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Adding Value at the Farm: The Case of Smallholder Potato Farmers in the Highlands of Uganda

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Authors' contributions

This work was carried out in collaboration between all authors. Authors JM, EK and AKK designed the study, wrote the protocol and supervised the work. Authors CS and HK performed the statistical analysis. Authors CS and HK wrote the first draft of the manuscript. The main author and co-authors managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This study set out to find out the profitability of engaging in activities that add value to the smallholder farmer's potato produce after harvest so that it fetches a better price to improve on household income. The study was a survey where structured pre tested questionnaires were administered to potato farmers.
Data were collected from 200 smallholder potato farmers in the highland districts of Kabale and Mbale in two potato growing seasons between December 2011 and August 2012. Thirty farmers were randomly selected from each of the two parishes in Wanale to give a sub-sample of 60 farmers from Mbale district. On the other hand, 35 farmers were randomly selected from each of the four parishes in Kabale district giving a total sub-sample of 140 farmers, and 60 farmers from Mbale district. Descriptive statistics, breakeven analysis and a bivariate probit model were used to

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analyse the data.
Results indicated that 23% of all farmers had added value to seed potato while 88.5% had added value to table (ware potato). Kabale had a significantly higher number of farmers (*P<0.01*) adding value to seed potato than Mbale while the reverse was true for ware potato. Results of the break even analysis showed that value addition to both ware and seed potato at the farm was profitable with value adding farmers earning 40% more than those who did not add value. Bivariate probit results indicated that how much a farmer harvested influenced their decision to add value to ware potato while access to extension services significantly and positively influenced value addition to seed potato.
Adding value to potato at the farm is therefore a profitable venture that can be used to increase household incomes according to these results.

Keywords: Highland farmers; value addition; profitability; Bivariate Probit model.

1. INTRODUCTION

Potato also known as Irish potato is grown worldwide and in most of the developing countries, it is considered the fourth most important food crop after rice, wheat and maize [1,2]. In terms of volume of production, potato along with cassava and sweet potato is ranked among the top ten food crops produced in developing countries [3]. It is a highly productive crop that produces more food per unit area and per unit time than wheat, rice and maize [1].

Since the second half of the 20th century the relative importance of potato has slowly shifted from developed to developing countries where more potato is produced in the latter than the former [4,5]. Area expansion has been cited to have fuelled its increased production more than any other major field crop with exception of soybeans with the estimated annual rate of area expansion exceeding 2% in the last 40 years [4].

Potato production in Sub Saharan Africa was estimated to have more than doubled from 100 metric tons to 290 metric tons between 1994 and 2008, with 70% of this growth concentrated in Eastern Africa [1]. Much of the potato in East Africa and Uganda in particular is grown by smallholders who own less than one hectare of land per household. Smallholders are a heterogeneous group whose resources, livelihood patterns and income sources are quite diverse and due to their location, income sources and the variety of economic and social costs they encounter in their participation in markets, they often have different responses to changes in economic variables and policy options [6,7]. Though many smallholder farmers are constrained by vulnerability to market changes and limited assets, producing and adding value to potato are vital livelihood strategies for millions of poor smallholders [8].

1.1 Agriculture and Potato Production in Uganda

In Uganda, agriculture contributes 22.5% to national GDP and employs 66% of the working population [9]. [10] earlier reported that 79% of all households were engaged in agriculture and operating an average landholding of 0.8 ha in eastern and 0.9ha in western Uganda. The national development plan recognises agriculture as one of the key productive sectors driving the economy because it plays a central role in development, economic growth and poverty reduction [11].

Potato was introduced in East Africa by the British in the 1880s. In Uganda, its production is mainly concentrated in the South Western and Eastern highlands which are between 1,500M and 3,000M above sea level [12]. The South Western highlands majorly comprised of the districts of Kabale and Kisoro that produce about 60 % of total Ugandan potato output [1] while the Eastern highlands contribute 10 % with the remaining 30%, mainly medium to low land potato coming from the districts of Mubende, Nebbi, Masaka, Mbarara and Rakai and fuelled by the recent introduction of low land varieties [13,14].

A number of factors have driven the growth in demand and consumption of potato, ranging from lifestyle changes, historical and cultural factors and evolution of tastes and preferences for roots and tubers [15,16,14,3] added that in Uganda, the rate of population growth and urbanisation were well correlated with the level of potato consumption, especially in the form of chips and

crisps and further predicted that demand and supply were likely to increase especially supplies from low to mid-altitude zones. [17] however, reported that despite the increasing production volumes of potato in Sub Saharan Africa, its productivity was decreasing quoting that of Uganda to be 5.8 ton/ha compared to 9.1 ton/ha attained in Kenya which was attributed to the reduction in land holdings per household. This is about 4-5 times lower than the 25 ton/ha obtained by NARO under experimental conditions [12].

1.2 Post Harvest Potato Preparation and Value Addition

After harvesting potato, a series of operations known as post harvest operations are needed to make it reach the consumer's table. Potato being a perishable and bulky agricultural commodity, appropriate and efficient post harvest technology and marketing are critical to the entire production-consumption system [18]. If potato farmers are going to take up post harvest value addition, there should be incentives that attract them to do so and these can be in terms of higher prices for the produce to which value is added or lower cost value addition materials.

[19] Noted that for farmers to decide on a change in their production system, they first judge the impact this will have on input use, costs and returns. [20] suggested that value addition to agricultural products is a means of attaining commercialisation, increase farm incomes and hence reduce rural poverty. [18] described value addition to potato at farm level as a series of post harvest operations such as cleaning, grading, bagging, transportation, processing and storage. [21] argue that rapid urbanisation opens up domestic and regional markets and offers new market opportunities for smallholder farmers to supply high value produce. However, the authors caution that to access these markets requires significant upgrading of produce in terms of quality, quantity and business management, which as are a function of value addition have to be undertaken.

Through sorting and grading of the potato from their gardens, smallholder farmers are able to get two products, that is ware or table potato and seed potato for propagation in the following season both of which are commercial products. The predominant sources of seed potato for the majority of smallholder farmers are self-supply and neighbour supply. In the former, farmers keep seed from a previous seasonal crop to be used in the following season and this constitutes 70-90% of all seed used seasonally in Uganda and in the latter they get from neighbours by buying, borrowing or as gifts [22,12,13,5,23,24]. Value addition to potato at the farm level in the context of this study is defined as undertaking one or more of the following activities; washing, sorting, packing, weighing, storage, and transportation. [25] in their study on on-farm processing of potato in Norway, defined value addition in the context of grading and packing fresh potatoes at farm level as well as marketing them to retail stores. [26] on the hand defined value addition as the process of changing or transforming a product from its original state to a more valuable state through creating value, innovation or industrial innovation at an advanced stage. Value can be added to agricultural products through form (cleaning, sorting, grading and cooling), location, time, ownership and information [27,28].

The framework for post harvest potato value addition in this study was hypothesised as in Fig. 1 below:

2. METHODOLOGY

2.1 Study Area and Sampling Procedure

The study was carried out in South Western and Eastern Uganda in the highland districts of Kabale and Mbale respectively. These were purposively selected for being the major potato producing highland districts in Uganda. Two sub-counties from Kabale and one from Mbale district were purposively selected based on their position as leading potato producing areas in each district. Two parishes from each sub-county were also purposively selected followed by stratified random sampling of respondents where 60 farmers were selected from Mbale and 140 from Kabale in proportion of the area's contribution to national potato output giving a total sample of 200 farmers. Data were collected for the two major potato growing seasons of 2011/2012 in the study area using a pre-tested structured questionnaire.

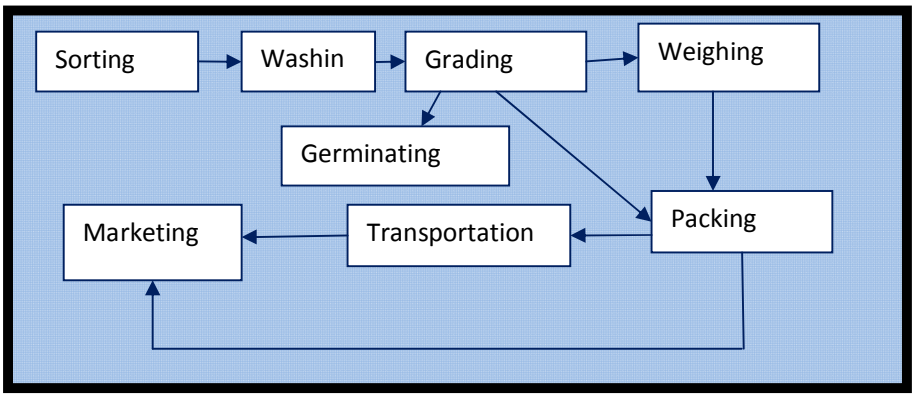

Fig. 1. Hypothesised value addition activities carried out by farmers

2.2 Analytical Methods

Descriptive statistics were used to understand the socio-economic and demographic characteristics of smallholder potato farmers in the highlands. This was done through generation of percentages and means as well as t-tests to test for significance of observed differences between characteristics.

2.2.1 Profitability of farm level potato value addition

To determine break-even point for potato farmers to take up post harvest value addition activities at the farm before selling off the potato, all costs incurred in sorting potato by quality, washing, and grading by size, or weighing, packing, transporting and marketing by farmers were captured. Breakeven analysis was employed in determining whether taking up post harvest value addition to their potato is profitable for farmers and what minimum selling price and sales needed to achieve that. The framework for post harvest potato value addition as hypothesized in Fig. 1 was followed. The figure indicates the various activities/routes that can be undertaken by farmers at farm level to add value to potato before selling it to their preferred channel. The breakeven price, breakeven output and variable costs for seed and ware potato types were calculated following the equations developed by [29]. The equations were stated as;

Break even output price for seed/ware potato (p_i);

$$P_i = \frac{VC_i + FC_i + \pi_i}{Y_i} \quad (1)$$

Breakeven yield (kg) for seed/ware potato (Y_i);

$$Y_i = \frac{VC_i + FC_i + \pi_i}{P_i} \quad (2)$$

Breakeven variable cost (UGX) for seed/ ware potato (VC)

$$VC_i = P_i Y_i - FC_i - \pi_i \quad (3)$$

The Single enterprise profit equation was expressed as,

$$\pi_i = P_i Y_i - VC_i - FC_i \quad (4)$$

Where:

P_i = Output price of commodity i (UGX/kg)
Y_i = Output of commodity i (kg)
VC_i = Variable costs for production of commodity i (UGX)
FC_i = Fixed costs for production of i excluding cost of land
π_i = Profit from production and sale of commodity i (UGX)
i = 1 for ware potato and 2 for seed potato.

Factors affecting smallholder potato farm post harvest value addition

A bivariate probit model was used to understand the factors that influence value addition to seed and ware potato at farm level using a link used by [30] and using two equations as suggested by [31] to model two simultaneous decisions made by a farmer. This was based on the theory of the behaviour of agricultural households under conditions of imperfect markets where

consumption and production decisions are inseparable and lead to variations across households in resource allocation and outcomes [32].

The bivariate (seemingly unrelated bivariate) probit model is then specified as;

$$y_{i1}^{*} = x_{i1}^{'}\beta_1 + \mu_{i1} \quad , y_{i1} = 1 \text{ if } y_{i1}^{*} > 0; \ = 0, \text{ otherwise for ware potato value adding farmer.....(5)}$$

$$y_{i2}^{*} = x_{i2}^{'}\beta_2 + \mu_{i2} \quad , y_{i2} = 1 \text{ if } y_{i2}^{*} > 0; \ = 0, \text{ otherwise for seed potato value adding farmer.....(6)}$$

Where y_i^{*} is a latent variable, which is the utility a farmer gets from adding value to either seed or ware potato by selling it to the market. Where y_i is a binary dependent variable that takes on a value of 1 if the farmer added value to potato and 0 if he/she did not add value. β_n are parameters to be estimated, $x_n^{'}$ are variables hypothesised to influence value addition to potato before selling it at farm level as elaborated in Table 1 with corresponding expected signs on the coefficients and μ_i are the error terms in each equation. Because of endogeneity problems that may arise, equations 5 and 6 are estimated simultaneously.

3. RESULTS AND DISCUSSION

The findings of the study are discussed here with some results summarised as means and percentages in tables. Profitability of post harvest farm potato value addition and determinants of farm level value addition to potato by smallholder farmers are discussed. The characteristics of interviewed potato farmers that were considered under descriptive statistics included but not limited to; household size, years spent in formal

2.2.2 *Apriori* variable expectations

Table 1. Explanatory variables and hypothesised relationship with potato value addition decision

Variable	Variable description	Expected sign	
y_i	Probability that a farmer added value to ware/ seed potato or not	Ware potato	Seed potato
	Household characteristics		
X_1	Age of farmer (Years)	+	+
X_2	Farmer's gender (1=male, 0=female)	+	+
X_3	Farmer's household size	+	–
	Farmer endowments (Assets)		
X_4	Farmer's monthly non- farm income (UGX).	+	+
X_5	Farmer's total annual potato harvest (kg)	+	+
X_6	Farmer has a mobile phone (1=Yes, 0=No)	+	+
X_7	Total land owned (ha)	+	+
	Information access		
X_8	Distance to nearest potato market (km)	–	+
X_9	Farmer has access to extension services (1=Yes, 0=No)	+	+
X_{10}	Farmer belongs to a group or cooperative (1=Yes, 0=No)	+	+
	Other factors		
X_{11}	Farmer has access to credit to invest in value addition (1=yes, 0=No)	+	+

school, age, dependency ratio, gender, main occupation, credit access and membership to a farmers' group or cooperative this is because farmers' characteristics influence the farm management decisions and are important in understanding their decision making process.

3.1 Characteristics of potato growing households in Uganda

The average household size was significantly different (P <0.01) for the sampled farmers in the two study districts with Mbale having a bigger size than Kabale (Table 2). Previous studies [33] have found farmers having larger household sizes to participate less in output markets due to the increased need to first satisfy the household consumption needs before selling to the market. On average, sampled farmers in the study area had seven years of schooling, which means that they had at least attained primary seven level of education according to Ugandan education standards. Kabale had slightly older farmers as compared to Mbale. In terms of dependants per working household member, Mbale had a significantly higher (P < 0.01) dependency ratio than Kabale.

Results in Table 3 show that male farmers constituted a larger proportion of the sample; 77.9% and 81.7% for Kabale and Mbale respectively. Results further indicate that majority of the household heads take farming as their main occupation with 93.6% in Kabale and 90.0% in Mbale. This result is in conformity with the national household survey findings where 78.8% of all households engaged in farming as the main income earning activity [34].

More farmers in Mbale (58.3%) than Kabale (41.4%) bought potato for home consumption in a year meaning that farmers cannot produce enough to sustain home consumption and selling in a market throughout the year. This is an indication of the subsistence nature of the smallholder farmers and the manifestation of inverse arbitrage where these farmers may be buying back at a higher price the same potato they sold cheaply earlier [35]. [36] also noted that farmers chose subsistence production for home consumption because it is subjectively the best option given all constraints.

Table 2. Characteristics of sampled potato growing households in Kabale and Mbale

Farmer characteristic	Mean (Std. Dev)		
	Over all n=200	Kabale n=140	Mbale n=60
Household size	6.55 (3.34)	5.94 (2.54)	7.79 (4.42)***
Farmer's education level (Years in formal school)	7.00 (3.43)	6.91 (3.69)	7.20 (2.75)
Farmer's age (years)	41.11 (12.34)	37.98 (10.83)	42.01 (12.63)
Dependency ratio (Number of dependants per working household member)	1.12 (1.09)	0.94 (0.92)	1.53 (1.32)***

*Significant level: * = 10%; ** = 5%; *** = 1%*

Mbale district had a significantly higher percentage of farmers with no access to credit to invest in agricultural production than Kabale (63.3% and 34.3% respectively). This means that smallholder potato farmers cannot easily invest in high yielding potato seed varieties, fertilizers or agrochemicals in times when they are cash constrained. [22] found that 15% of the farmers in Kabale had not accessed credit a year before. [37] agreed with the findings of this research by highlighting that in Uganda and Africa in general rural economies have remained backward under conditions of poor infrastructure and access to credit.

The levels of farmer cooperation in the study area were found to be very low with 72.1% and 81.7% of the farmers in Kabale and Mbale respectively not belonging to any farmer's group or cooperative. This result has implications for increased production and access to knowledge as well as markets because literature shows that smallholder farmers who cooperate usually have better access to markets and other services. [38] found that households with members of a marketing cooperative attained substantially higher output value per hectare, which they attributed to these households access to inputs on time from a cooperative that increased yields three times as much as for non-cooperative members.

Table 3. Other characteristics of sampled potato growing households in study districts

Potato farmer characteristic	Percentages		
	Overall sample (n=200)	Kabale (n=140)	Mbale (n=60)
Farmer added value to seed potato	23.00	30.71	5.00***
Farmer added value to ware (table) potato	88.5	85.71	95.00*
Farmer gender is male	79.00	77.90	81.70
Farming as main occupation of household head	92.50	93.60	90.00*
Farmer buys ware potato outside farm in a season	46.50	41.40	58.30***
Farmer has no access to credit for investment in potato farming	43.00	34.30	63.30***
Farmer is NOT a member of a group/Cooperative	75.00	72.10	81.70

*Significant level: * = 10%; ** = 5%; *** = 1%.*

3.2 Profitability of Post Harvest Farm Potato Value Addition

Available literature on value addition to crop produce shows that it is a way of enhancing farmer's incomes as well as accessing lucrative markets. [39] argued that cash crop development in terms of value addition offers some opportunities for meeting challenges faced by smallholder farmers in accessing markets.

Value addition to potato at farm level was taken in this study in the context of a smallholder farmer sorting, grading, weighing, packaging and transporting potato to the market in some cases and germinating. Farmers have the choice of carrying out two or more activity combinations or none at all and these activities are done to potato immediately after harvesting. Value addition to seed potato is mainly through germinating the selected tubers over a period of three months. The whole process involves covering the tubers that are either on the floor or on wooden shelves with grass, turning and sorting out rotten ones periodically and dusting with insecticides. The seed business has flourished in the research area due to presence of Zonal Agricultural Research and Development Institutes (ZARDI) at Kachwekano and Buginyanya which produce clean starter seed that is given to farmers for multiplication. However, it must be pointed out that in many cases farmers over recycle seed which leads to high disease incidences and also lower yields [8,22,24].

Results in Table 4 indicate that in adding value to potato at farm level, transportation to the marketing centre contributes the highest cost incurred by farmers at UGX 37.53 per Kilogram of potato. [13] asserted that transportation costs incurred by farmers when they take their produce to market often make up the bulk of marketing costs of agricultural products. This is followed by sorting the potato to remove the rotten and rejected ones with UGX 1.71 per kilogram. Grading potato into seed and ware types takes UGX1.23 per Kilogram because this is a joint cost for the two farm products and that seed and ware potato need the same basic inputs especially labour to produce.

Table 4. Costs involved in farm level potato value addition

Cost type	Mean (UGX/Kg)	Std. Dev
	n=200	
Sorting	1.71	2.07
Grading	1.23	1.86
Weighing	0.83	1.80
Packing	1.26	2.21
Storing	2.68	7.31
Transporting to market	37.53	44.34

NB: The cost of germinating seed potato for 3 months was not captured as much of it involves household labour. Source: survey data 2011

Fig. 2 depicts a combination of possible activities for farm level value addition to potato. A farmer adding value has to incur the cost of sorting, grading weighing and packing (excluding bag because in most cases traders provide them) before choosing between storage and immediate transportation to the market or selling at the farm gate. Route 1 (from sorting, grading, weighing, packing, transport to marketing) involves the highest cost of value addition at UGX 45.24 per Kilogram followed by route 3 (from sorting, grading, weighing, packing, transportation to marketing without storage) at UGX 42.56 per kilogram. The lowest cost route was found to be route 2 (from sorting, grading, weighing, packing to selling/marketing at the farm gate) at UGX 5.03 where a farmer sells at the farm gate rather

than travelling to the market. Therefore, depending on the price offered in the market, a farmer could choose to sell at the farm gate, store and sell at a later time or transporting the potato to the market. [40] noted that farmers usually venture in value addition either because the products offer a premium price or attract an expanded market. It should be noted also that farmers in Ugandan highlands do not wash potato and the reason given was that it can easily rot when washed. However, this is not true because in many countries and main supermarket chains, potato is washed before it is packed.

The results in Table 5 show that seed potato with value added had a higher price per kilogram of UGX.869.01 than seed potato without value added at UGX.668.01 per Kilogram. This means that by adding value to seed potato through properly germinating it, the farmer earns 30% more than without adding value. [41] also supported farmer based seed production systems, arguing that they are more sensitive to yield than to price fluctuations.

The results in Table 5 further show that ware potato with value added fetched a higher price than ware without value added at UGX.488.91 per Kilogram and UGX.406.29 per kilogram respectively. However, seed potato to which value is added overall had the highest price while ware potato with value added had the highest maximum price at Ugx.1, 200 per kilogram and ware potato without value added had the lowest minimum price of UGX.150.00 overall. The results therefore seem to suggest that adding value to either seed or ware potato fetches a higher price for the farmer than without adding value. [1] also recommended adoption of potato post harvest techniques such as grading, selecting and sorting and application of the marketing concept through product, packaging, promotion, place and price if smallholders are to be competitive in the market.

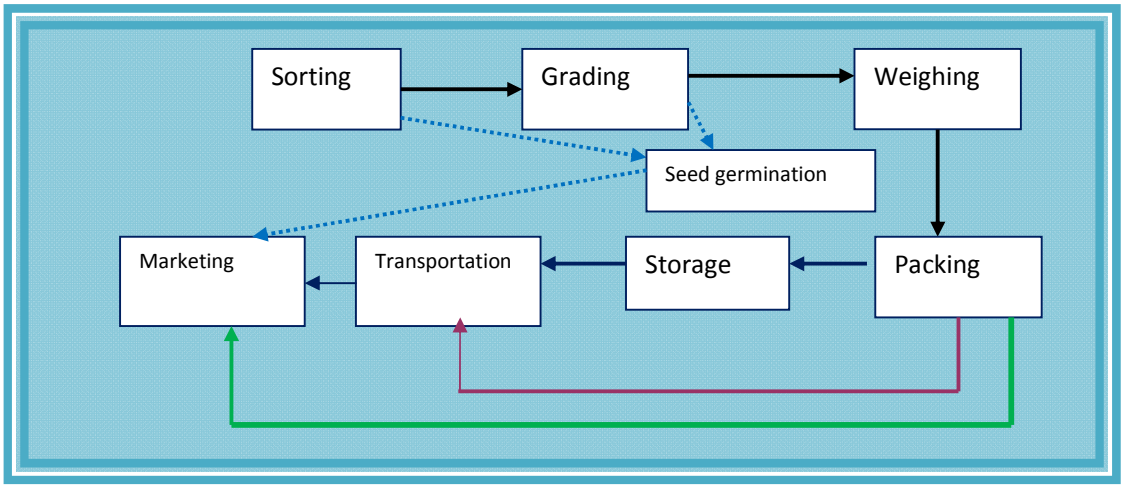

Fig. 2. Combinations of farm level potato value addition activities

Note: The arrows indicate the alternative potato value addition activity combinations farmers undertake at farm level

Table 5. Price and break even analysis of potato value addition

Variable	Mean (Std. dev)	Min	Max
Price of seed potato when value is added (UGX/Kg)	869.01 (126.34)	660.00	1000.00
Price of seed potato with no value added (UGX/Kg)	668.01 (219.53) ***	400.00	900.00
Price of ware potato when value is added (UGX/Kg)	488.91 (143.43)	200.00	1200.00
Price of ware potato with no value added (UGX/Kg)	406.29 (152.32) ***	150.00	1200.00
Break even point for value added ware potato (Kg)	303.894 (418.357)		
Break even point for value added seed potato (Kg)	75.423 (105.240)		
Break even price for value added ware potato UGX)	13.14 (22.67)		
Break even price for value added seed potato (UGX)	16.04 20.18)		

*N.B: Ware potato n=187, seed potato n=46; Significance level: *** = 1%. At the time of this study, the exchange rate was; 1USD=2480 UGX*

The breakeven point and price for value added ware potato were found to be 303.89 Kilograms and UGX. 13.14 per kilogram respectively while for seed potato they were 75.42 Kilograms and UGX.16.04 per kilogram respectively (Table 5). This shows that for a smallholder farmer to recover all costs of adding value they should produce 304 Kilograms and sell each at UGX.13.14. The breakeven point for seed potato however is lower at 75.42 kilograms though its breakeven price is higher. The reason for this is that seed potato shares the same resources with ware potato to produce apart from the labour required for turning and covering for the three months it stays in germination.

3.3 Factors Influencing Potato Value Addition Decision at the Farm

Table 7 reports results of the standard bivariate probit estimation and marginal effects for the decision to add value to ware or seed potato by a smallholder farmer. The Wald $\chi 2$ test for overall performance of the model indicates that we cannot accept the null hypothesis that all coefficients are equal to zero. Table 6 simply indicates the mean, minimum and maximum values of the variables used in Table 7.

At the conventional levels of significance, non-farm income, total annual potato harvest, total land owned and distance to the nearest market were statistically significant for the ware potato equation while access to extension services and distance to the nearest market were found to be statistically significant for the seed potato equation (Table 7). The farmer's monthly non farm income was found to negatively and significantly affect their decision to add value to ware potato at 1% level. This is because farmers who earn outside the farm are more likely to dedicate more time there than to the post harvest activities that would add value to the potato produce. However, this is contradicts [42] who argued that non farm income would induce investments into technologies at the farm.

Total land owned was similarly found to negatively and significantly influence value addition to ware potato by highland smallholder farmers at 5% significance level (Table 7). This is counter intuitive since farmers with more land would be expected to produce more and add value to earn a premium. One of the explanations for this scenario is that there has been a lot of land use change especially in Kabale district where farmers with bigger pieces of land are planting more trees especially eucalyptus to tap into the profitable fuel wood and construction timber business which leaves less and less land allocated to potato. [43] noted that where there is increasing production of bio fuels, there will be more land conversions from food crop to such bio fuel crops some of which are tree crops.

Related to the issue of land is the total annual potato harvested by the smallholder and how this is related to value addition to ware potato. Findings (Table 7) indicated that there was a positive and significant relationship between value addition and how much a farmer harvested at 5% level of statistical significance. Farmers who harvested more were more likely to add value to ware potato because by sorting and grading potato to get ware, a farmer also gets seed potato which can be replanted the following season or part of it sold to earn more income than without adding value. [44] pointed out that smallholders are faced with challenges of low output which shuts them out of markets since they have little to offer in terms of marketable surpluses.

Table 6. Independent variable values

Variables	Potato value adding farmers			Potato non-value adding farmers		
	Average (std. Dev)	Min	Max	Average (std. Dev)	Min	Max
Age of farmer (Years)	41.47 (12.33)	20	72	38.14 (12.30)	20	60
Farmer's household size	6.69 (3.39)	1	21	5.41	1	11
Farmer's monthly non-farm income (UGX).	54,853.93 (108,118.80)	0.00	700,000.00	103,363.60 (155,573.80)	0.00	500,000.00
Farmer's total annual potato harvest (kg)	4,304.27 (8,005.38)	250.00	82,200.00	2,121.36 (4,731.07)	315.00	22,400.00
Total land owned (ha)	1.47 (1.39)	0.10	8.30	1.49 (3.53)	0.08	16.20
Distance to nearest market (km)	7.64 (7.88)	0.10	35.00	4.77 (5.86)	0.50	22.00

Results in Table 7 indicate also that distance to the nearest market positively and significantly smallholder farmers' decision to add value to ware potato before selling it. This may be against much of the available literature that has suggested that farmers who are far from markets are less likely to invest in such activities like adding value to agricultural products [45,46,40,47,48]. In this case, the possible explanation is the higher price a farmer gets from the value added ware potato at the distant market. [49] noted that the gains in terms of yields, unit costs and farm efficiency for more remote areas and that the relationship between remoteness and farm outcomes has weakened over time. This is further supported by [42] when they found farmers farther away from market centres more willing to take up new technologies.

Household size, farmer's access to credit and a farmer having a contract were not significant at any of the conventional significance levels but they had intriguing signs on their coefficients. The household size had a positive influence on the decision to add value to ware potato. This can be explained by the fact that a bigger household size provides the labour needed to undertake the rigorous value addition activities, hence reducing the value addition costs if labour was to be hired.

Households with large families have been found to be technically efficient in production mainly because they strive to attain higher outputs that will secure their subsistence needs but also because a large household is assured of a larger labour endowment, where even children are involved in farm work [50,51] Access to credit and having a contract with buyers negatively influenced value addition because of the malfunctioning credit markets and contractual arrangements in rural areas which is exacerbated by the risk averse nature of smallholder farmers in many developing countries [42].

Seed potato value addition takes a long time though with low inputs, the main ones being labour and space. Post harvest value addition to this special product was affected significantly and negatively by distance to the market at 1% level (Table 6). This is because germinated seed potato is a delicate product that is not easily movable over long distances. Many of the farmers who add value to seed sell it to their nearest peers in the nearest villages. This is a case of creating a local niche market that facilitates farmers' creation of business relations with local and specialised buyers [28].

Table 7. Factors that influence smallholder farmers' potato value addition decision

Variables	Ware potato value addition	Seed potato value addition	Marginal effects
	Coefficient	Coefficient	
Age of farmer (Years)	0.0062	-0.0115	-0.0029
Farmer's gender (1=male, 0=female)	0.0398	0.0813	0.0213
Farmer's household size	0.0672	-0.0573	-0.0142
Farmer's monthly non- farm income (UGX).	-2.91e-06***	5.29e-09	-3.26e-08
Farmer's total annual potato harvest (kg)	0.0002**	3.08e-06	2.62e-06
Farmer has a mobile phone (1=Yes, 0=No)	0.2321	0.2056	0.0541
Total land owned (ha)	-0.1936**	-0.0237	-0.0085
Distance to nearest market (km)	0.0383**	-0.0507***	-0.0128
Access to extension services (1=Yes, 0=No)	0.3054	0.4561*	0.1134
Farmer belongs to a group/ cooperative (1=Yes, 0=No)	0.2246	0.3629	0.1054
Farmer has access to credit (1=yes, 0=No)	-0.4349	-0.0810	-0.0263
Farmer has contract with buyers (1=yes, 0=No)	-0.2151	0.3706	0.1020
Model statistics			
Log likelihood	-150.1979		
N	200		
P	0.2264		
Wald χ^2 (24)	59.97	[0.0001]	
Wald test: $\rho = 0$	1.2021	[0.2729]	

Significance level: * = 10%; ** = 5%; *** = 1%

Access to extension services on the other hand had a positive and significant effect on the smallholder farmer's decision to add value to seed potato (Table 7). This is because contact with the extension agents is a means of transfer of knowledge on how and which insecticides to apply in addition to giving market information to the farmers. Extension officers also play a vital role in advising the farmers on the varieties and sizes that are on demand as well as location of buyers due to their capacity to move around bigger geographical areas and ability to read market signals. [8] noted that in many cases to transform rural livelihoods of smallholder farmers there may be need to improve the quality of their products through accessing knowledge on controlling pests and diseases and introducing improved post harvest practices.

Household size as seen in Table 7 though not significant at any of the conventional levels was found to negatively affect seed potato value addition. This is because larger families face challenges of bigger consumption demands and hence tend to have little surplus to store or add value to as seed. Related to family size, is total potato harvest which had a positive coefficient but not significant. It shows that those farmers who produced more were more likely to have a surplus to add value to in form of seed.

4. CONCLUSION

Breakeven results of post-harvest potato value addition at farm level gave an idea about the breakeven prices and quantities, showing that seed potato with value added fetched a higher price than the same type of potato with no value added. Ware potato with value added could fetch a slightly higher price compared to ware (Table) potato without value added; supporting the hypothesis, that value addition to potato at the farm is profitable. Since transportation to the market takes the bigger portion of value addition costs, it was clear that high transport costs emanating from poor roads and long distances from the marketing centres are likely to deter smallholders in the highlands from adding value to potato.

Access to extension services was found to be a key determinant of smallholder farmers' decision to add value to potato especially seed potato. This is because adding value to seed potato requires special skills that can only be acquired through training by qualified extension agents. Therefore increased extension outreach would be a recommendable intervention if household incomes of the highland farmers.

Those farmers who grew more were found to be more likely to add value to their potato. This could be a result of the economies of scale and the bargaining power they have with the buyers. This therefore is an indication that if farmers are supported to produce enough, they are capable of adding value to their produce which in turn will empower them to access lucrative markets since they can achieve the necessary market and buyer standards.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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