign, 2008).

Mbowa and Mwesigye (2016) posit that the incentive for smallholder farmers investing in seed potato is high given that returns on investment are three times higher than cost of investment. However, despite the returns, the number of smallholder farmers investing in seed potato production is still low. In Africa, studies investigating investment decisions within agriculture have attributed the low investment in the sector to institutional related failures, such as poor market structure, financial loss risks, inadequate infrastructure, information gaps and high transaction costs (Niringiye 2014; Qurat et al. 2019). Studies that examine the role of institutional related factors in light of the contextual characteristics of the farmer (socio-demographics and perceptions) are rare and necessitate further investigation. Pursuing such studies is likely to be insightful for the smallholder seed potato investment, because recent studies indicate that smallholder farmers' decisions are not always due to

economic calculations, but could succumb to the factors that originate from their environment (Ndaula et al. 2021). Farmers could invest or fail to invest in agriculture due to constraints emanating from demographics (Ihli and Mußhoff, 2013), socio-cultural constraints (Mak and Ip (2017), socioeconomic constraints (Okeke et al. 2015) or because of conflicts in the information farmers possess in their social, mental and implementation contexts (Ndaula et al. 2020; Mulugo et al. 2020a; Sebuliba et al. 2022). Moreover, emerging evidence from studies that use double-hurdle regression model suggests that smallholder farmers' decision process goes through two stages; 1) decision to participate and; 2) the decision to do so with meaningful intensity, where determinants of either stage could differ (Mulongo et al. 2020; Sanya et al. 2020). This type of research has, however, not been undertaken in the area of smallholder farmers' decisions to invest in seed potato production. This study aimed to assess how institutional related factors combine with farmer characteristics and psychology factors to influence their decision to invest as well as intensify their level investment in seed potato production. The next section highlights the conceptual framework, methodology used in the study, then presentation and discussion of results. The conclusion and policy implications of the study are presented in the last section.

Conceptual framework

Figure 1, presents the conceptual framework of this study. It models investments decision (dependent variable) as a two-staged variable. The first stage is on the argument that farmers' behaviour to use new technologies or accept interventions, such as producing seed potato is initially a binary choice problem (Mulongo et al. 2020). In doing so, the outcome behaviour is clustered depending on whether or not an individual would decide to get involved in the deserved action/intervention. After the binary decision, farmers who would have decided to invest, again have to decide how intensively they ought to invest to fulfill their goals. Based on previous studies, (e.g., Mulongo et al. 2020), the two-decision levels are expected to primarily depend on the decision an individual farmer makes regarding whether the intervention fits his/her farming contexts and the desired production goals. This kind of relationship has not been modeled empirically in previous research on smallholder farmers' investment in seed potato sector, thus the focus of this article. This study builds on the theorization of behavioural finance (Angner and Loewenstein 2006; Chaudhary, 2013) to model the factors that are likely to influence farmers' decisions to invest and their level of investment in seed potato production.

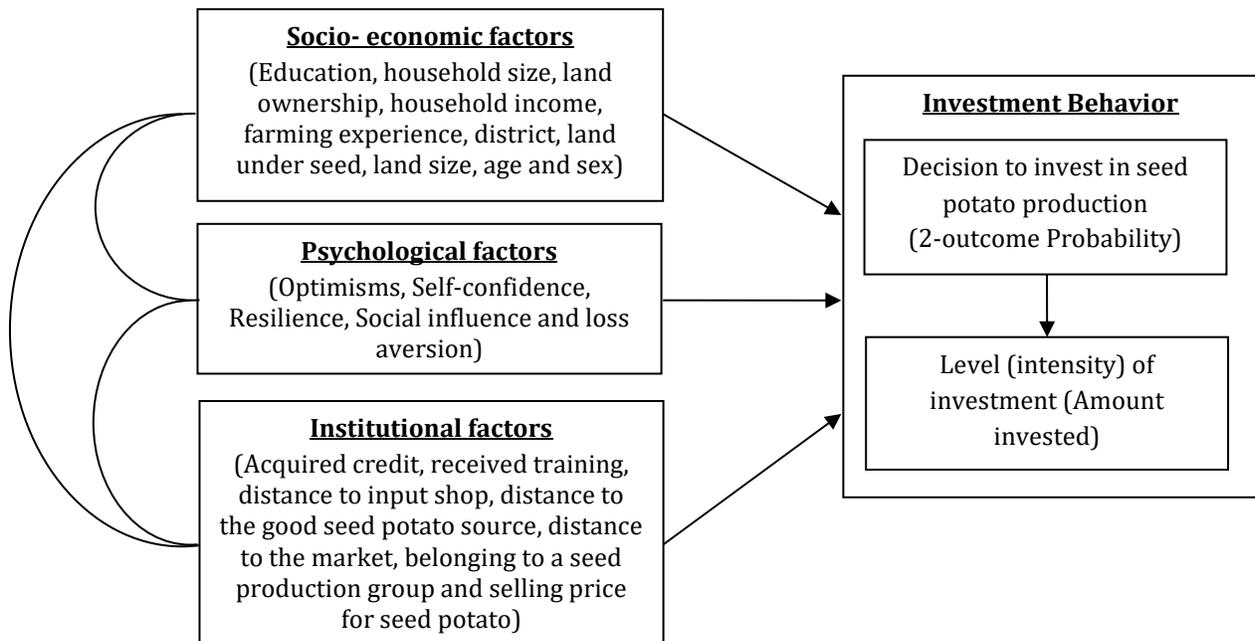


Figure 1. Conceptual frame work modeling factors influencing farmers' decision to invest and the level of investment in seed potato production.

Behavioral finance seeks to predict systematic behaviors related to use of resources as an outcome of sociological and/ or psychological hurdles individuals face (Chaudhary, 2013). According to behavioral finance, people are not always rational and markets are not always efficient, even where full access to necessary information and best tools for decision making are available (Angner and Loewenstein 2006). Thus, behavioral finance explains why individuals and markets do not always behave as expected in relation to investment. Irrational investment decisions are more common in inefficient markets (Chaudhary, 2013). Behavioral finance was deemed appropriate for this study because it incorporates sociological and psychological elements into explaining investment decision making under inefficient markets, such as those in which the smallholder farmers operate (Ndaula et al.2019). In this study, farmers' decisions to invest are assumed to be determined by their psychological and institutional contexts in which they operate (Wegary 2013). Psychological factors are concerned with mental predispositions about the world while institutional factors are about the spatial conditions that constrain or support access to seed potato.

Psychological factors are likely to influence the understanding of how smallholder farmers evaluate investment in SPP. Several studies show that attitudes and perceptions play an important role in explaining the investment behavior of farmers (Shefrin, 2002; Njabulo et al. 2018). For example, Shefrin (2002) suggests that emotional pain of losing money is three times greater than the joy of earning money. Chaudhary (2013) outlines, anchoring (optimism), over-under reaction (resilience), over confidence, loss aversion and herd behaviour (social influence) as the major psychological factors affecting financial decisions. Anchoring refers to the tendency of people to attach or "anchor" their thoughts to a past reference point, even though its logic does not align with the decision at hand. Over-under reaction is concerned with disproportionate reaction to opportunities, news or information leading to irrational optimism or unjustified pessimism. Over confidence refers to people's tendency to underestimate the imprecision of their beliefs and to overestimate their ability. Herd behaviour (social influence) is the tendency of an individual to follow the actions (rational or irrational) of a larger group. Loss aversion refers to the

willingness of people to take more risks to avoid loss than to take similar risks to realize gains.

Regarding institutional factors, Biemond et al., (2012) note that inefficiencies related to the status of distribution channels of seed explain why a farmer would prefer one seed acquisition system over another. Assefa et al. (2014) for example, notes that farmers who are less exposed to quality seeds and poor market positioning of the seed (price, promotion, and distribution place) account for most of the low access of farmers to seed. Poor market positioning increases the real price of the seed through increasing transaction costs, which discourages farmers from investing (Gonfa ,2015). Thus, contexts that increase transaction costs, such as access to credit, distance to input shop, distance to the good seed potato source and distance to the market are likely to increase farmers' decision to invest in the seed potato. By doing so, cheaper production ways would be attained (Barungi et al. 2013). Farmers could also lower cost through subscribing to associations where they could easily obtain seed without investing in seed potato production (Stockbridge et al., 2003). Farmers, who belong to seed producing groups, could also invest more in SPP than their counterparts who do not subscribe to such groups because those who subscribe could be forced to conform to group rules. Lastly, the selling price of seed potato and training in seed potato production are expected to have a positive effect to investment (Chaudhary, 2013) because higher price and knowledge could be expected to motivate farmers to join as well as produce more seed in order to save and to gain an extra income from seed sales.

Previous research (Simtowe et al. 2016; Saini and Kumar 2020) show that the decisions farmers make are influenced by their socioeconomic characteristics, such as sex, age, education, income, access to credit, farming experience, household size and land attributes (ownership, farm size and area allocated to seed). In this study, socioeconomic factors were introduced given that every farmer differs from the others in almost all aspects of the socioeconomic contexts. These factors are known to vary in the way they influence the psychological orientation of individuals and their interpretation of the capacity of their institutional environment to support their investment decisions (Kumar, 2020). It is assumed that the influence of socioeconomic factors on investment decision could vary from that of previous studies due to

their interactions with institutional and psychological factors.

METHODS

Description of the Study Area

The study was conducted in southwestern region of Uganda, an area purposively selected because it was producing over 69% of the potato in Uganda but also has had a record of the highest potato production and productivity recorded at 60,826 MT and 4.2 MT/ha, respectively (UBOS ,2020). From the southwestern region, former Kabale and Kanungu districts were deemed most suitable sites because several NGOs and

government initiatives had been implemented in these districts to support the production of quality seed potato over the past decade (Mbowa and Mwesigye 2016). Besides, Kabale had the highest (59%) and Kanungu the lowest (8%) proportion of households in the districts engaged in potato production for both food and income security (UBOS 2016; UBOS 2020). Muko and Kamuganguzi sub-counties were purposively selected from Kabale while Rutenga sub-county was selected from Kanungu district, (see study map in figure 2) because of their seed potato production intensity. The choice of these sub-counties also permitted the capturing of parities in SPP investment levels by farmers.



Figure 2. Location of study districts and sub counties.

Study design

A cross-sectional survey was conducted in April 2019, a period that corresponded with the peak of the first growing season. Fieldwork timing ensured that the responses farmers gave reflected vividly their experiences. The sampling frame had 866,986 potato producing households consolidated from the lists of farmers obtained from Uganda National Seed Potato Producers Association (UNSPPA) in study areas. Data used were collected from 236 randomly selected potato producing households determined using online sample size calculator called Calculator.net found at <https://www.calculator.net/sample-size-calculator>. The sample was drawn from the population size of 866,986 households at 95% confidence level and at a population proportion of 70% and total 227 farmers were considered for the final analysis. Out of the 227, 126 were ware farmers while 101 were seed potato producers

Measurement and data collection

A four-part pre-tested interview schedule was administered by trained interviewers in Rukiga, the native language of the respondents. Interviewers were used because the respondents lived in areas of high illiteracy levels (UBOS, 2020). Part one was concerned with psychological factors, which were measured in terms of optimism using 5 scale items, resilience (6 items), self-confidence (4 items), loss aversion (5 items) and social influence measured with 4 items as *adapted from* (Chaudhary, 2013). All item scales were on a 5point likert scale (1= strongly disagree, 2= disagree, 3= not sure, 4= agree 5=, strongly agree). Part two assessed farmers' institutional factors, that included whether the farmer acquired credit, received training, accessed NGO support and belonged to seed potato producer group, all measured as a dichotomous variable (yes = 1 or no = 0). This section also measured farmer's distance to input shop, seed potato source and the market, all in kilometers and selling seed potato price measured in Uganda shillings. Part three, was concerned with socioeconomic factors, which included age of the farmers measured in years, highest education attained in years of schooling, sex of the farmer in terms of male = 1 or female = 0, total accessible land size in acres, income of farmer in Uganda shilling, land allocated for SPP in terms of acres, expected revenue in shilling, knowledge of seed potato production (yes = 1 or no = 0) and experience in seed potato production in years of production. The last part assessed

the dependent variable where decision to invest was measured as a yes = 1 or no = 0 and the Level of investment was measured using the discounted amount of money put in five priority seed potato production requirements, that is land, seed potato, training, fertilizer and storage.

Analysis

Broadly, two stages of analysis were used. The first stage involved the use of frequencies and means to describe the status of the independent (socioeconomic, institutional and psychological factors) and dependent (investment decision and investment intensity) variables. Given that investment in seed potato requirements may not be done simultaneously because some investments such as storage are fixed as others are variable, the investment costs were discounted using the Net Present Value (NPV) analysis. This method has been largely used in investment studies and economic analysis because it takes into account all inflows, out flows, time periods and risks associated with an investment. Accordingly, the NPV was computed as: $NPV = \left(\frac{CF}{1+r}\right)t \dots\dots\dots (1)$

Where (CF= cash flow, r= discount rate and t=time period). The bank of Uganda discount rate of 6.5% was used while seasons were used as the time periods).

The second stage involved the use of double-hurdle regression model to estimate the factors that were likely to affect farmers' decisions to invest in SPP and their level of investment. A simple model was developed following the assumption of Cragg (1971) where the analysis of the factors that influence the decision and level of investment in seed potato production are obtained through two regression models. The first hurdle employed a probit model which is a two-outcome decision dilemma for the farmers with two possibilities, investing in SPP (Y=1), and not investing in SPP (Y=0). Thus, the first hurdle equation was specified as follows:

$$Y_i = \alpha_0 + \alpha_1 M_1 + \alpha_2 M_2 + \alpha_3 M_3 + \alpha_4 M_5 + \dots + \alpha_n M_n + \varepsilon_i. (2)$$

Where Y_i is the dependent variables with (investing=1 and not investing =0); α_0 is the Intercept; $\alpha_1 - \alpha_n$ are the coefficients to be estimated, $M_1 - M_n$ are the vector of explanatory variables (see table 4 for their description) and; ε_i is the error term.

The second model (truncated normal model) involved the assumption that farmers with non-zero values face a second hurdle, which accounts for their variation of the

level with which they invested in the SPP. Thus, the dependent variable of the second hurdle was continuous (Level of investment) measured by the total sum of all the discounted money invested in seed potato production. The truncated normal model that determined the factors influencing farmers' level of investment in SPP was specified as below.

$$Y_i = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \dots + \beta_n Z_n + \varepsilon_i \dots \dots \dots (3)$$

Where Y_i is the dependent variable; β_0 is the intercept; β_1 - β_n are the parameters or coefficients to be estimated, Z_1 - Z_n are the vector of explanatory variables (See table 5 for their description), and; ε_i is the error term. Since the proposition of double-hurdle model is that the factors that determine the first hurdle (decision to invest) may or may not influence the second hurdle (how much to invest), relatively similar factors were in put into the truncated model in this study (Woldeyohanes *et al.* 2017; Wooldridge 2010).

Ethical Considerations

An introductory letter from the department of Extension and Innovation studies Makerere University was obtained and it was shared and discussed with the district and local council leadership who then permitted the research team to conduct the study in the sampled areas. Additionally, informed oral and written consent was sought from all participants in the study and data collection and processing was done in a way that protected the interests and health of all participants.

RESULTS AND DISCUSSION

Characterization of potato growing households

Potato growing households were characterized into investors and non-investors. Investors constituted households that participated in seed potato production but also deliberately invested in any of the five investment requirements while the non-investors were farmers that deliberately participated in ware potato production.

Table 1 and 2 summarizes the description socio-economic, institutional and psychosocial statistics that characterize farmers that invested in seed potato production and those that did not. Table 1 shows that average age across the farmer study participants was 43 years. Farmers who invested had 2.987 acres while the non-investors had about 2.781 acres. Further, farmers that invested in seed potato production were 5.988 km

distant to the market while the non-investors were 4.937 km away from the market. This implies that broadly farmers who invested in seed potato production and those who did not operated within similar constraints (land size and distance to the market). However, the average distance to input shops for farmers who had invested in SPP (6.118km) was shorter by 2.9 km pointing to the importance of access to inputs most especially seed potato, fertilizer and pesticides in seed potato production (ISSD, 2016). Although there were no significant differences in income between those who invested and those that did not, the investors in seed potato production had slightly higher incomes.

Table 2 shows that significantly fewer female farmers (27%) invested compared to their male counterparts. This can be explained by the variation in production objectives where females prefer to produce for food security and so they are more likely to engage in ware potato production. The men on the other hand have interest in engaging in cash investments and hence they may have preferred to invest more in seed compared to ware potato production. Ninety percent of the investors owned land compared to only 46% of the non-investors that owned land. Furthermore, 89% of the investors reported to have been trained, 78% had acquired credit and 87 % of the investors reported to have received extension services compared to only 5 % of the non-investors that received extension services. Among those who did not invest in seed potato production, only 19% had trained, 36% had accessed credit and 35% had accessed extension services. Regarding psychological variables, significantly more farmers who invested were optimistic, loss averse and resilient. Additionally, 98% of the farmers that invested succumbed to fellow farmers influence as opposed to their counterparts that had not invested in SPP. Both seed and ware potato farmers were broadly self-confident invested, given that difference was not significant. Significantly more farmers who invested in SPP had received NGO support to facilitate their seed potato production activities.

Priority investment requirements for seed potato production

The study showed that 5 key requirements are central in seed potato production. These are; fertilizer, seed potato, land, store and training. Table 3 summarizes the major recurring and fixed assets that farmers invested as they pursued benefits nested in seed potato production. The

results show that most of the farmers (82%) invested in fertilizer, followed by 60% that invested in foundation seed. High investment in fertilizer is due to the decline in soil fertility in the region (Nazziwa *et al.* 2017) and the extensive campaigns of fertilizer usage and trainings on proper use of fertilizer by NGOs such as International Fertilizer Development Centre (IFDC). Results further reveal that only 40% of the farmers invested in the purchase of land for producing seed. Land could have ranked in a relatively lower position because most seed

potato producers are farmers who were already producing ware potato. This means that for most farmers, the decision to produce seed may not necessarily have attracted the need to purchase additional land, but a re-allocation of owned land to a new production function. Regarding investment in the seed potato stores, only 37 of the seed potato producers invested in construction of a store while, only 6% invested in training.

Table 1. Description of socio economic and institutional characteristics for the sampled potato producers by investment category (n = 227).

Variable	Invested in SPP (n=101)	Not invested in SPP (n=126)	Significance	
	Means		T-value	Sig
Age (Years)	42.9	42.7	0.273	0.784
Household size (Number)	6	5	1.179	0.238
Average annual income (UGX)	1,939,407	1,677,015	0.565	0.572
Land size (acres)	2.987	2.781	1.340	0.180
Distance to seed source (Km)	11.351	13.205	1.240	0.054
Distance to the market (Km)	5.988	4.937	1.395	0.163
Distance to the input shop (km)	6.118	9.001	2.490	0.001

Table 2. Description of institutional and psychological characteristics for the sampled potato producers by investment category (n = 227).

Variable	Invested in SPP (n=101)	Not invested in SPP (n=126)	Significance	
	Percentages		χ^2	Sig
Sex of respondent (1=Female)	27	67	2.86	0.091
Owned Land(1=Yes)	90	46	5.70	0.072
Received training (1= Yes)	89	19	14.45	0.000
Acquired credit (1= Yes)	78	36	3.90	0.048
Access to extension (1=Yes)	87	35	12.79	0.000
Optimism(statements)	65	13	12.67	0.002
Loss aversion (statements)	54	46	22.90	0.000
Resilience to production risks (statements)	48	22	10.83	0.001
Self-confidence (statements)	87	68	0.74	0.39
Social influence (statements)	98	54	11.17	0.001
NGO support (1= Yes)	67	22	16.43	0.000

Table 3. Priority investment requirements for Seed potato production (n = 101).

Requirements	% of seed potato producers That invested in the input requirement	Mean amount invested (UGX)	Standard Deviation
Fertilizer	82	211,494	300,224
Seed potato	60	692,903	1214,26
Land (purchase)	40	1,725,000	216,421

Store (own)	37	539,200	173,413
Training	6	76,923	277,350

Given that the recommended store which is a “diffused light store” is expensive, majority of the farmers cannot afford it and so they resort to keeping seed potato with other farm implements or even with household assets. The communal stores built by NGOs such as African 2000 Network were distantly located from farmers’ production zones and thus accessed with difficulty due additional transport cost of reaching those stores. Notably, for investment to be complete, farmers invest in other secondary seed potato production requirements such as pesticides, fungicides, packing materials and labour costs.

Determinants of farmers' decision to invest in seed potato production

The probit model was used to establish the factors responsible for farmers’ decision to invest in seed potato production. The results of the model indicate that it was a good fit ($P \leq 0.01$, Wald Chi-square 130.34). Results show that institutional factors as opposed to socio-economic factors largely influenced farmers’ decisions to invest in seed potato production. Specifically, the results revealed that female farmers were 13% less likely to invest in seed potato production than their male counterparts. (Average marginal effect= -0.13). Normally the primary decision-makers in cash crop related investment are male farmers in a household, thus, it could have been possible as argued by Mulate et al. (2018) and Mudege et al. (2015) that men invested in the cash-oriented seed potato production while women continued to invest in ware potato

production. Similarly, male farmers have also been reported to dominate ownership of production inputs. Thus, the combined effect of the production resource constraint female farmers’ face and limited frequency of women to move outside households could have limited their exposure to information regarding investing in seed potato production. Previous studies such as Vorley, *et al.* (2015) and Mutinda *et al.* (2020) attest to this finding that male farmers have access to production resources such as capital, land and information which may intensify their investment in cash related enterprises such as seed potato production.

Being trained had a positive significant influence on the likelihood of investing in seed potato production ($p \leq 0.001$). Increasing the number of trainings in seed production by one unit, in turn, increases the likelihood that farmers would invest in seed potato production by 88%. This suggests that farmers with have had several trainings in seed potato production are more likely to invest in producing seed potato than those that have not been trained. The high effect of training on the decision to invest is due to the fact that unlike ware potato production, seed potato production require additional technical knowledge in areas of seed selection, grading, fertilizer application and marketing. Results are similar to those of Mezgebo and Tesfahum (2018) as they found that training positively influenced farmers’ decisions to participate in bean seed production cooperatives in Ethiopia at the 10% of level.

Table 4. Determinants of farmer’s decision to invest in seed potato production.

Variable	Coeff.	Robust Std. Error	Average marginal effects
Socio-economic factors			
Sex of the farmer (1=Female)	-0.213*	0.082	-0.13
Age of the farmer (years)	0.0048	0.004	0.022
Knowledge of SPP	0.096	0.31	0.434
Land size(acres)	0.033	0.052	0.012
Annual income	-0.291**	0.147	-1.107
Institutional factors			
Received training in SPP (1=Yes)	0.191***	0.053	0.888
Acquired production credit(1=Yes)	-0.127**	0.053	-0.592
Distance to seed potato source (Km)	0.002 *	0.002	0.012

Selling price for Seed potato (UGX)	0.099**	0.24	0.445
Distance to inputs shop(km)	0.094***	0.676	0.216
Registered in a seed producer group (1=Yes)	0.106*	0.288	0.31
Psychological factors			
Self confidence	0.195**	0.106	0.759
Optimism	0.197**	0.106	0.765
Social influence	0.602**	0.281	2.801
Loss aversion	-0.158***	0.094	0.566
Resilience	0.0164***	0.116	0.482
Constant	0.261***	0.033	0.195
Number of observations	227		
Log likelihood	-144.88		
Wald chi-square	130.34***		
Mean VIF	1.63		

Dependent variable: (Decision to invest) Binary

Indicates significance at 10% (*), 5% () and 1% (***) probability level.*

Contrary to a similar study by Mutinda *et al.* (2020) who reported access to credit as an enhancer of investment into clean seed potato in Kenya, the model estimates show that the acquisition of production credit had a negative effect on the decision to invest. Farmers who had acquired production credit were 59% less likely to invest in seed potato production. This could be possible because of the human tendency to invest in enterprises they have technical 'know how' in. Additionally, smallholder farmers have been reported to appropriate loaned money to investments other than those formally declared in loan acquisition documents (Alio *et al.* 2017) and as such, it is possible that the farmers could have accessed production credit to invest in seed production but instead diverted it to other purposes.

As expected, the selling price for seed potato had a positive effect on farmer's decision to invest in seed potato production ($p \leq 0.01$). A unit increase in seed potato selling price by one Uganda Shilling, increases the likelihood of investing by 45%. A possible explanation of this result is that since price directly relates to revenues and incomes, a higher selling price for seed potato motivates farmers to invest in seed potato production. These findings conquer with Sebatta *et al.* (2014) who found that price had a positive and significant effect on farmer decision to participate in potato market

In terms of marginal effects, the positive result of 0.216 in respect to distance to inputs implies that on average, a one-kilometer increment in distance to the input shop

increases the probability of farmer investment in seed potato production by 21%. This suggests that farmers who are distant from input shops for seed potato, fertilizer or even pesticides are more likely to try out investing in seed potato production than those that are near input shops. This finding points to the fact that farmers may resort to producing seed as a way of cutting down transaction costs such as those involved in accessing seed potato from far away markets or stores.

Regarding the psychological factors, our results show that social influence had a significant and positive effect on investment decision ($p \leq 0.05$). Our findings show that that a unit increase in farmer to farmers learning increases the chances of farmers investing in seed potato production by 280%. Farmers are more willing to invest in producing seed once they see the results of fellow farmers who have invested. This is possible because they could readily access seed potato, production information and learn from successful farmers. Ndaula *et al.* (2019) also found the more experimental smallholder farmers with new interventions (orange-fleshed sweet potato) to support the less experimental peers to also appreciate the intervention via snowballing the key ideology of the new intervention in farmers' social networks. The importance of peer farmer influence fits the sociological theorization on decision making for socially bound persons, such as smallholder farmers. Typically, decision making in social contexts has two goals, making effective action and building and maintaining social relationships where

looking up to peers' actions is one important way to arrive at effective action when situations are novel and/or uncertain (Ndaula *et al.* 2019).

For self-confidence, the marginal effect of 0.759 meant that a 1% increment in farmer confidence to invest in seed potato production increases the likelihood of farmer's decision to invest in SPP by 76%. This could be explained by the fact that farmers normally prefer to invest in enterprises that are aligned with their abilities. Furthermore, Anu and Anstead (2017) found overconfidence as the most dominant factor that highly influenced investment decision making of investors in Kerala. In relation to optimism, the study found that, the additional unit increase in farmer's belief that the benefits of investing in SPP are high was associated with a 77% chance of farmers investing in SPP. Farmers who did not invest in seed potato production feared that investing in novel enterprises could end up failing. This is aligned with the argument of Chaudhary (2013) who suggested that people anchor investment valuation of present decisions on past reference points, where they may have succeeded or failed. For the unit reduction in loss aversion, it led to 57% likelihood of farmers investing in producing seed potato. Chaudhary (2013) suggests that people with higher loss aversion predispositions are more concerned with avoiding loss in what they already own than pursuing gains through new investments. This could be so, given that emotional pain of losing money is three times greater than the joy of earning money (Shefrin, 2002). Thus, the reduction in loss aversion could have narrowed the risk through supporting farmers' appreciation of seed potato production as a compatible enterprise to ware potato production.

Determinants of farmers' level of investment in Seed potato production

The truncated normal regression model was used to determine the factors that influence farmers' level of investment in seed potato production. The results indicated that the model was a good fit ($p \leq 0.01$, Walid chi-square 134.2). Findings revealed that socio-economic factors compared to institutional and psychological factors were important in determining the level of investment in seed potato production (Table 5). The results show that farmers in Kanungu were 11% less likely to increase their level of investing in seed potato production than their counterparts in Kabale district. The probable explanation for this could be related to demand for seed potato, given that only 8% of households in Kanungu produce potato compared to 59% of those in Kabale that produce potato (UBOS, 2016). Related to the decision results, we found that female farmers were 12% less likely to increase their level of investment in seed potato production as compared to the male farmers. As discussed in the previous section, this could be due to the constraints in accessing production assets (Vigneri and Vargas 2011).

Additionally, women investing less in seed potato production than men could also be attributed to the cultural factors; women are more concerned about food security and hence are likely to invest more in ware potato production (Doss, 2001). The findings further reveals that most socio-economic factors (Land size owned, knowledge of SPP, expected revenue and farming experience) had a positive significant influence of the level of investment in SPP.

Table 5. Determinants of farmers' level of investment in seed potato production.

Variable	Coeff.	Robust Std. Error	Average marginal effects
Socio-economic factors			
Sex of the farmer(1=Female)	-0.288**	0.138	-0.121
Age of the farmer(years)	-0.007	0.006	-0.003
Land ownership(acres)	0.310**	0.23	0.124
Land allocated to SPP (acres)	0.030***	0.001	0.217
Annual income (UGX)	0.612**	0.25	0.0317
Household size (Number)	-0.173	0.073	-0.046
Knowledge of SPP practices	0.214**	0.095	0.092
Expected revenues (UGX)	0.550***	0.312	0.342
Farming experience (Years)	0.159*	0.089	0.068

District (Kanungu = 1)	-0.260**	0.145	-0.112
Institutional factors			
Received training(1=Yes)	0.406***	0.127	1.768
Support from NGOS(1=Yes)	-0.452**	0.183	-0.194
Cost of storage (UGX)	-0.615***	0.225	-0.259
Seed potato selling price (UGX)	-0.09	0.077	-0.038
Distance to inputs shop(km)	0.189**	0.092	0.081
Distance to source of seed (km)	0.009**	0.003	0.004
Distance to the seed market (km)	0.004	0.005	0.002
Acquired credit (1=Yes)	0.292*	0.12	1.13
Psychological factors			
Self confidence	0.064**	0.285	1.093
Social influence	0.094	0.102	0.007
Optimism	0.349**	0.165	0.758
Loss aversion	-0.398**	0.169	0.566
Resilience	0.171**	0.079	0.274
Constant	11.605***	0.391	0.23
Number of observations	101		
Log likelihood	-14.3		
Wald chi-square	134.24***		
Mean VIF	1.85		

Dependent variable: Investment level (money invested in seed potato production)

Indicates significance at 10% (*), 5% () and 1% (***) probability level*

Essentially, the results specifies that if farmers expect higher revenues from their investments, then they are more likely to increase the amount to be invested in seed potato production by 34%. This implies that the farmers weigh the costs against the benefits before deciding to increase the level at which they invest in seed potato production, where the farmer aims to maximize the benefits and minimize costs.

Further, we found that, an increase in farmer's farming experience by one year was associated by an increase in the investment level by 7%. Experience could have offered the farmers a framework to compare seed potato production culture and ware potato production as enterprises that do not greatly differ, thus, leading farmers to increase the level of investment in the more beneficial seed potato production enterprise (Okeke, 2020).

For the case of income, it is probable that higher income increased disposable cash to invest in SPP. Farmers with higher income will investment more in inputs, which will consequently increase the investment amount. The

finding agrees with Fatima et al. (2018) who found a positive correlation between income and investment frequency but differs from Mutinda et al. (2020) who reported a negative influence of annual income on the amount invested in clean SPP in Kenya.

Unlike the first hurdle where access to production credit had a negative effect on investment decision, the results of the second hurdle revealed that acquisition of credit increases the likelihood of increasing the level of investment by 177%. Hence access to production credit affected the level of investment positively. The reason for this change of effect could have been due to the fact that farmers who would have accepted to invest in seed potato production get an opportunity to fully experience and appreciate SPP as more rewarding than ware potato production. This agrees with Saini & Kumar, (2020) who found that availability of credit increased investment in Punjab Agriculture by 8%.

Distance to an input had a significant positive effect on investment intensity. Given that that a kilometre increase in the distance to input was associated with 8% likelihood

to increase the level of investment in seed potato production, suggests farmers could have invested in seed as a strategy to reduce the cost they would spend travelling to input shops. Similarly, the influence of distance to source of seed on levels of investment was positive and significant, although marginally small (0.4%). This could have been so, given that foundation seed can be recycled by farmers for three to four seasons. This explains the high level (99%) of significance of distance to seed source and its low effect on level of investment.

Surprisingly, farmers who had received support for seed potato production from NGOs were 19% less likely to increase the level of investment in seed potato production when compared to peers who had not received NGO support. This kind of trend is common among smallholder farmers, where intervention taking up rather than the intensity of taking up is promoted by change agents as a condition for adopting farmers to receive incentives issued out by the promoters. Ndaula et al. (2021) also revealed that farmers grew a few symbolic mounds of OFSP in a typical garden of over 400 mounds of sweet potato, which they could quickly display to visitors in order merit receiving periodically gifts, such as t-shirts, tours, bicycles and free seed, which were distributed by technology promoters. In this study, NGO gave out fertilizers, pesticides, foundation seed potato and training to seed potato producers, although they did not tag the handouts to specific level of production. Such support significantly lowers investment size farmers need to put into SPP.

As was the case in the first hurdle, psychological factors, self confidence ($P \leq 0.01$), optimism ($P \leq 0.01$) and resilience ($P \leq 0.01$), had a positive significant effect on level of investment in seed potato production. Interestingly, although social influence had the strongest effect on decision to invest among psychological factors, it turned out not to matter when it came to levels of investment. This suggests that after farmers had started to produce seed potato, the decision to increase the level of investment in seed potato production rested upon the specific calculations individual farmers made and how the decision fits their goals. This argument is corroborated by the fact that a unit increase in a farmer's self-confidence and optimism increased the likelihood of farmers increasing the level investment by 109% and 76%, respectively. Thus, farmers did not look up to levels of investment by peer to decide own level.

CONCLUSION AND POLICY IMPLICATIONS

This study assessed the factors that determine smallholder farmers' decisions to invest as well as their level of investment in seed potato production using data collected from 227 smallholder potato farmers in Southwestern Uganda. This study demonstrated that socioeconomic, institutional and psychological factors influence the potato farmers' decision to invest and level of investment in seed potato production. Specifically, factors with the strongest influence on investment decision were social influence, training, optimism, self-confidence and loss aversion, which leads to the conclusion that the decision to invest, is largely an individual farmer's psychological encounter that largely thrives/ or is enhanced by one's knowledge about the enterprise and observation of peer activities about seed potato production. Given that investing in seed potato production was also associated with low income and farmers who had not acquired credit, it leads to the conclusion that offering seed potato production credits and targeting high income farmers is not likely to lead to investment in SPP. Subscription to seed producer group and provision of information on selling price of seed potato will, however, externally attract potato farmers to invest in seed potato production. For the case of levels of investment in seed potato production, the factors with the strongest influence were having been trained in SPP, having acquired credit, optimism, self-confidence and loss aversion. Factors, which did not matter in decision to invest, such as land owned and that allocated to SPP, experience, expected revenue, came out as influencers of investment intensity. In addition, annual income that negatively associated with decision to invest in seed potato production, positively and significantly influenced level of investment, selling price effect changed to negative while farmers seized to conform to social influence when it came to level of investment. Altogether, these finding leads to conclusion that level of investment in seed potato production is largely due to ownership of the necessary production assets (land, finance and know-how) and the cognitive readiness to invest.

The above conclusions lead to recommendations that programs delivering seed potato production promotions should enroll resource empowered farmers, who should also be supported through training and access to seed potato production financing. Use of peer-to-peer visits and the status of the price of seed potato against ware

potato should serve the purpose of enrolling producers onto seed potato production.

The study found both decisions to invest and the level of investment in seed potato production to be gender sensitive, where male farmers were more likely to invest as well as intensify investment in SPP, hence, there is need for deliberate efforts to promote women participation in seed production. This however, will call for a detailed study on what is constraining women from actively participating in producing seed potato yet they are active producers in potato agriculture. Future research, therefore, needs to apply the gender lenses to explore constraining factors to women's low level of investing in seed potato production. In addition, given the hitherto limited evidence on the effect of psychological factors on investment behavior of smallholder farmers, this work has shed some light on this very issue by including psychological factors in modeling investment decision and intensity of investment in seed potato production. Thus, the utility of socio-psychological theories in studies investigating investment behavior especially in the context of the smallholder farmer should be intensified.

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DECLARATION OF CONFLICT OF INTEREST

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