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Potato market access, marketing efficiency and on-farm value addition in Uganda

Harriet Kyomugisha[a], Christopher Sebatta[b], Johnny Mugisha[b,*]

[a] Institut fuer Agrarpolitik und Marktforschung, Justus-Liebig Universität Giessen, Germany
[b] Department of Agribusiness and Natural Resource Economics, School of Agricultural Sciences, Makerere University, P.O. Box 7062, Kampala, Uganda

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ABSTRACT

Understanding barriers to market access for smallholder farmers and their marketing efficiency when they participate in agricultural value chains is key to unlocking the market potential and overcoming market failures. This study aimed at determining factors limiting farmers' market access, the break-even point for undertaking postharvest value addition activities by the farmers, and the market efficiency of the Uganda potato market chains in which the smallholder farmers are participating. Our study was based on the hypothesis that market access and efficiency are higher where farmers have contract arrangements with buyers, and where they are directly linked with the buyers at the end of the value chain. The study was carried out in the popular potato growing districts of Kabale and Mbale in Uganda. The survey involved purposive selection of the study areas and random selection of potato farmers and traders. We used an Ordinary Least Square model to determine factors that influence potato smallholder farmers' market access. We also used break-even analysis to determine the break-even point for potato farmers to take up postharvest value addition activities, and a value addition approach to determine market efficiency. Results indicate that having a contract with buyers, size of land owned, number of forked hoes owned and variety grown positively and significantly influenced farmer market access. We found that adding value to potato on farm earns farmers relatively more income. A farmer would earn 25% higher than when no value addition was done. Market chains where farmers sell to local rural traders were more efficient than selling to other alternatives. We recommend farmer involvement in value addition, collective and/or contractual marketing, and selling directly to the nearest actor in the value chain.

Introduction

Farmer market access is a vital component of market participation. Smallholder farmers can access the market either by selling at the farm gate or physically transporting produce using available means to the market place. A number of scholars have studied drivers of market access. For example, Jari and Fraser [36] and Ruijs et al. [60] found out that good

* Corresponding author.
E-mail address: jomugisha@caes.mak.ac.ug (J. Mugisha).

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road condition and access to information positively influenced farmer access to markets due to their effect on reduction in transaction costs. Johnson [37], however, points out mainly volumes sold, sub-standard quality of products sold and lack of market information as barriers to smallholder access to lucrative markets.

In expounding the issue of market access, Pingali et al. [55] asserted that high value crops, which are often perishable, are typically associated with high transaction costs, high transport costs and lack of cold chain facilities, which limit smallholders' access to markets. However, the authors caution that accessing these markets requires significant upgrading of produce in terms of quality, quantity and business management. Zezza et al. [74] and Katungi et al. [40] also got results supporting the idea that access to basic agricultural inputs and key agricultural assets are strongly associated with farmer's ability to successfully access and participate in agricultural output markets.

Market access as well as market efficiency is further constrained by the perishability of the products. Unless the market infrastructure and related systems function well, products that are more perishable tend to have relatively lower market efficiency. The perishability nature also limits the number of participants in the market. This is the case with potato in most developing countries. Potato is a perishable and bulky commodity; hence appropriate and efficient postharvest technology and marketing are critical to the entire production-consumption system [35]. Studies have underscored benefits to value addition in agriculture. Pravakar et al. [56] reported that value addition to agricultural products is a means of attaining commercialisation, increase farm incomes and hence reduce rural poverty. Ekman and Andersson [18] asserted that on-farm processing offers an alternative for diversification and rural development in the event of increasingly deregulated agricultural markets. However, before smallholder farmers take up postharvest value addition, they first judge if there are economic incentives, mainly in terms of higher prices for the produce to which value has been added that make them break-even.

The demand for potato in developing countries between the period 1993 and 2020 is expected to rise by 2.3% annually for food and 0.4% for feed [61]. These predictions point to the growing importance of the potato as a food security and income generating crop mainly in Sub Saharan Africa [24]. On the other hand, globalization is increasing competition for smallholder farmers, particularly in developing countries who have limited knowledge about the needs of the market but sell what they produce rather than produce for the market.

In Uganda, potato is both a food security and cash crop with prospects for increased growth in quantity demanded estimated to reach 32.8% by 2015 from 18.5% compared to the year 2000 statistics due to the increasing population [28]. It is one of the 12 agricultural commodities prioritised by Government of Uganda [50]. FAO [23] estimated potato production at 800,000 metric tonnes per annum (7.14 tonnes per ha). Production of potato is concentrated in Kigezi highlands of Kabale and Kisoro in the south-western part of the country, and Mt. Elgon highland districts of Mbale and Kapchorwa in eastern with altitudes between 1,500 and 3000 m above sea level [72]. The Kigezi highlands produce about 60% of total Ugandan potato output [25] and South Eastern Uganda contributes 10%. The remaining 30% comes from the districts of Mubende, Nebbi, Masaka, Mbarara and Rakai [28,52]. In recent years, the introduction of lowland varieties extended the crop to other regions like the central and west Nile as a commercial activity and increased potato output over the years [28,52].

The rapid growth in farmer engagement in potato production and market demand is attributed to rapid urban population growth, and changing food eating habits of urban dwellers. This has a strong impact on potato markets, creating opportunities for the smallholder farmers but also posing serious threats due to competition with larger suppliers of potatoes globally (Njuki et al., 2005; [38]). Although Uganda is ranked third producer of potato in East and Central Africa, the bulk of the crop produced (80%) is consumed domestically [69], implying limited participation in regional markets partly attributed to limited value addition to potato required by these markets.

Although potato production is largely localised in few areas of Uganda, its supply chain commonly ends in almost all the urban markets and restaurants in the country. As such a number of market chain actors are involved. These include rural traders, urban traders (retailers and wholesalers) and brokers. To a great extent, potato is demanded by urban occupants in various forms including chips, crisps and French fries ([72]; Jansky et al., 2009), bringing small scale processors in the value chain. The most common marketing channel is where farmers sell on cash basis to wholesalers who in turn transport it to urban centres [4]. There are few cases where potato is sold as seed to other farmers. Generally individual farmers and intermediate sellers, market small quantities of the crop and the sector is generally fragmented with uncoordinated chain actors [4]. This increases the marketing costs, making the market chain less efficient [72].

Despite the seemingly developed and perfectly competitive potato value chain, smallholder farmers continue to complain of limited market access in terms of low prices, limited outlets, and hence low net returns. The problem of limited market access has been associated with inefficiencies along the market chain that starts from the farmer to the final consumer (Africa 2000 Network, 2007). The chain actors generally lack sufficient knowledge, information and enough resources to help them meet quality standards and formal market specifications (Shang, 2010), hence limiting their access to lucrative markets. Causes of market inefficiency are well documented [12,32,65]. However, the level of inefficiency and the node at which the inefficiency is high is not empirically known; and given the different actors in the potato market chain and different market channel options from which a farmer has to choose, it is imperative to understand the level of inefficiency in order to recommend alternative value chain options the farmers could choose for improved gains from potato. This study therefore aimed at determining factors limiting farmers' market access, the break-even point for undertaking postharvest value addition activities by the farmers, and the market efficiency of the Uganda potato market chains in which the smallholder farmers are currently participating.

Our hypothesis was that market access and efficiency was higher where farmers had contract arrangements with buyers. We further hypothesised that market efficiency was higher where farmers were linked directly with the buyers at the end

of the value chain (urban traders) compared to where middlemen (rural buyers and/or brokers were part of the transactions). There has been arguments and counter-arguments that end-chain buyers and middlemen exploit farmers due to lack of market information and weak bargaining power by the farmers, lack of alternative market options, risk aversion, lack of patience, high transportation costs, and the perishable nature of the crops [51]. Ranjan [57] reported that horticultural farmers tend to lose out to middlemen who extract the most profits from the trade. A study by Abebe et al. [1] in Ethiopia indicated that farmers selling without intermediation realised a 225% higher gross profit, but further noted that most farmers continued trading via middlemen. Chigusiwa et al. [13], on the other hand, reported middlemen to be largely beneficial to farmers, carrying out daily assessment of markets that provide farmers a cheap source of information.

Different approaches have been used to determine market chain efficiency [2,27,64,66]. These include gross margin analysis, net farm income and rate of return on investment. Gross margins reveal how much a farm earns taking into consideration the costs that it incurs for producing its products and/or services [9,27]. In other words, gross margin is equal to gross income divided by net sales. Gross margin is a good indicator of how profitable a farm is at the most fundamental level. A business is profitable if the gross revenue is greater than the total variable costs. Farms with higher gross margins will have more money left over to spend on other operations. High gross margins increase household acquisition of resources hence broadening the resource base [45]. In carrying out a profitability analysis on round potato in Tanzania, Mpogole and Kadigi [49] also used gross margin and net margin as indicators to estimate crop and farm profitability. As noted by Zulauf and Scott [75], a market is efficient if gross trading returns do not exceed transaction costs, and marketing efficiency is brought about by information availability at a time t provided economic returns generated by trading on the available information do not exceed transaction and information costs. Using Grossman and Stiglitz's model of marketing efficiency, Zulauf and Scott further pointed out that positive market returns can be earned by those who are fast to acquire new information or possess superior analytical quality. This study used the approach by Tallec and Bockel [66] that weights the total value added against the costs incurred in adding the value.

Methodology

Description of the study area

The study was carried out in Kabale and Mbale districts because of their position as the leading potato producers in Uganda [4,28]. Kabale is located in south-western Uganda, in the mountain ranges where the soils are suitable for potato production. Other main crops grown are sorghum, peas, beans, sweet potato, bananas, tobacco and vegetables ([10,39]. Due to the district's mountainous terrain, the road service to rural communities is generally poor, which constrains farmers' access to markets. Farmers sell their produce at farm gate, while others sell in markets localized within the district. Similarly, Mbale district located in eastern Uganda is characterised by steep slopes of Mt. Elgon where the conditions are favourable for potato production. Other common crops grown include coffee, sweet potatoes, bananas, maize and beans. The main market for farmers' produce is Mbale town and some localised weekly village markets. Potato is marketed by traders who transport it to neighbouring towns and districts with Mbale town as the main distribution centre while, market access is limited by poor road infrastructure [42].

Sample selection and data collection

With the guidance from the National Agricultural Advisory Services (NAADS) personnel at the district and sub county levels, the potato market chain actors were identified as farmers, rural traders, brokers, urban traders, processors and consumers. This information was needed in establishing the sampling frame on which basis the respondents were selected. The different market chain actors were sampled to obtain a representative sample of each.

The first step in farmer sampling was purposive selection of sub-counties and parishes in each district which were commonly known for potato production. According to the information got from district NAADS personnel, two sub-counties in Kabale, (Kamuganguzi and Muko) and one in Mbale (Wanale) were the most popular potato producers, hence selected for this study. In each of the selected sub-counties, two parishes were randomly selected from which 30 farmers were selected randomly per parish. This gave a total sample size of 180 farmers; 120 from Kabale and 60 from Mbale. In selecting the traders, the interviewed farmers helped to identify the traders thus forming a sampling frame. This was then used to randomly sample the traders to be interviewed.

The urban centres from which the considered traders operated included Kabale, Mbale and Kampala. In each urban centre/market, 20 traders were randomly selected making a sample of 60 traders. In selecting processors, the selected farmers, traders and/or key informants in the selected sub counties and urban centres assisted in locating the processors. Processors were purposively selected because they were relatively few at the time when the study was carried out. In total, 32 processors were identified. Eight processors were selected from Mbale, 18 from Kampala and only six processors from Kabale. The processors considered were small scale mainly producing chips and some crisps using local methods of processing. Few processors were identified from Kabale (the most common potato zone), because potato chain actors in the area mostly dealt in raw ware potato and had not picked up potato processing as a serious business. There was one large and modernised processor of potato crisps in Kabale (Tomcris) but was not included in the sample because of the wide deviation from the other processors' scale of operation. More processors were found in Kampala because of growing urbanisation and consumer

Table 1
Explanatory variables hypothesised to influence farmer's market access.

Variable	Variable description	Hypothesised sign
y_1	Farmer grows other foods apart from potato (dummy)	+
y_2	Farmer's education level (Years in school)	–
y_3	Distance to the nearest market (km)	–
y_4	Average price of potato (Uganda shillings/kg)	+
y_5	Farmer has a contract with buyers (Dummy)	+
y_6	Total land owned (ha)	+
y_7	Credit access (Dummy)	+
y_8	Road condition (Good = 1, Bad = 0)	+
y_9	Household size (number of people in household)	+
y_{10}	District (Kabale = 1, Mbale = 0)	+/–
y_{11}	Marketing experience (Years of marketing potato)	+
y_{12}	Access to potato related extension information	+
y_{13}	Potato type sold (Seed = 1, ware = 0)	+
y_{14}	Number of hand hoes owned	+
y_{15}	Number of forked hoes owned	+
y_{16}	Number of pangas owned	+
y_{17}	Transport cost per 100 kg of potato to market (Shillings)	–
y_{18}	Potato variety grown (improved)	+

desire to have more convenient forms of food ([53]; Jansky et al., 2009). The study collected primary data from the sampled respondents in cross-section surveys using pre-tested structured questionnaires. Different questionnaires were designed for the farmers, traders and processors.

Data collected and used

The study used quantitative primary data collected in a cross-sectional survey from potato farming households and businesses located in selected major towns. Field observations to further validate the findings were made. For farmers the variables that were considered include potato marketing mode, that is, individual or group marketing, and contractual relationships with buyers. Others were access to marketing information, value addition, transport means used to take potato to the market, amount of land (hectares) allocated to potato production, access to credit services, marketing experience measured by years and distance travelled by farmers from home to potato markets. For the traders, data on marketing arrangements (contractual relationships with farmers), volumes handled, value addition activities performed, and distance from markets to potato sources, among others, were considered. Similar data, including preference of specific potato varieties for processing, amount of financial support and district of operation, were collected from processors. Data was entered in SPSS software due to its being user friendly in data coding and entry.

Data analysis

Descriptive and econometric analyses were done using STATA computer software. Market access was defined in terms of the volumes of potato a farmer sold to the market. Volume sold was adopted as a good measure of potato farmers' market access because in the context of potato production in the study area, many of the producers are subsistence in nature, growing potato mainly for food and selling some. We hypothesised that by selling some potato, a farmer accesses the market and the higher the volumes sold, the more the market access. An ordinary least squire (OLS) model was estimated to determine factors that affect the volumes of potato farmers sold to the market (market access proxy). The model is stated as;

$$Q_m = f(y_1,\ y_2,\ \ldots,\ y_n,\ \varepsilon) \tag{1}$$

Where Q_m is the quantity (kg) of potato sold annually in the market by a smallholder farmer in two seasons; $y_1 \ldots y_n$ are the variables that were hypothesised to affect market access as shown in Table 1, and ε is the error term.

We tested for endogeneity of total potato sold and found it to be exogenous to amount of potato harvested, total land and farm equipment while controlling for location in terms of district of production. The Durbin-Wu-Hausman test of endogeneity using the approach proposed by Castineira and Nunes [11], ruled out endogeneity with $p = 0.960$. Much as the variance inflation factor (VIF) test ruled out multicollinearity among the model variables, the Breusch-Pagan/Cook-Wesberg test for heteroscedasticity was significant at 1%. We therefore estimated an OLS model with robust standard errors to address the problem.

We assume a potato growing farmer who harvests Q_h kilograms. Such a farmer is faced with a choice problem either to sell all of it or to partition it into home consumption Q_C, keep a portion for seed to plant in the next season Q_s, give out some as gifts or food assistance to friends and relatives Q_g, and sell some to the market Q_m. This gives us two farmer's choices as;

$$Q_m = Q_h - Q_C - Q_s - Q_g \tag{2}$$

Where $Q_h > 0$ and $Q_c, Q_s, Q_g \geq 0$

In Eq. (2), the proportion of potato sold $Q_m/Q_h = 1$ if a farmer sold all the potato harvested, or $0 < Q_m/Q_h < 1$ if a farmer partitions their harvest but sells some of the potato to the market.

Traditional neoclassical theories of comparative advantage relate the flow of goods from countries with high supply and surplus, the exporters to those with low supply but strong demand, the importers. A similar theory can be applied to home and especially food markets where food flows from areas of high supply to areas of high demand nationally or regionally [15]. In developing countries, perfect market conditions rarely exist. Not all products and factors of production can be traded on markets because of the high cost of transactions, shallow markets, and risks and uncertainty about markets and weather conditions [6]. This usually creates bottlenecks to accessing markets even where the farmers have a surplus and in some region there exists high demand [22]. Barriers to market access and information flows may be structural and behavioral. Structural barriers of a horizontal nature may be gender, family, educational levels, ethnicity and other social factors. Information that is available to rural communities may not be equally distributed, and smaller scale producers and those distanced further from the market are more disadvantaged [44].

Based on this theory, this study defines market access in terms of the output sold from the farm and the bottlenecks a farmer has to overcome to sell potato to the market. Market access has been studied in some cases using market participation models. In some cases, output marketing decisions have been modelled as a two-step process where a farmer decides whether to sell or not and then they decide how much to sell [3,31,47,73]. However, in this study we consider only sellers. It has been argued that market access is not uniform because households may face different transaction costs which may be related to differences in geographical markets [7,21,41].

To determine the break-even point for potato farmers to take up postharvest value addition activities, we considered the various postharvest activities farmers undertook before selling the potato to the different market outlets. The activities included washing, sorting, grading, weighing, packing and transporting to the market. The costs incurred in sorting potato by quality and grading by size, or weighing, packing, transporting and marketing by farmers were captured. Mitchell [48] and Dillon and Casey [16] defined break-even yield as the yield at a given price needed to recover all costs, and break-even price as the price needed to cover all costs. Our study refers to Mitchell's work to determine break-even yield, output prices, and variable costs for seed and ware potato value addition. We calculated the break-even price and break-even output for seed and ware potato following the equations by Dillon [17] as in Eq. (3) for break-even price for seed/ware potato and Eq. (4) for break-even output.

$$P_i = \frac{VC_i + FC_i + \pi_i}{Y_i} \tag{3}$$

$$Y_i = \frac{VC_i + FC_i + \pi_i}{P_i} \tag{4}$$

Where:

P_i = Price of potato i (Uganda shillings /kg), with i standing for either ware or seed potato
Y_i = Output of potato i (kg)
VC_i = Variable costs for production of potato i (Uganda shillings)
FC_i = Fixed costs for production of potato i excluding cost of land
π_i = Profit from production and sale of potato i (Uganda shillings)

The main fixed costs were the cost of farm equipment, composed of mainly hand hoes, forked hoes and pangas since the potato farmers have not mechanised their production.

In addition, we used the value addition approach [66] to determine the efficiency of the potato market chains. This approach determines the value added by each of the actors, and consequently the total value added for the entire chain. Value added (VA) by an actor in the market chain was defined by Tallec and Bockel [66] as the difference between the value of output (Y) and the value of inputs (X) the actor used, which is also a measure of profits for a given node of the chain. The analysis considered the value addition functions of the different potato market chain actors (farmers, f, processors, p and traders, t) as:

$$VA_{fi} = P_{fi}Q_{fi} - \sum_{i=1}^{i=n} r_{fi}X_{fi} - MC_{fi} \tag{5}$$

$$VA_{pi} = P_{pi}Q_{pi} - \sum_{i=1}^{i=n} r_{pi}X_{pi} - MC_{pi} \tag{6}$$

$$VA_{ti} = P_{ti}Q_{ti} - \sum_{i=1}^{i=n} r_{ti}X_{ti} - MC_{ti} \tag{7}$$

Where;

VA_i = Value added or profit earned by actor i
P_i = Price of potato sold by actor i
Q_i = Quantity of potato sold by actor i
r_i = Unit cost of the inputs j used by actor i
X_i = Quantity of inputs j used by actor i
MC_i = Potato marketing costs incurred by actor i
f, p and t represent the market chain actor (farmers, processors and traders, respectively)

In determining marketing efficiency of the potato market chain at each node, the ratio of value added to marketing cost was computed as in Eq. (8). A marketing node in this case refers to any point in the marketing chain where the potato produce was exchanged or went through a major transformation or processing [33]. In other words, a chain is a network and a node is a connection point (redistribution or end point).

$$ME_{ai} = \frac{P_{ai}Q_{ai} - \sum_{i=1}^{i=n} (r_{ai}X_{ai} + MC_{ai})}{\sum_{i=1}^{i=n} (r_{ai}X_{ai} + MC_{ai})} X\ 100 \tag{8}$$

Where,

ME_{ai} = Marketing efficiency of actor i at nth node of the chain
$r_{ai}X_{ai}$ = Input costs incurred in marketing potatoes by actor i at nth node of the chain
P_{ai} = Price of potato sold by actor i at nth node of the chain
Q_{ai} = Quantity of potato sold by actor i *at* nth node of the chain
r_{ai} = Unit cost of the inputs j used by actor i at nth node of the chain
X_{ai} = Quantity of inputs j used by actor i at nth node of the chain
MC_{ai} = Marketing costs incurred in marketing of potatoes by actor i at nth node of the chain
$P_{ai}Q_{ai} - \sum_{i=1}^{i=n} (r_{ai}X_{ai} + MC_{ai})$ = Value added at nth node of the chain

Hence Eq. (8) could be re-written as;

$$ME_{ai} = \frac{VAai}{r_{ai}X_{ai} + MC_{ai}}\ x\ 100 \tag{9}$$

A negative ratio means that marketing costs exceed the value added implying that the chain actor is incurring losses. On the other hand, a positive ratio means that the value added exceeds the incurred costs, hence the market is efficient, and the higher the ratio, the higher the market efficiency.

Results and discussion

Characterisation of potato farmers and market access

Table 2 results indicated that on average farmers sold two tons of potato into the market annually which is seven kilometres away in case they did not sell at the farm gate and decided to travel to the market. The cost of transporting 100 kg of potato to such markets was found to be about US$1. Potato farmers in the study area were smallholders owning less than 2 ha of land, majority (82%) of whom grew other food crops alongside potato. The most popular potato varieties grown were Rwangume, Victoria and Kinigi (Table 2). These results are in agreement with the findings of Mbowa and Mwesigye [46] in the study area.

Potato farmers were characterised according to the type of potato sold. Some farmers produced and sold some of the potato for food (ware), while others were more specialised in selling some seed potato but also sold ware. Results in Table 3 show that seed sellers harvested significantly ($P \leq 0.10$) higher volumes of potato than ware sellers. The seed sellers had higher than the average yield producing 6.9 tonnes/ha as compared to 5.5 tonnes/ha for ware sellers. The seed producers are more commercialised compared to the ware producers some of whom produce largely at subsistence level for home consumption. They use yield-enhancing inputs more than the ware producers do. However, their yields were lower than the 25 tonnes/ha that progressive farmers could attain under rain fed conditions [26]. FAO (2010) and FAO [24] point out the causes of low potato productivity at farm level as lack of high yielding varieties, low use of inputs and inadequate storage facilities. Von Oppen et al. [70], however, had earlier reported that improved market access leads to aggregate productivity increases contributed by specialisation and intensification effects on varying farm sizes.

There was also a significant difference ($p \leq 0.01$) between the quantity of potato seed kept for planting the following season by seed and ware potato selling farmers (Table 3). The results confirm earlier studies such as Wagoire et al. [71], Kaganzi et al. [38], Kaguongo et al. [39], Scott et al. [61] and Ferris et al. [28] that many potato smallholder farmers recycled potato seed from one season to another which led to high prevalence of diseases and pests and consequently low yields.

Table 2
Descriptive statistics of variables used.

Variable	Mean	Std. Dev.
Total potato sold annually (Kg)	2050.0	1947.28
Farmer's education level (years in school)	7.00	3.43
Distance to the nearest market (km)	7.33	7.73
Average price of potato (Uganda shillings/kg)	401.88	134.95
Total land owned (ha)	1.48	1.74
Household size (number of people in household)	6.55	3.47
Marketing experience (years of marketing potato)	10.36	8.20
Number of hand hoes owned	4.08	2.38
Number of forked hoes owned	1.46	0.92
Number of pangas owned	1.69	0.93
Transport cost per 100 kg of potato to market (Shillings)	3293.50	2168.32
	Percentage	
Farmer grows other foods apart from potato (Dummy)	82	
Farmer has a contract with buyers (Dummy)	19	
Credit access (Dummy)	57	
Road condition (Good = 1, Bad = 0)	12	
District(Kabale = 1, Mbale = 0)	69	
Access to potato related extension information(Yes = 1, No = 0)	69	
Potato type sold (Seed = 1, ware = 0)	59	
Potato variety grown		
Rwangume	39.9	
Victoria	17.7	
Kinigi	12.3	
Rwashaki	74	
Other	22.7	

Table 3
Potato disposition by seed and ware potato selling farmers.

Quantity disposed	Pooled sample ($n = 180$)	Seed & ware seller ($n = 106$)	Ware seller ($n = 74$)	t-value	p-value
Total potato output (kg/year)	4,064.20	4,862.20	3,832.50	−0.79	0.43
First season harvest (kg/season)	2,495.50	2,742.40	2,423.80	−0.28	0.78
Second season harvest (kg/season)	1,568.60	2,119.80	1.408.6	−1.76	0.08
Percentage of total potato output sold	66.4	72.5	64.6	−1.33	0.19
Family consumption (kg/year)	1,069.80	918.7	1,113.70	0.63	0.53
Potato seed kept for planting (kg/year)	626	1,124.40	481.3	−3.12	0
Seed potato sold (kg/year)	356	1,580.00	0	−8.09	0
Given away as gift to others (kg/year)	18.7	42.9	61.6	0.31	0.76
Bought out side farm (kg/year)	123.9	125.89	123.33	−0.05	0.96
Ware potato sold (kg/year)	2,376.40	1,952.90	2,499.30	0.66	0.51
Average potato yield (kg/ha)	5,834.70	6,941.80	5,513.30	−1.43	0.15

As regards the factors that influenced farmers' market access, Table 4 indicates that a farmer having a contract with potato buyers positively and significantly ($p \leq 0.05$) influenced market access in terms of the potato volumes sold to a market. It was found that having a contract led a farmer to sell 1035 kg of potato annually more than when they had no contract. Contract farming has been recommended as a strategy to reduce production risks especially for smallholders who are risk averse. Glover and Kusterer [30], Tripathi et al. [68] and Reardon et al. [58] indicated that contract is farming a livelihood strategy that buffers rural households against production risks but also spurs investment on farm.

Total land owned as a proxy for farm size positively and significantly ($p \leq 0.01$) influenced level of potato farmers' market access. For every additional hectare of land owned, a farmer sold 460 kg of potato (Table 4). These findings indicated that the scale of operation in terms of land is a key factor in promoting potato market access because usually buyers want to deal with producers with large amounts of produce to reduce transaction costs. Ouma et al. [54] agreed with the findings of these study that production enhancing factors such as land and equipment are key in influencing market participation for smallholder farmers. A related result showed that non-dependency on potato alone by growing other foods also had a significantly negative effect on amounts marketed. This is because the farmers in the study area have small pieces of land whereby growing other foods creates competition for the little land resources available between potato and other foods.

The number of forked hoes owned, one of the major farming tool used in potato production, significantly increased the amounts sold. Another technology-related outcome was that growing *Rwashaki* variety had a negative effect on quantities sold. *Rwashaki* is a local variety that is of low market value, hence farmers grow it for home consumption. However, when *Rwashaki* variety was grown by highly experienced farmers in marketing, there was a significant ($p \leq 0.05$) increase in the amounts marketed. This is because experienced farmers have established customer bases who usually buy from them regardless of the variety. Results show that growing *Rwangume* (a reference variety in the model), Victoria and *Kinigi* varieties

Table 4
Factors affecting market access by potato farmers.

Variables Dependent variable: total potato sold annually (Kg)	Coef.	Std. Err.	t	$p > t$
Farmer's education level (Years in school)	46.33	41.16	1.13	0.26
Distance to the nearest market (km)	−7.62	26.44	−0.29	0.77
Average price of potato (Uganda shillings/kg)	0.05	0.98	0.05	0.96
Farmer has a contract with buyers (Dummy)	1,034.59	406.04	2.55	0.01
Total land owned (ha)	460.02	139.19	3.3	0.001
Credit access (Dummy)	224.62	258.76	0.87	0.39
Road condition (Good = 1, Bad = 0)	−148.88	512.69	−0.29	0.77
Household size (number of people in household)	5.90	38.44	0.15	0.88
District (Kabale = 1, Mbale = 0)	963.02	519.35	1.85	0.07
Marketing experience (Years of marketing potato)	41.22	32.09	1.28	0.20
Access to potato related extension information	−260.33	305.65	−0.85	0.40
Potato type sold (Seed = 1, ware = 0)	357.19	299.39	1.19	0.24
Number of hand hoes owned	38.44	72.49	0.53	0.60
Number of forked hoes owned	569.05	230.15	2.47	0.02
Number of pangas owned	103.22	173.03	0.6	0.55
Transport cost per 100 kg of potato to market (Shillings)	0.16	0.07	2.16	0.03
Potato variety grown				
Victoria	83.06	589.11	0.14	0.89
Kinigi	328.11	857.69	0.38	0.70
Rwashaki	−1,192.16	534.36	−2.23	0.03
Other	1,098.30	646.21	1.7	0.09
Potato variety grown # marketing experience				
Victoria	9.79	50.60	0.19	0.85
Kinigi	−43.84	64.33	−0.68	0.50
Rwashaki	90.22	43.49	2.07	0.04
Other	−65.20	37.10	−1.76	0.08
Constant	−982.16	1,040.54	−0.94	0.35
Model summary				
Number of observations	180			
F(25, 154)	4.24			
Prob > F	0.01			
R-squared	0.68			
Adjusted R-squared	0.44			
RMSE	1912.6			

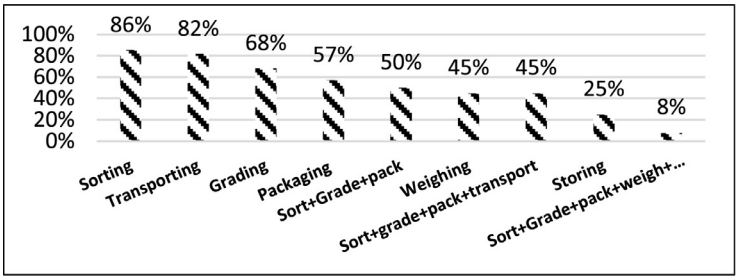
promoted marketed volumes of potato because they command a high market share due to their use in chips making in urban centres. These findings are also supported by Mbowa and Mwesigye [46] in their research done in the same study area.

The other result that was counter hypothesis was that farmers who accessed extension services tended to have less market access. Table 4 indicated that is a farmer accessed extension services, their marketed quantities reduced by 131 kg of potato sold. The reason for this could be that messages and skills extension workers imparted in farmers were not appropriate or adequate for their situation at that time. The kind of marketing processes suitable for resource-poor farmers are different from those who are resource-endowed, and therefore the extension services given should be specific to a farmer category and tailored appropriately. For example, Abebi et al. (2016) are of the view that the low resource-endowed farmers benefit by trading via middlemen, while direct trading with wholesalers is beneficial for the relatively better resource-endowed farmers (Table 4).

Selling potato seed had a positive and but no significant effect on potato amounts sold in the market. Other factors that were not significant but seemed to positively influence potato market access levels were access to credit, household size and marketing experience. Bellemare and Barret [8] indicated that successful repeated contacts, gained as a result of long term relationships, enhances trust, a key ingredient in market exchanges. Escobal and Cavero [19] also explained that small scale producers are the most affected by transaction costs in the marketing of their produce; justifying collective action in form of group membership.

Postharvest potato value addition on farm

In Uganda, value addition to potato at the farm and market level is limited to one or more of the following activities; washing off soil from harvested potato, packing potato in gunny bags or baskets. Weighing using either a locally accepted container or weighing scale, storage of produce in a specialised building structure or in a farmer's house, transportation to the market either using bicycles, head loads or motor vehicles and sorting the potato into good and poor quality and grading it are the other value addition activities. The order of the activities is illustrated in Fig. 1. Whereas some farmers undertake all the activities shown in Fig. 1, others perform only some of them while some harvest and market potato without any value addition done. Sometimes no packaging is done because farmers sell to traders who harvest and package in the



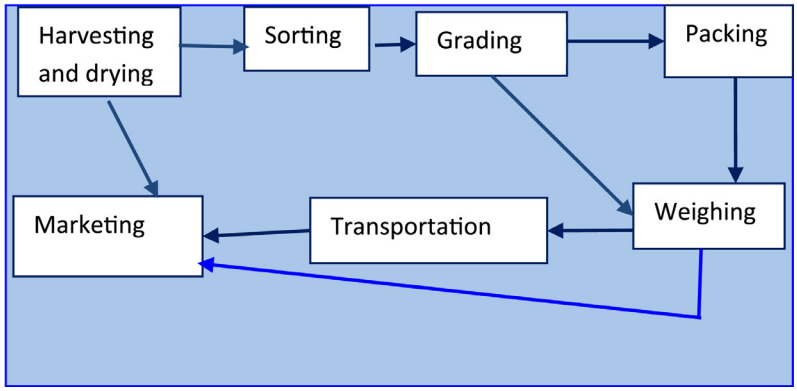


Fig. 1. Potato value addition activities carried out by farmers (%) at farm level.

Table 5
Variable costs involved in farmer level potato value addition.

Value addition activity	Mean cost (UGX/Kg)* ($n = 180$)	Std. Dev	Min	Max	Percent of total value addition costs
Sorting	1.71	2.07	0.00	10.00	3.78
Grading	1.23	1.86	0.00	10.00	2.72
Weighing	0.83	1.80	0.00	10.00	1.83
Packing	1.26	2.21	0.00	24.00	2.79
Storing	2.68	7.31	0.00	50.00	5.92
Transporting to market	37.53	44.34	0.00	450.00	82.96

* *UGX = Uganda Shillings (USD1 = UGX3,400); A farmer was regarded as adding value if he/she carried out at least one of the six activities.*

garden, hence no costs are incurred by farmers. The most common activities are sorting, transporting and grading of potato. Few farmers performed all the three value addition activities, though a sizeable number were carrying out a combination of two or three activities.

Results in Table 5 indicate that transportation of potato to the market accounted for the highest value addition cost incurred by the farmers. This is attributed to the terrain in the study area. The area is mountainous and not easily accessible by motorists. Shepherd [63] made similar observations that transportation costs often made up the bulk of farmers' marketing costs of their agricultural products. Almekinders et al. [5] also found that transport was a major determinant of potato seed cost that increased with increasing distances from the point of sale. The second most important value addition cost was sorting the potato to remove the rotten and rejected ones. The farmers' capital capacity, the urgent need for cash and/or the market demand pressure for the potato determined the value addition activities farmers undertook. Where the capacity was low or where the farmer needed quick cash and/or where the market demand was high, fewer or no value addition activities were done.

A comparison of smallholder farmers who added value and those who did not (Table 6) show a significant difference ($p \leq 0.05$) in age between the two categories. Those who added value were younger. Younger farmers are more likely to invest in farm practices than older ones as Hirpa et al. [34] noted that age of a farmer is an important factor in adoption of value addition technologies. Roe [59] also reported that as farmers grow older they tend to invest in non-farm assets and less likely to expand their farming operations.

Results of this study further show that farmers who mainly added value to potato were those nearer to markets. Farmers far away from the markets, in rural areas, tend to have lower capacity to add value and higher demand for quick cash, hence do less or no value addition to their produce. Their distant location already imposes on them relatively higher mar-

Table 6
Characteristics of farmers who add/ do not add value to potato.

Farmer characteristic	Pooled sample ($n = 180$)	Mean value		t-value	p-value
		Added value ($n = 45$)	Did not add value ($n = 145$)		
Potato farmer's age (years)	41.11	37.98	42.01	1.94	0.05
Total farmland owned (ha)	1.48	1.30	1.50	0.40	0.69
Potato sold annually ('000 UGX/kg)	2.73	3.53	2.50	−1.19	0.88
Farmer education (years in school)	6.84	6.91	6.82	−0.17	0.87
Dependency ratio	1.12	0.88	1.18	1.68	0.10
Distance from home to market (km)	7.33	3.26	8.51	4.18	0.00
Variable costs (Shillings per ha)	53,709.33	58,064.14	0.00	−1.52	0.13
Profit (million shillings per ha)	2.27	2.34	1.42	−0.83	0.41
Output (tonnes per ha)	5.18	5.10	6.53	1.18	0.23
Price of potato (Shillings per kg)	401.88	402.03	400.00	−0.06	0.96

Table 7
Breakeven points and prices for seed potato.

Variable	Seed potato with value added		Seed potato without value added		t-value	p-value
	Mean	Std. Dev	Mean	Std. Dev		
Average price (UGX)	846.45	146.59	648.23	159.75	6.13	0.00
Annual revenue ('000UGX)	1265.00	2244.55	1081.14	1810.65	0.43	0.67
Annual profit ('000UGX)	1243.07	2218.83	1081.14	1810.65	0.38	0.70
Break-even price (UGX)	465.55	218.74				
Break-even yield (kg/ha)	1459.63	2466.46				
Break-even variable cost (UGX/100 kg)	22,901.00	43,881.88				

Table 8
Break-even points and prices for ware potato.

Variable	Ware potato with Value added		Ware potato without value added		t-value	p-value
	Mean	Std. Dev	Mean	Std. Dev		
Average price (UGX)	503.64	170.96	401.71	137.95	6.38	0.00
Annual revenue ('000UGX)	1305.51	2656.40	1113.73	2495.38	0.72	0.47
Annual profit ('000UGX)	1280.86	2644.69	1089.87	2482.81	0.72	0.46
Break-even price (UGX)	503.86	212.73				
Break-even ware	2779.41	5084.03				
Break-even variable cost (UGX/100 kg)	24,392.82	66,133.39				

ket transaction costs [29], and undertaking value addition increases their cost burden. The study also noted a significant difference ($p \leq 0.10$) in terms of the dependency ratio between farmers who added value to potato and those who did not; the former had a lower dependency ratio. The high dependency ratio could mean that a small portion of the produce is available for the market and hence little is left for adding value. On the contrary, Lawal et al. [43] found that farmers who added value had bigger families and higher dependencies which provided labour for the value addition activities. We found no significant differences in terms of prices, profit and output between the two groups of farmers.

Break-even for potato value addition and market efficiency

The average break-even yield and price for seed potato were 1460 kg and 466 UGX/kg, respectively (Table 7). This means that for a smallholder farmer to recover all costs of adding value to seed potato, he/she should have produced at least 1460 kg to be sold at a minimum price of UGX 466/kg. During the time of this study, these quantity and price levels were below what prevailed implying that the farmers could realise higher profit levels by carrying value addition activities before selling their potato.

Similar to seed potato, Table 8 shows that ware potato with value added fetched a significantly ($p \leq 0.01$) higher price than the ware without value added. By adding value to ware potato through sorting, grading, weighing and packing, a farmer would earn 25% higher than when no value addition was done. This finding is consistent to what Roe [59] noted that farmers who invested in farm value addition are more likely to earn more incomes and also face less income variability. Findings hence suggested that all farmers are already operating above the break-even points.

Potato farmers in the study area had a number of market chains for their produce, but the study identified three major chains (Fig. 2). Chain one was the shortest, composed of farmers who sold potato to rural traders that finally sold to final consumers. Chain two involved farmers selling directly to urban traders who, in turn, sold to final consumers. The third and longest chain is where farmers sold potato to urban traders but through brokers. The traders then sold to processors

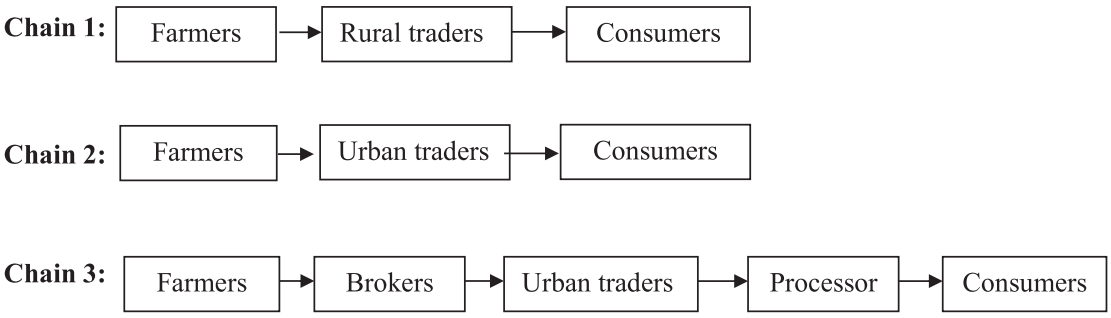


Fig. 2. Major potato market chains in this study.

Table 9
Comparison of farmers' value added and market efficiency in the various potato market chains.

Marketing channel	Mean value added (UGX/tonne)	*t*- value	*P*-value
Farmer- rural trader (chain one) vs.	344,501.10		
Farmer-urban trader (chain two)	303,987.50	0.35	0.73
Farmer- rural trader (chain one) vs.	344,501.10		
Farmer-broker (chain three)	339,248.50	0.04	0.97
Farmer-urban trader (chain two) vs.	303,987.50		
Farmer-broker (chain three)	339,248.50	0.29	0.77
Mean marketing efficiency (ratio)			
Farmer- rural trader (chain one) vs.	1.59		
Farmer-urban trader (chain two)	1.17	0.67	0.67
Farmer-rural trader (chain one) vs.	1.59		
Farmer-broker (chain three)	1.28	0.67	0.51
Farmer-urban trader (chain two) vs.	1.17		
Farmer-broker (chain three)	1.28	0.20	0.84

who processed the potato into either chips or crisps for final consumption. Consumers in chains one and two purchase raw potato, while those in chain three buy processed potato.

By comparing value added (profits) earned by potato chain actors and efficiency levels of the three main market chains that were identified, results showed that some chains were more profitable and efficient than others. Table 9 compares the average value added (profit) and market efficiency of farmers in the different market chains. The results, however, show that there were no significant differences in terms of profits earned and market efficiency levels at farmer nodes of all the major potato market chains. This situation was because of competition from the chain actors (traders) that bought the potato produce. Nonetheless, farmers selling to rural traders (market chain one), were better off because they generally earned higher profits than their counterparts who sold to urban traders either directly (chain two) or through brokers (chain three). By-passing brokers increases farmers' market share. However, Costopoulou and Karetsos [14] asserted that brokers are important in the market for they provide services such as searching for business partners, negotiating terms of the deal and ensuring delivery of goods. The authors recommended the presence of brokers in the market chain with an affirmation that they reduce search costs, contract risks and manage prices better. Besides, chain one (Farmer-to-rural trader) cannot be the only recommended market outlet for the farmers because it may not have the capacity to absorb all that the farmers produce.

A similar comparison of value added and market efficiency was done at the trader node. Results presented in Table 10 show that the profits made by potato traders in market chain two were significantly higher ($p \leq 0.05$) than those made by traders in chain three. Chain three involved brokers who worked for a commission, hence reducing profits earned by the traders. In some cases, brokers were reported to conceal market information from other chain actors (farmers and traders) in order to sustain their existence in the chain. However, previous literature, for instance, Eskola [20] affirmed that brokers play a vital role in business facilitation as well as lowering transaction costs between 'the unknown' parties (in this case, farmers and traders).

Table 10 shows that market efficiency at trader node in chains one and three differed significantly ($p \leq 0.10$) with traders in chain one portraying higher market efficiency. This was attributed to the existence of brokers in chain three who increased the costs incurred by the traders through commission payments. Rural traders in chain one, were in the same locality with farmers. They therefore bought potato directly from farmers and sold directly to consumers hence incurring minimal marketing costs compared to the urban traders in chain three [62]. Marketing efficiencies also differed significantly ($p \leq 0.01$) between traders in potato market chains two and three. Chain two was more efficient than three, again attributed to the presence of brokers in chain three. Bypassing brokers and dealing with farmers directly (chain two traders) enhanced

Table 10
Comparison of mean value added and market efficiency for traders in the potato market chain.

Trader marketing channels	Mean value added (million UGX)	*t*- value	*P*-value
Rural trader-consumer (chain one) vs.	15.10		
Urban trader-consumer (chain two)	17.30	−0.32	0.74
Rural trader-consumer (chain one) vs.	15.10		
Urban trader-processor (chain three)	10.70	0.62	0.54
Urban trader-consumer (chain two) vs.	17.30		
Urban trader-processor (chain three)	10.70	1.23	0.05
	Mean market efficiency (ratio)		
Rural trader-consumer (chain one) vs.	0.78		
Urban trader-consumer (chain two)	0.81	−0.26	0.79
Rural trader-consumer (chain one) vs.	0.78		
Urban trader-processor (chain three)	0.56	1.89	0.06
Urban trader-consumer (chain two) vs.	0.81		
Urban trader-processor (chain three)	0.56	−2.73	0.01

the rate at which potato produce was sold hence not delaying sales process. Tschirley and Hichaambwa [67] in their study 'Do brokers help or hinder the marketing of fresh produce in Lusaka?' noted that the chaotic nature of the market and lack of formal regulatory and enforcement structure for brokering activity, leads to increased brokers' dishonesty with farmers and traders as they tend to charge hidden commissions, cause lack of transparency, reduce prices and slow produce sales.

Conclusions and recommendations

We draw a number of conclusions related to market access and marketing efficiency of smallholder potato farmers in the South western and Eastern highlands of Uganda. First, we conclude that formal contracts between buyers and sellers can enhance market access and efficiency at the same time. We also conclude that key farming equipment when accessed and utilized has capacity to increase output and marketed surplus for farmers to sell in markets. In addition, variety of potato grown prays a key role in enhancing output and eventually marketable produce for the smallholder farmers. The fact that transportation costs were taking the largest share of the marketing and value addition activities, collective action including group marketing would be a remedy to help farmers share these costs to farther reduce marketing costs and increase their bargaining market power.

Value addition to potato at the farm yielded higher economic benefits to the farmers. Adding value would earn a farmer 25% higher than when no value addition was done. In addition, market chains where farmers sold to local rural traders were more efficient than other alternatives. We therefore recommend farmer involvement in value addition, collective and/or contractual marketing, and selling directly to the nearest actor in the value chain.

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Conflict of interests

None.

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Supplementary material

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