

Boosting Potato Enterprise Performance among Smallholder Farmers in Tanzania through Risks Management

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ABSTRACT

Smallholder potato farmers in Tanzania use different on-farm risk management strategies to boost potato enterprise performance. However, knowledge on how on-farm risk management strategies boost potato enterprise performance remains undocumented and scarce. Therefore, this study uses cross-sectional data collected from 384 potato smallholder farmers in 2019, to first identify various on-farm risk management strategies and then to determine the effect of risk management strategies on potato enterprise performance. Data is analysed by use of content analysis and descriptive statistics. Further, a multiple regression model is used to determine the effect of risk management strategies' attributes on potato enterprise performance. The findings of content analysis and descriptive statistics indicate that potato smallholder farmers use various strategies to boost potato enterprise performance. The strategies include application of chemicals, irrigation, furrowing, increased frequency of fungicide application, field sanitation practices, searching for markets, transporting potatoes direct to the markets, use of market information and delaying harvesting of potatoes by leaving them in the soil. Empirical results from multiple regression model reveal that, frequent use, perceived effectiveness, costs and the number of on-farm risk management strategies boost potato enterprise performance in Tanzania. The findings of this paper have several policy implications. First, more and effective risk management strategies such as the use of irrigation system, fungicides, accessing marketing information should be employed to boost potato enterprise performance in Tanzania. Second, since, the cost of risk management strategies had improved potato enterprise performance among smallholder farmers in Tanzania. However, the cost of employing risk management strategies is higher than the benefit potato smallholders get as a result of the strategies employed. The high costs had resulted from employing risk management strategies such as the purchase of irrigation systems during low rainfall and frost bites. Hence, potato smallholder farmers through public-private partnerships between Lusitu Agribusiness Group and Tanzania Agricultural Development Bank (TADB) should establish a village hiring irrigation to dramatically reduce the costs associated with risk management strategies such as irrigation.

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1. Background Information

The risks associated with agricultural enterprises have long been acknowledged as derived from unpredictable factors such as weather, bio security threats (pests, weeds and diseases) and market fluctuation (Duong *et al.*, 2019; Hardaker *et al.*, 2015; Lipinska, 2016). As such, risk management has become increasingly important among all actors of the agricultural value chains including potato smallholder farmers. Potato is a major crop in tropical highland regions of Sub-Saharan Africa including Tanzania, where it is grown as both a horticultural and food security crop. The crop plays an important role as a staple food among producing households and contributes to poverty alleviation through income generation (Mende, 2014). Moreover, it provides calories and nutrition to nearly

350,000 smallholder farming households and millions of urban poor in cities and towns in Tanzania (Kilimo Trust, 2012). As in the rest of the tropical highlands of Africa, potato production in Tanzania is dominated by smallholder farmers with an estimation of 500,000 farmers growing potato in the country. In addition, the subsector employs other actors such as retailers of ware potatoes and street food vendors along the value chain (The Netherlands Enterprise Agency, 2017). Moreover, potatoes are more profitable compared to cereals such as maize and paddy especially in the southern highlands with experts estimating threefold higher income from the crop (Kilimo Trust, 2012). On average, 88 percent of all potato produce is sold out (Mpogole, 2013). This indicates that potato is among the

highest commercialized crops in the country. Despite the potential contribution of potato in the income generation among smallholder farmers, the enterprise in most Sub-Saharan countries including Tanzania is a risky business as it faces many risks including production and market that can affect the profitability and viability.

Many research studies have been conducted on the effect of risk management strategies on farmers' welfare such as food security. For example, Bairagia *et al* (2020), investigates the adoption of three climate-resilient strategies, drought/flood-resistant rice varieties, integrated pest management practices, and weather advisory; their impact on food security (crop productivity and profits of the Cambodian paddy). However, little empirical evidence exists to substantiate how risk management strategies' attributes boost potato enterprise performance among smallholder farmers. Therefore, this study aims at determining the effect of risk management strategies' attributes in boosting potato enterprise performance among potato smallholder farmers in Tanzania.

2. Literature review

2.1. Review of Studies on Risk Management Strategies

There are various risk management strategies farmers employ to manage yield variability. These strategies include enterprise diversification, contract farming and crop insurance among others. On the other hand, commodity markets present unique challenges such as price volatility. Price volatility has created more risk for the producer as well as more opportunity. The increased variability in commodity prices has increased awareness farmers on price risks and enhanced their marketing skills. Farmers have been responding to price volatility by employing different strategies such as minimum price contracts, market information, keeping records among others. Some marketing responses minimize risk by reducing price variability, but other responses include the transfer of risks to others. Generally, producers use a combination of risk management strategies in their farm operations. For example, Makate *et al.* (2016) noted that crop diversification is a viable climate smart agricultural practice that significantly enhances crop productivity and consequently resilience in rural smallholder farming systems. Therefore, enterprise diversification of production can be used to manage price, yield, and income risk. Additionally, Bartolini *et al.* (2014) revealed that, participation in enterprise diversification plays an important role in increasing rural household income. Enterprise diversification is therefore seen as a way to secure income and increase food security (Bartolini *et al.*, 2014). Crop insurance also plays an important role as an ex-ante risk management tool that helps smallholder farmers to cope with crop losses. In many cases, crop insurance covers against loss of crop yield due to the production risks such as pests and diseases, drought, and floods among others. For example, Farm Risks Management for Africa (FARMAF) project promotes the adoption of crop insurance among farmers in order to compensate them for weather related yield losses and simultaneously ease access to production finance (FARMAF, 2015). Market Information Systems is another risk management strategy which helps smallholder farmers to timely access market information. For example, Burger, (2017) noted that, providing prices in real time via market information systems (MIS) has become a technically feasible risk management tool. Timely information is

intended to guide the choice whether producers' sell (selling now or latter, changing point of sale) and strengthen bargaining power in the event of immediate transaction. MIS is used by smallholder farmers to provide guidance on production and marketing decisions such as choice of what, when and where to sell the produce based on market information hence reduces market risks through informed market decision making (FARMAF, 2015). On the other hand, producers' collaborative models can play a role in risk-management and increasing able-members who can engage in high risk/higher return activities (Ethan, 2009). The models also play significant role in improving food security and generating employment opportunities. Bernard *et al* (2010) points out that, producers' collaborative models considerably contribute to rural poverty reduction through agricultural cost reduction, access to market and better price for outputs. The models specifically, supports small agricultural producers and marginalized groups such as young people and women (FAO, 2015).

2.2. Theoretical framework of the study

The study is hinged on the decision theory. Decision theory is a principle that is associated with decisions. The theory is an interdisciplinary approach to determine how decisions are made given unknown variables and an uncertain decision environment framework (Parmigiani *et al.*, 2010). The theory was developed mid-20th century with the support of several academic disciplines. It is typically used by economists, statisticians, psychologists, political and social scientists or philosophers (Jeffrey 1992). Additionally, its origin is derived from economics by using the utility function of payoffs. It proposes that decisions are made by computing the utility and probability, the ranges of options, and also lays down strategies for good decision. The theory has a history of applications to real world problems in many disciplines, including economics, risk analysis, business management, and theoretical behavioral ecology (Maguire & Albright, 2005). Generally, decision theory provides a structure that helps economic agents to make rational choices in the situation of uncertainty. Given a specific set of alternatives, set of consequences and a correspondence, the theory offers conceptually simple procedures for choices. In addition, decision theory deals with methods for determining the optimal course of action when a number of alternatives are available and their consequences cannot be forecasted with certainty (Parmigiani *et al.*, 2010). In this study, potato smallholder farmers face uncertainty conditions that dictate them to decide how much risk to take and which risk management strategies farmers should employ for the specified amount/type of risk. Therefore, it is important to use decision theory in this study.

3. Materials and Methods

3.1. Research Design

A multi-stage sampling procedure was employed to select the study areas. The study employed cross-sectional survey whereby both qualitative and quantitative data were collected at one point in time. Household data were collected from 384 potato smallholder farmers with a semi-structured questionnaire.

3.2. Study area

The study was conducted in Njombe Town Council where Lusitu Agribusiness Group (LAG) is located. The council lies between Longitudes 340 25' and 350 27' East and Latitudes

90 10' and 90 45'South which is a total surface area of 3,212 square kilometers. According to United Republic of Tanzania (2013) the council had a population of 130,223 and it had two main features, namely: the highland zone of the council with rainfall ranging between 1,200-1,400mm per annum. The northern-west part of the council gives way to lower zone covered by black and loam soil, experiencing rainfall ranging between 1,000 to 1,200mm annually. Agriculture is the main economic activity in the council whereby about 78

percent of the residents depend on it as the main source of household income (URT, 2013). Additionally, the council has a cold weather, fertile soil and reliable amount of rainfall which is a favorable condition for agriculture. This enables the council to be a biggest producer of crops such as potatoes and maize. As a result, potato is the leading food and cash crop in the council with the highest production per hectare (8.4t per ha) compared to Maize (2.5t/ha), Beans (3.2t/ha) and Wheat (2.9t/ha).

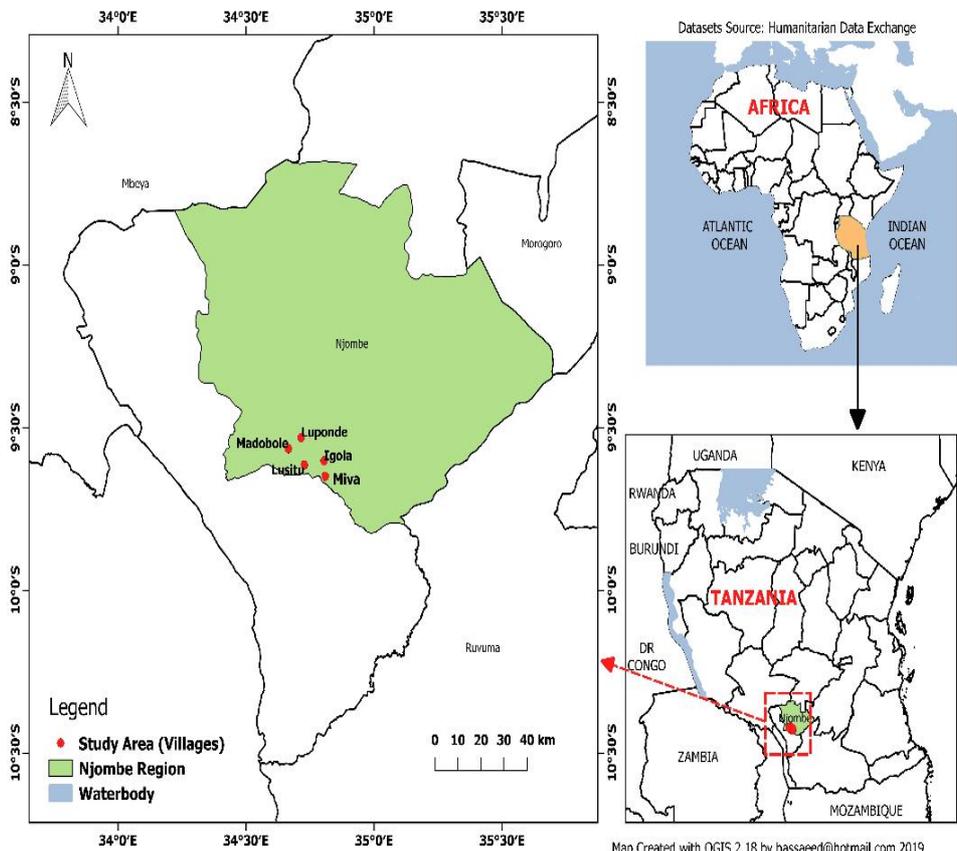


Figure 1: Map of Tanzania showing study areasSource: ICPAC Geoportal and Humanitarian Data Exchange (2019)

3.3. Population and Respondents of the study

The target population for this study was potato smallholder farmers who are members of Lusitu Agribusiness Group. Lusitu Agribusiness Group is a group of potato smallholder farmers located in Igominyi division, Njombe town council. The group implemented the Lusitu Potatoes Pack House and Marketing Project in partnership with Kilimo Trust Tanzania.

3.4. Sampling procedure

The study employed a multi-stage sampling technique where the first stage involved purposive selection of the Igominyi division from Njombe Town Council. In stage two, Luponde ward where Lusitu Agribusiness Group operates was purposely selected from Igominyi division. In stage three, five villages namely Lusitu, Luponde, Mbega, Miva and Igola were also purposively selected from Luponde ward. These villages were selected for the study since most of potato smallholder farmers from these villages are active members of Lusitu Agribusiness Group. The study, used proportionate stratified sampling technique to determine the number of potato smallholder farmers from each village giving 115 respondents from Lusitu, 77 from Luponde, 58 from Mbega, 96 from Miva and 38 were from Igola village. Finally, the actual SHFs of Lusitu Agribusiness Group were randomly selected from each of the five village from the source list provided by the coordinator of Lusitu Agribusiness Group.

3.5. Methods of data collection

A semi-structured questionnaire was used to collect data on the effect of risk management strategies on potato enterprise performance. The study first identified various on-farm risk management strategies potato smallholder farmers used to manage production and marketing risks. Then data on number of risk management strategies, types of risk management strategies, total cost of risk management strategies and frequency of risk management use were collected.

3.6. Data analysis

The study employed descriptive statistics to determine various on-farm risk management strategies employed by potato smallholder farmers. Additionally, multiple linear regression model was employed to determine the effect of risk management

strategy to manage the disease. The findings are similar to Okello *et al.* (2015) who reported that, in Njombe majority of potato smallholder farmers used fungicides in controlling late blight disease. On the other hand, the results show that, potato smallholder farmers employed strategies such as chemical, use of improved seed potatoes, uprooting and burning infected plants, crop rotation, fallowing in controlling bacterial wilt disease in the study area. This implies that, farmers in the study area were aware that bacterial wilt is a soil borne disease and currently there is no chemical for managing it to manage it therefore the only method of controlling it is by soil fertility management such field sanitation. In the same line, Kagona (2008) revealed that the dominant method to control bacterial wilt in the study area by potato farmers was uprooting the infected plants and bury them.

4.1.3. Market-related risk management strategies

In terms of potato price volatility, the results show that smallholder farmers employ strategies such as searching for markets, transporting potatoes direct to the markets such as Dar es Salaam, gathering market information from neighbors, brokers and traders. The respondents further indicated that they leave their potatoes in the soil and sell them after some time. This enables them to fetch higher potato prices as they would have sold their potatoes in the off season. This implies that, potato is highly commercialized crop in Njombe as a results farmers use different strategies such as transporting potatoes direct to the market to manage price volatility risk. Similar findings were reported by Alamerie *et al* (2013) that potato farmers in Ethiopia employed sequential marketing in managing price volatility. The sequential sale refers to the spreading sales and making several sales of potatoes during the year. This strategy is commonly used by potato smallholder farmers in the study area. Furthermore, it was noted that, smallholder farmers harvested potatoes in piecemeal over the harvesting time to manage price volatility risk (Alamerie *et al.*, 2013). Additionally, Nyunza and Mwakaje (2012) pointed out that, potato smallholder farmers in Tanzania especially the rich ones were selling potatoes to wholesalers in urban area such as Mbeya, Arusha, Dodoma and Dar es Salaam.

In terms of managing potato post-harvest losses, the findings show that potato smallholder farmers use strategies such as re-harvesting potatoes and use as seed potatoes for the next planting season, close supervision during harvesting and selling immediately after harvesting. This suggest that, management of post-harvest losses among potato smallholder farmers is an important aspect in potato farming. This could be explained by the fact that, in the most of the developing countries such as Tanzania, post-harvest losses at the farm level not only reduces available food for family consumption but, directly affects smallholder farmers' income and livelihoods in general. Alamerie *et al.* (2013) also reported that strategies such as selling perishable crops immediately after harvesting was one of the strategies that farmers employed in managing potato post-harvest losses.

4.1.4. Number, Frequency of use and average costs of Risk Management strategies among potato smallholder farmers

Regarding the number of risk management strategies used by potato smallholder farmers, results show that an average of 5 risk management strategies were used in the study area. This indicates that, most of potato smallholder farmers use a combination of strategies in managing both production and marketing risk hence improved potato enterprise performance. In the same line, Namwata, *et al.* (2010) also revealed that, an increased household income was significantly positively associated with number of technologies adopted. In terms of the frequency of risk management strategies use, the findings show that, potato smallholder farmers had an average of 20 times. This suggests that, potato smallholder farmers frequently faced with climate, pests-disease and marketing risks as a result they increased the frequency of risk management strategies use. Additionally, the findings indicate that, potato smallholder farmers had a mean of Tshs 388,383.1135 (167.39USD) as the costs for employing risk management strategies per one acre per season, in the study area. Potato smallholder farmers incurred this cost in management of climate, pests-disease and marketing risks. The risk management strategies potato smallholder farmers employed in controlling these risks included the use of seed potato, fungicides and pesticides, irrigation costs, harvesting for second time and transporting their potatoes to the market. Okonya *et al.* (2019) also revealed that, the top four most important constraints identified by farmers for potato were diseases, high costs of planting material, high cost of fungicides, and insect pest in Rwanda.

Table 2: Number, Frequency of use and average costs of Risk Management strategies among potato smallholder farmers

Variable	Mean	Standard deviations
Number of Risk Management strategies	5	1.54295
Frequency of Risk Management strategies use	20	5.49163
Average costs for RM strategies	388,383.1135	311,961.18845

4.2. Potato production Costs and Revenues

Potato smallholder farmers had a mean of 1,264,752.8684Tshs (545.11USD) as a total production and marketing costs for one acre per season in the study area. This amount is mostly used in purchasing clean seed potatoes, transport their potatoes to the big market, frequently spray their farms with fungicides and pesticides hence higher potato cost of production and marketing. These findings are in line with Daniel (2015) that in Njombe town council the cost of production and marketing per acre was Tshs 1,273,889 (549.05 USD) higher compared to Wanging'ombe district because in Njombe urban district majority of potato farmers depend on irrigation while farmers in Wanging'ombe district depends on rain fed agriculture. Additionally, Nyunza and Mwakaje (2012) pointed out that, most of the poor and low producer farmers were selling their potatoes to village traders or fellow farmers, while big producers and rich farmers were selling to wholesalers in urban areas. This is because the poor cannot afford to take round potatoes to the larger markets. They also produce round potatoes in small quantities.

In terms of potato revenue, in rainy season, potato smallholder farmers got 2,520,090.28 Tshs (1086.16USD) per season in the study area. On the other hand, in dry season, the potato revenue was 2897603.52 Tshs (1248.87 USD) among smallholder farmers. This indicates that, potato smallholder farmers had higher (2,897,603.52 Tshs equivalent to 1248.87 USD) potato revenues in the dry season compared to rainy season. The possible explanation for this could be that, in the dry season potato smallholder farmers had higher potato yield of 100.65 bags than in rainy season hence higher potato revenues. Additionally, potato smallholder farmers might probably had allocated large size of land on potato production during dry season hence increased the likelihood of having higher yield thereby making potato revenues higher. For example, the studies by (Glauben *et al.* 2003; Goetz and Debertain 2001) show that large farm sizes make farming much more economically viable for the farmers by enabling them to reap economies of scale and bring in use better and cost-effective technologies hence higher revenues. Moreover, less pests and disease in dry seasons hence higher yield which is translated to higher revenues than in rainy season among potato smallholder farmers.

Table 3: Potato Production Costs and Revenues for Potato smallholder farmers in Tanzania

Variable	Mean	Standard deviations
Potato revenue in season one-rainy (Tshs)	2,520,090.28	317,991.56
Potato revenue in season two-dry(Tshs)	2,897,603.52	315,703.07
Annual potato farm income (Tshs)	2,634,645.66	317,260.66
Total production and marketing costs for one acre	1,264,752.86	749,281.63

4.3. Effect of on-farm risk management strategies' attributes on potato enterprise performance among smallholder farmers

Multiple regression model was employed to determine the effect of on-farm risk management strategies' attributes on potato enterprise performance. In this model, the dependent variable was potato enterprise performance which was proxied by potato revenues. In terms of explanatory variables, number of risk management strategies, frequency of risk management strategies use, effectiveness of risk management strategies and average costs of risk management strategies were considered in the model. Findings show that, number of on-farm risk management strategies had positive and significant effect on potato enterprise performance among potato smallholder farmers in Njombe at 10% level of significance. This implies that, more number of risk management strategies made potato smallholder farmers to control both production and marketing risks hence higher potato revenues which then improved potato enterprise performance.

This is in line with findings by Namwata *et al.* (2010) that, increased household income was significantly and positively associated with number of technologies adopted in the study area. Hence, employing more risks management strategies among potato smallholder farmers minimize the negative impact associated with both production and marketing risks which in turns improves potato enterprise performance. Rahuta and Alib (2017) also illustrated that smallholder farmers who adopted more adaptation practices had higher food security levels than those who did not, and experienced lower levels of poverty. This is because, climate change adaptation practices at farm level can thereby have significant development outcomes in addition to reducing exposure to weather risks among smallholder farmers. It was further pointed out that, household income levels are high per month indicating that those households adopting climate-risk management strategies have higher income levels. Regarding the frequency of risk management strategies uses, the results reveal that a unit increase in the frequency of risk management strategies leads an improved potato enterprise performance among potato smallholder farmers. However, the findings further highlight that, there was no significant effect of frequency of risk management strategies used on potato enterprise performance among smallholder farmers.

Perceived effectiveness of the risk management strategies employed by potato smallholder farmers had a positive and statistical significance at 5% level of significance. This suggests that, when risk management strategies are more effective, then potato revenues increased which led to the improvement in the potato enterprise performance. This is because, an effective risk management strategies help potato smallholder farmers to manage climate risks, pests-diseases and marketing risks hence increase their potato yield and revenues as a results potato enterprise performance improved. Moreover, effective risk management strategies mean controlling production and marketing risks better hence fewer losses and lower operational costs and more profit. In the same line, Chakra borty and Banerjee (2016) reported that, production risks such as late blight of potato can effectively be managed by applying fungicides such as Fenamidone, Mancozeb among others. The study further pointed out that, spraying potato farm with Fenamidone and Mancozeb had exhibited best management of late blight of potato in terms of percent reduction of disease. On the other hand, Beyanet *et al.* (2014) revealed that, irrigation is one of the most useful and effective risk management strategy which increases production and productivity and reduces risk related with rainfall variability and increasing income of rural farm households. The findings further highlighted that, participation in irrigation has a significant and positive effect on farm households' income (Beyanet *et al.*, 2014). In addition, Osewe *et al.* (2020) postulated that, the use of farmer-led irrigation was effective and had a positive and significant effect on the smallholder farmers net crop income in the Southern highlands of Tanzania. In the same line, FAO (2016) noted that, effective agricultural risk management strategies play a vital role in fostering productive and sustainable investment across the agricultural value chain. This in turns ensure food and nutrition security, eliminate hunger and reduce poverty. In additional, effective risk management strategies enable African countries to achieve the annual target of 6 percent agricultural GDP growth (FAO, 2016).

Cost of risk management strategies, had a statistical and positive effect on the potato enterprise performance at 10 % level of significance implying that, an increase in unit of cost of risk management strategies improved potato enterprise performance. However, the cost of employing risk management strategies is higher than the benefit potato smallholders get as a result of

employing the strategies in managing production and marketing risks. The high costs could be as a result of potato smallholder farmers employing risk management strategies such as irrigation systems, transporting potatoes to the market, use of pesticides and fungicides among others. This shows how important the employed risk management strategies are in the study area. FAO (2013) pointed that, an important aspect of risk management is that all responses to risk involve a cost. This cost is expressed by the amount of resources tied up in order for the farmer to manage the production and marketing risks more effectively. Rahko (2012) on the other hand highlighted that, due to the challenge of pests and diseases, use of chemicals has been among the significant determinant of potato yield in Tanzania. These findings are in line with Okello *et al.* (2015) who pointed out that, majority of the respondents in Tanzania use pesticides to control potato pests and diseases as a results high demand of the chemicals which lead to high price hence high cost of risk management strategies among potato smallholder farmers. In the same line, Daniel (2015) also recommended the government to come up with policies aimed at subsidizing the cost of farm inputs such as pesticides so as to lower the cost of production among potato smallholder farmers in Tanzania. Schreinemachers *et al.* (2012) also reported that, chemical use per hectare especially fungicides and bactericides had generally increased more than proportionally with crop output per hectare.

Table 4: Multiple Regression results of the effect of risk management strategies on potato enterprise performance among potato smallholder farmers

Variables	Coefficient	Std. Error	t-value	p-value
(Constant)	-646078.856	571105.926	-1.131	0.259
Number of RM Strategies used	197489.975*	112585.954	1.754	0.080
Freq. of RM Strategies use	8391.092	30682.543	.273	0.785
Effectiveness of RM Strategies	43109.513**	20544.848	2.098	0.037
Costs of RM Strategies	0.654*	0.365	1.791	0.074
Number of observations	375			
F-test	6.454***			0.000

Note: **, *Significant at 5% and 10%, respectively

Conclusion

Perceived effectiveness, cost and number of on-farm risk management strategies are the key determinants of potato enterprise performance among smallholder farmers in Tanzania. On the other hand, frequency of risk management strategies use was insignificant variable in determining potato enterprise performance.

Recommendations

- Cost of risk management strategies had improved potato enterprise performance among smallholder farmers in Tanzania. However, the cost of employing risk management strategies is higher than the benefit potato smallholders obtain as a result of the strategies employed. The high costs had resulted from employing risk management strategies such as irrigation systems during low rainfall and frost bites. Therefore, Lusitu Agribusiness Group through the loans from the Tanzania Agricultural Development Bank (TADB) to establish a village center with irrigation facilities (LAG-Irrigation Centre) that potato smallholder farmers will be hiring. This will dramatically reduce the costs associated with risk management strategies in the study area.
- Potato smallholder farmers to continue employing the effective risk management strategies such as the use of irrigation system, fungicides, accessing marketing information in order to boost potato enterprise performance in Tanzania.
- Potato smallholder farmers should increase the number of risk management strategies employed in managing both production and marketing risks to boost potato enterprise performance in Tanzania.

Further research

The study was limited in determining how the on-farm risk management strategies' attributes boost potato enterprise performance. Hence, a research on the impact of risk

management strategies on food security would be interesting. Additionally, it could help to figure out how risk management strategies' attributes such as crop insurance' coverage level and indemnity affects food security of potato smallholder farmers in Tanzania.

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REFERENCES

- Alamerie, K., Ketema, M. and Gelaw, F. (2013). Risk Management Strategies and Pesticides Use in Vegetable Production; the case of Smallholder farmers in Kombolcha, Woreda, East Harare Zone, Oromia National Regional State, Ethiopia. *Journal of Economics and Sustainable development*, Vol.4, (7), pp. 108-115.
- Banterle, A. and Vandone, D. (2013). Price Volatility and Risk Management: The Case of Rice. Paper presented at the 164766, International European Forum on Innovation and System Dynamics in Food Networks in Innsbruck-Igls, Austria.
- Bauer, L. and Bushe, D. (2003). *Managing the Modern Farm Business: Designing the Management Strategies* 3rd edition. Edmonton, Canada: University of Alberta.
- Beyan, A., Jema, H. and Adem, K. (2014). Effect of Small-scale Irrigation on the Farm Households' Income of Rural Farmers: The Case of Girawa District, East Hararghe, Oromia, Ethiopia," *Asian Journal of Agriculture and Rural Development*, vol. 4(03), pages 1-10.

- [5] Cervantes-Godoy, D., Kimura, S. and Antón, J. (2013). Smallholders' risk Management in Developing Countries. OECD Food, Agriculture and Fisheries Papers, No. 61, OECD Publishing.
- [6] Chakraborty, A. and Banerjee, H. (2016) Effective Management Strategies against Late Blight disease of Potatoes, *Journal of Agriculture* 14(1): 111-117.
- [7] Daniel, B. (2015). Economic Analysis of Irish potato value chain in Njombe urban and Wanging'ombe districts, Tanzania; A Dissertation submitted in partial fulfilment of the requirements for the degree of MSc. in Agricultural and Applied Economics of Sokoine University of Agriculture, Morogoro, Tanzania. Pp. 116.
- [8] FAO (Food and Agricultural Organization of the United Nations). (2016). Agriculture and Food Insecurity Risk Management in Africa; Concepts, lessons learned and review guideline.
- [9] FAO (Food and Agricultural Organization of the United Nations). (2007). Approaches to linking producers to markets, Rome, FAO.
- [10] FAO (Food and Agricultural Organization of the United Nations). (2013). Farm management extension guide, MANAGING RISK in farming, Rome, Italy.
- [11] Hardaker, J. B., Huirne, R. B. M., Anderson, J. R. and Lien, G. (2004). *Coping with Risk in Agriculture*. 2nd Edition. CAB International Publishing. Wallingford, United Kingdom.
- [12] Jaffee, S., Siegel, P. and Andrews, C. (2010). Rapid agricultural supply chain risk assessment: A Conceptual Framework. *Agriskmanagementforum.org*. Accessed on 10th February 2018
- [13] Jeffrey, R. (1992). *Probability and the Art of Judgment*. Cambridge University Press, 1992. ISBN 0-521-39770-7
- [14] Kabungo C.V.D. (2008). Evaluation of Irish Potato production and marketing performance in Mbeya rural District, Tanzania, MSc. thesis in Agricultural economics of Sokoine University of Agriculture, Morogoro, Tanzania. 104pp.
- [15] Kagona, J.D.Z. (2008). The incidence of Bacterial wilt (*Ralstonia solanacearum*) in informal potato planting material used by farmers in Dedza and Ntcheu districts of Malawi. A thesis submitted in partial fulfillment of the requirement for the degree of Masters of Science (Management of Natural Resources and Sustainable Agriculture) pp. 50
- [16] Kammar, S. K. and Bhagat, R. (2009). Constraints experienced by farmers in adopting risk and uncertainty management strategies in Rain fed agriculture. *PusaAgri Science* 32: 70-74. Accessed on 26th November 2017.
- [17] Kilimo Trust. (2017). Calories and Household Incomes from Potatoes Sub-sector (CHIPS) Project, Baseline survey report, unpublished.
- [18] Kisaka-Lwayo, M. and Obi, A. (2012). Risk Perceptions and Management Strategies by Smallholder famers in Kwa Zulu-Natal Province, South Africa. *International Journal of Agricultural Management*, 1(3), 28-39.
- [19] Korir, L. K. (2011). Risk management among Agricultural households and the Role of OFF-farm investments in Uasin-Gishu county, Kenya. MSc. thesis in Agricultural and Applied Economics of Egerton University, Kenya. 48pp.
- [20] Korir, L. K. (2011). Risks Management among Agricultural Households and the Role of Off-farm Investments in Uasin-Gishu County in Kenya. *Current Journal of Economics Theory*, 3(2), 62-68.
- [21] Maguire, L. A. and Albright, E. A. (2005). Can behavioral decision theory explain risk-averse fire management decisions? *Journal of Forest Ecology and Management* 211. 47-58.
- [22] Majeed, A. Ahmad, H., Ali, M. A. and Khan, H. (2014). Effect of systemic and contact fungicides on late blight disease and tuber yield of potato. *Journal of Agricultural Technology* Vol. 10(1):209-217
- [23] Mantecon, J.D. (2007). Potato yield increases due to fungicide treatment in Argentinian early blight (*Alternariasolani*) and late blight (*Phytophthorainfestans*) field trials during the 1996-2005 seasons. *Journal of Fungi and Nematodes Tests*. 55:221.
- [24] Mwakaje, A. E. (2010). Information and Communication Technology for Rural Farmers: *Journal of Information Technology Impact* 10 (2):111-128.
- [25] Namwata B. M. L, Lwelamira, J. and Mzirai, O. B. (2010). Adoption of improved agricultural technologies for Irish potatoes (*Solanum tuberosum*) among farmers in Mbeya Rural district, Tanzania: A case of Ilungu ward. *Journal of Animal & Plant Sciences*, Vol. 8, Issue 1: 927- 935.
- [26] Nyunza, G. and Mwakaje, A. (2012). Analysis of Round potato marketing in Tanzania: The case of Rungwe district, Tanzania. *International Journal of Business and Social science* vol. 3 no. 23; pp.86-96.
- [27] Obalola, T. O., Agboola, B. O., and Odum, E. B. E. (2017). Profitability and Constraints to Irrigated Onion Production in Wamakko and Kware Local Government Areas
- [28] Okello, J. J., Kwikiriza, N., Kakuhenzire, R., Parker, M., SchulteGeldermann, E. and Pambo, K. (2015). Micro and Meso-level issues affecting Potato production and marketing in the Tropical highlands of Sub-Saharan Africa: The Known and the Unknowns: Selected Paper Submitted to the 2015, American Applied Economics Association meetings at San Francisco, California, United States of America.
- [29] Osewe, M., Liu, A. and Njagi, T. (2020). Farmer-Led Irrigation and Its Impacts on Smallholder Farmers' Crop Income: Evidence from Southern Tanzania, *International Journal of Environmental Research and Public Health* 17(5).
- [30] Parmigiani, G., Johns-Hopkins, J. and Lurdes Y. T. (2010). *Decision Theory Principles and Approaches*: Wiley Series in Probability and Statistics.

- [31] Raghuvanshi, A., Gauraha, A. K. and Chandrakar, M. R. (2018). Post-harvest losses in potato and factors affecting post-harvest losses at farm level in Chhattisgarh, *Journal of Pharmacognosy and Phytochemistry*; 7(3): pp.3122-3124.
- [32] Rahko, J. (2017). Potato Value Chain in Tanzania. MSc. Thesis, University of Helsinki.
- [33] Rahuta, B. D. and Alib, A. (2017). Coping with climate change and its impact on productivity, income, and poverty: Evidence from the Himalayan region of Pakistan. *International Journal of Disaster Risk Reduction*; 24 pp 515-525.
- [34] Schreinemachers, P. and Tipraqsa, P. (2012). Agricultural pesticides and land use intensification in high, middle and low income countries. *Food Policy* 37:616–626.
- [35] Shikuku, K. M., Winowiecki, L., Twyman, J., Eitzinger, A. and Perez, J.G. (2017). Smallholder farmers' attitudes and determinants of adaptation to climate risks in East Africa, *Journal of Climate Risk Management* 16. 234-245.

