Potential Implications of Production and Market Risks on Potato Farming Enterprise among Smallholder Farmers in Tanzania

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ABSTRACT

Despite the risks that potato smallholder farmers face that are thought to affect the profitability and viability of the enterprise, little is known on the implications of the production and market risks on potato farming enterprise in Tanzania. Therefore, this study aims at determining the effects of production and market risks on potato farming enterprise among smallholder farmers in the study area. Therefore, this study uses cross-sectional data collected from 384 potato smallholder farmers in 2019, to first the likelihood of the selected production and market risks affect potato farming enterprise and how they affect the potato farm income among smallholder farmers. Data is analysed by use of descriptive statistics and, a multiple regression model is used to determine the effect of the selected production and market risks on potato farming enterprise. Empirical results from multiple regression model reveal that, climate risks (low rainfall and frost bite) and market risks (price volatility) have a positive and significant effect on potato farming enterprise among smallholder farmers in Tanzania. The findings of this paper have several policy implications. First, potato smallholder farmers to invest/ hire irrigation facilities especially during low rainfall and frost bites incidences so that they able to take advantages of the low supply of potato in the market hence fetching higher potato market prices. Second, potato smallholder farmers to observe price movement which follows a pattern of being high before the harvest, dropping at harvest time and rising again towards the end of the season. This information, could help potato smallholder farmers to plan when to plant and harvest potatoes and be able to have potatoes ready to sell when prices are good. Third, the government should come up with policies that help potato smallholder farmers to develop resilience mechanisms to manage potato price volatility. The polices should focus on developing Information Communications Technologies (ICT) related platforms such as (M-Kilimo) with the purpose of improving the content and speed of disseminating market information such as potato price volatility.

KEYWORDS: Production risks, market risks, potato farming enterprise

1. INTRODUCTION

Potato enterprise in most Sub-Saharan countries is a risky business. The enterprise faces many types of risks that affect its profitability and viability. These risks include production, market, policy and personal risks (Cervantes-Godoy *et al*., 2013). Most of these risks cannot be controlled by smallholder farmers as many of them are systemic in nature as with a single event leading to multiple and highly

correlated crop losses. Production risks specifically, present a challenge to farmers whose livelihoods depend on income generated from potato farming. On the other hand, marketing risks such as output prices in Tanzania are very volatile. Potato smallholder farmers lack facilities for storing their produce to sell when prices are more favorable. This discourages smallholder farmers from marketing their potatoes and removes a key incentive for farmers to invest more in potato enterprise. The fluctuations in farm-incomes caused by yield loss, price volatility and potato post-harvest losses may present welfare problems for rural potato producers and other actors in the value chain. For instance, potatoes lost through bacterial wilt and late blight reduces employment opportunities for smallholder farmers and limit sales by potato farmers, traders, retailers and agro-processors. This not only reduces average income and welfare among value chain actors but also reduces the national income from the sub sector.

Production and price risks contribute significantly to high economic losses throughout the developing world and help to perpetuate poverty and income inequality. Most studies reveal that production and price risks are likely to reduce agricultural productivity, production stability and household income in some areas that already have high levels of food insecurity (Greg *et al*., 2011). On the other hand, Harvey *et al*. (2014) reveals that the amount of crop lost to pests, diseases, storage problems or extreme weather events and the accompanying income loss was highly variable across households, with impacts ranging from mild to severe. Specifically, the research shows that on average, about 29 percent of farmers lost less than a quarter of their crops to the cyclone while 10 percent lost more than 75 percent of their crops. Global markets have lately been fueling the price volatility of the agricultural commodities to such an extent that farmers often perceive price as being risky as yield (weather events and natural disaster). This non-weather risk, in the opinion of farmers, is a key influence on their income and it highly systemic of all agricultural risks (Janowicz-lomott *et al*., 2015). The concerns of farmers are confirmed by the fact that volatility in the market prices of agricultural products has a strong influence on crop revenue. Barret *et al*. (2008) reviewed a relationship between price volatility and small holder welfare found that greater price risk and low prices for potato has a negative on smallholder farmers discouraging them from selling their produces.

Producers are normally concerned about the downside risk, which is the risk that actual price is lower than the expected price. This means that prices for the crops grown may be so uncertain that what appears profitable when planted ends up unprofitable due to price decreases in the following months (Banterle & Van done, 2013).For example, in Rwanda, downward price fluctuation of potatoes is forcing farmers out of commercial farming due to losses. The fluctuation of price of potatoes may cause a problem first to farmers who fall in loss despite the effort in their investment in production process. Secondly, consumers of potatoes will encounter difficulties in finding potatoes in the country. As a result, the government will be forced to spend money on importing potatoes. However, farmers are also affected by the upward price fluctuation. Therefore, both cases, price volatility can adversely affect farm profitability (Dick, 2010; Pasaribu, 2010; Wolf, 2012).Despite the risks that potato smallholder farmers face that are thought to affect the profitability and viability of the enterprise, little is known on the implications of the production and market risks on potato farming enterprise in Tanzania. Therefore, this study aims at determining the effects of production and market risks on potato farming enterprise among smallholder farmers in the study area.

2. MATERIALS AND METHODS
2.1. Research design and study area
The study employed cross-sectional survey whereby data were collected at one point in time. This 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. The council has two main agroecological zones, namely: the highland zone of the council situated on the western escarpment, with rainfall ranging between 1,200-1,400 mm per annum. The northern-west part of the council gives way to lower zone covered by black and loam soil and experiencing rainfall ranging between 1,000 to 1,200 mm annually. Agriculture is the main economic activity in the council whereby 78 percent of the residents depend on it as the main source of household income (URT, 2013). Njombe town 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 the largest producer of potatoes and maize in the country. As a result, potato has become the leading food and cash crop in the council. In addition, potato has the highest production per hectare (8.4t per ha) compared to maize (2.5t/ha), beans (3.2t/ha) and wheat (2.9t/ha).
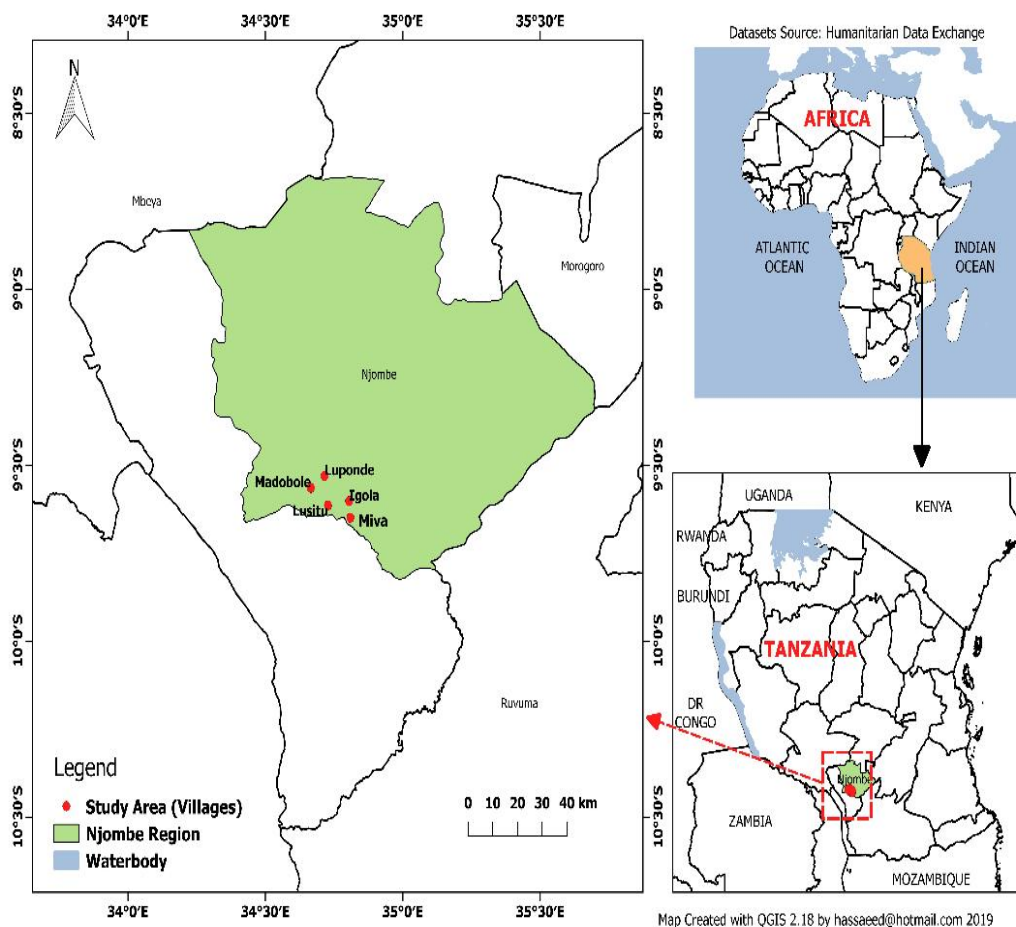

Figure 1: Map of Tanzania showing study areas
Source: ICPAC Geoportal and Humanitarian Data Exchange (2019)

2.2. Population of the study and Respondents
The target population for this study was the potato smallholder farmers who are members of Lusitu Agribusiness Group. Lusitu Agribusiness Group is a group of potato smallholder farmers which is located Igominyi division, Njombe town council. This Group has a total of 2000 members a of different sub groups from the villages of Igominyi division. The group has been implementing Lusitu Potatoes Pack House and Marketing Project in partnership with Kilimo Trust Tanzania.

2.3. 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. In stage three, five villages namely Lusitu, Luponde, Mbega, Miva and Igola were also selected. Then, proportionate stratified sampling technique was used to determine number of potato SHFs from each village. Finally, the actual potato smallholder farmers of Lusitu Agribusiness Group were randomly selected from the given source list to make a sample size of 384.

2.4. Data collection
The study employed a semi-structured questionnaire to collect data on perceived effect levels of the selected production and marketing riskson potato farm incomes in the study area. This method was suggested by Senkondo (2000) which is referred to as risk analysis using a structured questionnaire. The method specifically used a five-point likert scale approach to enable quantification of the perceived effect levels of the selected production and marketing risk on potato farm incomes. Potato smallholder farmers were therefore first asked to rank the likelihood of risks to affect potato farm incomes. The ranks were 1=Very unlikely, 2= Unlikely, 3= average/moderate, 4=Likely and 5= Very likely. Then, smallholder farmers were asked to rank the perceived effect levels of the selected revenue risks on potato farm incomes by using

a five point likert scale where 1 = very low, 2 = low, 3 = average/moderate, 4 = high and 5 = very high/severe.

2.5. Data Analysis

SPSS and STATA software were used to manage the collected data.Descriptive statistics were used to describe the smallholder farmers' likelihood and perceived effect levels of the selected production and market risks on potato farm incomes from a five-point likert scale of very low, low, average/moderate, high and very high/severe. Since data pertaining to perceived effect levels of the selected production and marketing risks consists of possibly correlated variables, then confirmatory factor analysis was used to reorient the data and to create a few numbers of orthogonal variables which account for as much of the available information as possible (Jollife, 2002). The basic idea underlying factor analysis is that, p observed random variables,

$$X = [x1, x2, \ldots \ldots \ldots xp] \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Equation 1 can be expressed as linear functions of m (<p) latent factors

$$F = [f1, f2, \ldots \ldots \ldots fm] \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots ((2)$$

$$\sum_{k=1}^{m} \lambda jk fk + ej \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3)$$

Where

$\lambda jk, j = 1,2 \ldots p, k = 1,2, \ldots m$ denotes factor loadings and $ej, j = 1,2, \ldots, p$ error terms

Factors that were confirmed from this analysis have the property that each factor is uncorrelated with all others and thus can be included as explanatory variables in the multiple linear regression model to determine the perceived effects of the selected revenue risk on the potato farm incomes. The model is specified as follows:

Potato farm revenues = f (PELsClimate risks, PELspestsdiseases, PELsMarketing risk)

$$Yi = \beta0 + \beta1X1 + \beta2X2 + \varepsilon \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4)$$

Bo=intercept

$\beta1$and $\beta2$=Coefficients of independent variables

Yi=Dependent variable

X1, X2…Xk= Explanatory variables

$$PFIs = \alpha + \beta1PELsClimate\ risk + \beta2PELsPestsdiseases\ risk + \beta3PELsMarket\ risk \ldots (5)$$

Table 1: Variable description

Variable	Description	Unit of Measurement	Exp. sign
Effect of the selected revenue risk on potato farm revenues			
Dependent variable	Dependent variable	Dependent variable	
POTATOFARINCOME	Potato farm incomes	Continuous (TZS)	None
Independent variables	Independent variables	Independent variables	
EFFFROSTREVE	Effect of frost on potato revenues	Ordinal 1 = very low, 2 = low, 3 = average/moderate, 4 = high and 5 = very high/severe	-
EFFRAINSOREVE	Effect of too much rains on potato revenue	Ordinal 1 = very low, 2 = low, 3 = average/moderate, 4 = high and 5 = very high/severe	-
EFFDROUOREVE	Effect of low rainfall on potato revenue	Ordinal 1 = very low, 2 = low, 3 = average/moderate, 4 = high and 5 = very high/severe	-

Variable	Description	Unit of Measurement	Exp. sign
EFFLATEOREVE	Effect of Late blight on potato revenue	Ordinal 1 = very low, 2 = low, 3 = average/moderate, 4 = high and 5 = very high/severe	-
EFFBACTOREVE	Effect of Bacterial wilt on potato revenue	Ordinal 1 = very low, 2 = low, 3 = average/moderate, 4 = high and 5 = very high/severe	-
EFFVOLAONREVE	Effect of potato price volatility on potato revenue	Ordinal 1 =very low, 2 = low, 3 = average/moderate, 4 = high 5 = very high/severe	+/-
EFFPPLOSSESONREVE	Effect of Potato post-harvest losses on potato revenues	Ordinal 1 =very low, 2 = low, 3 = average/moderate, 4 = high 5 = very high/severe	-

3. RESULTS AND DISCUSSION
3.1. Characteristics of potato smallholder farmers in the study area
3.1.1. Household Characteristics

Results show that, the average age of potato household head was 39.34 years in Njombe town council. This implies that, more middle aged people are engaged in potato farming than the younger ones. This finding could be attributed by the fact that youth are mainly limited with resources including land as a result they only able to have less or one acre of land hence less of them area engaged in potato production. For example, Ahaibwe *et al*. (2013)points out that young people encounter significant constraints and are disadvantaged in their attempt to engage in agriculture compared to the prime age group. The findings are in line with Daniel (2015) that, middle age group is more active compared to the younger group in potato production. Additionally, Kilimo Trust (2017) pointed out that, the distribution of age among potato smallholder farmers shows that 30% of them were aged between 18 to 35 years (36%) followed by 35 to 45 years (32%). Similarly, Kabungo (2008) also reported that age has influence on round potato production since activities associated with its production are very tough hence require energetic people.

In terms of education level of respondent, the findings point out that, potato smallholder farmers had a mean of 7.29 years spent in school. This suggest that, on average potato smallholder farmers in Tanzania had attained primary school level. In other words, the results imply that, majority of household heads in the study area were literate enough to adopt and use agricultural production technologies from different sources such as agricultural extension agents, publications and mass media. In addition, it is expected that educated farmers would be more profit oriented than those with no formal education. Similar results were reported by Daniel (2015) that majority (70%) of Irish potato producer had primary education in Njombe town council. Additionally, Okello *et al*. (2015) also pointed out that, on average potato smallholder farmers in Njombe spent 6.34 years in schooling.

Moreover, the results show that potato smallholder farmers had a mean household size of 5 in the study area. Household size has implication on family labour availability and production costs. Large household size is an important asset in working together in household economic activities. However, this occurs where almost all of the household members take part in production and or service provision to contribute to the economy of the household. On the other hand, large household size for the small potato farmers imply higher food and non-food expenditure forcing the households to allocate more land for potato production hence be able to have additional economic benefits to meet their basic needs. According to Ayuya *et al*. (2015) more household members imply higher food and non-food expenditure forcing the households to try out new low cost initiatives that could have additional economic benefits to meet their basic needs.

Furthermore, findings reveal that potato smallholder farmers owned an average of 18 of animals in the study area. This indicates that, potato smallholder farmers depend on crop and livestock farming as the main source of income and livelihood in general. The various types of animals that are kept in the study area included dairy animals, poultry, rabbits and sheep among other. These findings are in line with Okello *et al*.

(2015) that potato farmers in Njombe also keep various types of livestock such as dairy animals, poultry, rabbits and sheep. The study moreover pointed out that, livestock are kept for the source food, income and also act as a stock of wealth, hence play a significant role in the wealth-ranking of the households. The size and type of flock determines whether the household is considered very wealthy, of average wealth or poor. Large animals (e.g., cattle and donkeys) are associated with wealthier households while small animals such as rabbits and poultry (e.g., chicken, ducks and pigeons) are associated with poorer households (Okello *et al*., 2015).The average annual household income for the potato smallholder farmers in the study area was 4,464,432Tshs. Moreover, about 2,634,645.6693 Tshs of the annual household income comes from potato production. This implies that, potato is a highly valuable crop among potato small farmers and it has a considerable contribution to household income. Mende *et al*., (2014) pointed out that, potato was the main source of income in Mbeya and Makete Districts. On the other hand, about 40 percent of the total household income is contributed by other economic activities such as livestock keeping in the study area. According to Okonya *et al*. (2019) annual income from both on-farm and off-farm activities contributed to the total annual household income. Mende*et al.*(2014) also revealed that, most of the households had been obliged to undertake nonagricultural activities to improve their incomes and the non-agricultural activities had been filling up the gap by directly increasing households' income and providing cash for investment in farm inputs to increase agricultural production. The study further pointed out that, livestock keeping was also one of the income sources for most of the potato households. The livestock keeping activity plays multiple roles in the study area as it facilitates income generation, employment and draught power (Mende *et al*., 2014). Moreover, results of this show that, 73.8 percent of potato smallholder farmers in the study area were male where as 26.2 percent of them were female. In terms of household status, 83.6 percent of potato smallholder farmers' households are male headed while 16.4 percent of them were male headed households. This implies that potato is a male dominated crop in Njombe town council. This could be attributed by the fact that potato is considered as a cash crop in the study area hence more male in the enterprise. Mpogole et al. (2013) reported that, on average, 88 percent of all potato produced by farmers is sold out. This indicates that potato is among the highly commercialized crops in Tanzania as a result more male are attracted to the crop. In terms of main income earner, the findings show that 84.3percent of the interviewed respondents are the main income earners in the study area. On the other hand, only, 15.7 percent of them are not the main income earners. This implies that, potato farming has become a main source of income hence most of potato smallholder farmers in Tanzania are main income earners.

Table 2: Descriptive statistics of household characteristics of potato smallholder farmers

Variable	Description	Mean	Standard deviations
Age of the HHH	Age of the HH head (years)	39.34	13.02
Edu	Education (years)	7.29	2.83
HHousehold size	Household size	5.00	2.23
Noanimals	Number of animals	18.00	6.00
Annual HH income	Annual HH income (Tshs)	4,464,432.80	647,565.64
Variable	**Description**	**Frequencies**	**Percent**
Gender of respondent	Male	282.00	73.80
Gender of respondent	Female	100.00	26.20
Household status	Male headed household	321.00	83.60
Household status	Female headed household	63.00	16.40
Main income earner	Yes	323.00	84.30
Main income earner	No	60.00	15.70

3.2. Likelihood of climate risks affecting potato farming enterprise

In terms of the likelihood of low rainfall to affect potato farm income, the results pointed out that, 32.1% of respondents reported it is very likely for low rainfall to affect potato farm income while 14.9% of potato smallholder farmers reported that it is likely for the low rainfall to affect potato farm income in the study area. This is because most of the potato farmers use irrigation system as a risk management strategy when it comes to low rainfall. These findings are in line with Daniel (2015) that in Njombe town council, majority of smallholder farmers depend on irrigation hence their potato farm income is less affected by the presence of low rainfall.

Figure 2shows that 63.5% of small holder farmers reported that it is very likely for too much rainfall to affect potato farming enterprise whereas 23.5% of them revealed that it is likely for the too much rainfall to affect it. This implies that, too much rainfall is a major challenge that affect potato farm incomes. This could be contributed by the fact that, too much rainfall is a conducive environment for the development of fungal pathogens which are responsible for the late blight disease thereby affecting potato farm income among smallholder farmers in the study area. According to the report by the United Republic of Tanzania URT (2016) change of weather conditions such as too much rainfall, affects potato production hence potato farm incomes in Njombe. In terms of frost bites, findings revealed that, 66.1% of the interviewed smallholder farmers reported that it was very likely for the frost bite to affect potato farm income compared to the 15.7% who said the bite was likely to affect potato farm incomes in the study area. This implies that, about 81.8 % of smallholder farmers in Njombe town council revealed that, frost bite is likely to affect potato farm income among them. URT (2016) also reported that change of weather conditions such as frost affects potato production hence affect income from potatoes among the smallholder farmers.

3.3. Likelihood of Pests-diseases affecting potato farming Enterprise

The findings show that, 60.6 percent of potato smallholder farmers reported it was very likely for the late blight disease to affect potato farming enterprise whereas 27.4 percent said that late blight disease can likely affect potato farm incomes. This implies that, majority (88%) of potato smallholder farmer agree that late blight disease affects potato farm income in the study area. Okonya (2019) also revealed that, potato late blight is the most prevalent disease among smallholder farmers in Rwanda and Burundi. Moreover, the results of this study pointed out that, 67.6% of all the smallholder farmers in the study area reported that bacterial wilt was very likely to affect potato farm income. It was further revealed that 18.5 % said that the disease was likely to affect potato farm incomes. This suggests that, bacterial wilt is an important potato disease in the study area with 86.1 % of smallholder farmers reported that it is likely for the disease to affect potato farm income. Okonya (2019) suggested that bacterial wilt disease was ranked as the most important potato disease in Rwanda and Burundi. In the same lineKagona (2008) pointed out that,100% of the farmers were aware of the occurrences of bacterial wilt in their field and how it spreads in the study area. Therefore, the results confirmed that bacterial wilt is a great problem and threat to the Malawi potato industry(Kagona, 2008). Additionally, Okello *et al.* (2015) revealed that majority of potato farmers are planting potato on the same plots every season. These practices have resulted in the build of pests and diseases in the study areas.

3.4. Likelihood of marketing risks affecting potato farming Enterprise

Results show that, 72.6 percent of potato smallholder farmers report that price volatility is very likely to affect potato farming enterprise whereas 17.2 percent price volatility is likely to affect their farms. This suggests that majority (90 percent) of potato smallholder farmers in the study area perceived the price volatility is very likely to affect potato farming in the study area. In line with these findings, Daniel (2015) revealed that marketing risk is the major challenge that potato smallholder farmers face in Njombe. Additionally, the study pointed out that majority of the farmers (32%) mentioned that low prices and inability to transport potatoes to market where prices were high were the main challenges in the study area. Nyunza and Mwajake (2012) further pointed out that, during harvest prices were very low in big markets and during post-harvest period prices were about thrice of the peak harvesting price.When it comes to post-harvest losses, the findings show that, 43 percent of potato smallholder farmers reported that post-harvest losses are very likely to affect potato farm incomes. This might be explained by the fact that, most of potato smallholder farmers use hand hoe to harvest potatoes as a results there is a possibility of more potatoes being left in the soil which lead to a decrease in yield thereby reduce potato farm incomes. These findings are in line with Kilimo trust (2017) that majority of potato producers (77%) were not using good post-harvest handling techniques hence the likelihood of post-harvest losses to affect potato farm income is very high. Tatwangire and Nabukeera (2017) also indicated that, use of different harvesting tools is strongly associated with significant levels of potato damage and this damage is highest when hand hoes are used to harvest in Uganda.
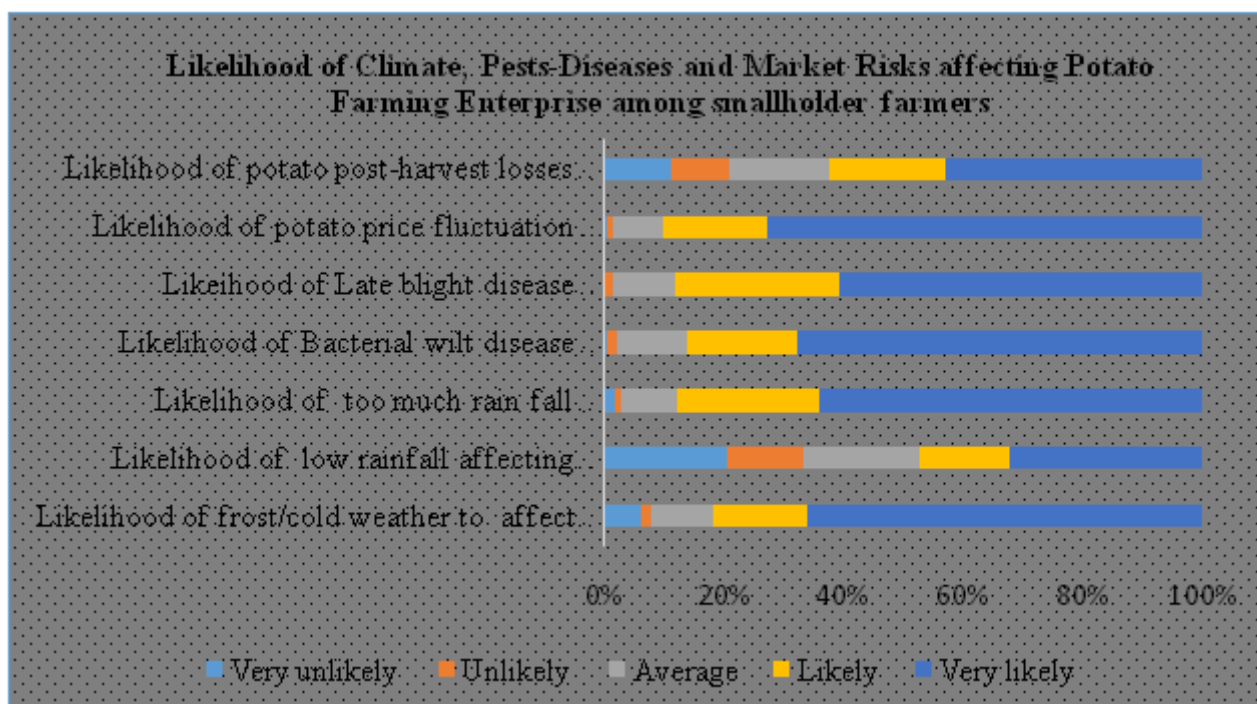
Figure 2: Likelihood of climate, pests-diseases and marketing risks affecting potato farming enterprise

3.5. Effect of selected climate, pests-diseases and marketrisks on potato farm income among smallholder farmers

Multiple linear regression model was used to determine the effect of the selected risks on potato farm income among smallholder farmers in the study area. The results from table 6 reveal that, when potato smallholder farmers experience frost bite their potato farm income increases by 266801.48 Tshs. This could be contributed by the fact that; the presence of frost bite potato smallholder farmers may experience reduced potato yield that might lead to low supply of potatoes in the market which may then cause high potato price thereby making potato farm income higher. Additionally, frost bite had a positive and significance effect on potato farm income at 10 % level of significance level among smallholder farmers.

In terms of perceived low rainfall, results show that when potato smallholder farmers experience low rainfall, their potato farm income increases by 579,715 Tshs. The findings further revealed that, there is a positive and statistically significant effect of low rainfall on potato farm income among smallholder farmers in the study area. This implies that, when potato smallholder farmers experience low rainfall, the supply of potatoes in the market is low which leads to high demand of potatoes thereby making potato market price higher and this contribute to potato smallholder farmers to have higher potato farm income. Daniel (2015) reported similar findings that low rainfall made potato smallholder farmers in Njombe urban to irrigate their farms hence be able to supply potatoes in the market thereby fetching higher price and higher gross margins. The study further pointed out that irrigation was statistically significant at 5% significance level and positively related to the Irish potato gross margin. This implies that farmers who irrigated their land had higher chances of getting larger gross margin than those who areproducing under rain fed.The findings reveal that, too much rainfall has a positive effect on potato farm income. This suggests that, the presence of high rainfall lead to the increase of potato farm income by 93177.82 Tshs among farmers in the study area. This might be contributed by the fact that; high rainfall leads to high moisture content which becomes a conducive environment for fungal pathogen development hence high incidence of late blight disease. As a result, farmers may experience low potato production which lead to low supply of potatoes in the market hence high prices thereby contributing to high potato farm income. However, the effect of too much rainfall on potato farm income was not significant.

In terms of perceived effect of pests-diseases on potato farm incomes, the findings reveal that, the presence of pests and disease had negatively affect potato farm income in the study area in line with.Okonya *et al.* (2019)reported that crop losses due to pests and diseases for potatoes was 33%-38%in Rwanda and Burundi. The study also pointed out that, pests and diseases reduce the profitability of root and tuber crops, threaten food security, and constitute a disincentive for investment among farmers.Additionally, these pests-diseases decrease agricultural yields, raise production costs and limit the storability and marketability of food. They

also make farming riskier as a livelihood or a commercial enterprise. Specifically, the findings revealed that, the presence of bacterial wilt decreases potato farm income by 60022.8 Tshs per among smallholder farmers whereas that of late blight decreases potato farm income by 317541Tshs per season. This implies that, late blight has a negative effect on potato farm incomes among potato smallholder farmers in the study area. However, there was no statistically significant effect of pests-disease on Potato farm income. These might be contributed by the fact potato smallholder farmers in the study area employ fungicides and pesticides to manage the effect of pests-disease on potato farm hence no statistical significant on potato farm incomes. These findings are in line with the ones from the descriptive statistics on the effectiveness of risk management strategies employed whereby majority of smallholder farmers agreed that fungicides and pesticides were effective in managing pests-disease risks.Moreover, the results show that, when smallholder farmers experience potato price volatility, their potato farm income increased by 522319.60 Tshs (225.12 USD). This means that, potato price volatility had a positive and significance effect at 5% on potato farm income among smallholder farmers in the study area. This could be explained by the fact that, potato price volatility concerns both the upside and downside therefore, during the upswing it is good for farmers hence their farm income is positively affected but it becomes a problem during a down swing. Nyunza and Mwijake (2012) revealed that, the average farm gate price of round potato in Mbeya ranged between Tshs 8,000 (3.45 USD) and Tshs 22,000 (9.49 UDS) per bag and that the prices varied depending on the variety of round potato, season and the buyer involved. The study further pointed out that, seasonal market flooding and scarcity were termed to be the cause of fluctuation in round potato price. Additionally,Arisoy (2017)noted that, in Turkey, potato prices increased in line with the decreasing supply that was caused by the occurrence of wart disease in the country. The study further revealed that, when the disease stopped affecting production, supply increased once again and this led to a serious cut in prices. Hence, potato farm income farmers obtained decreased approximately 3 times in comparison to the previous year (Arisoy, 2017). This implies that, when potato smallholder farmers experience climatic, pests-diseases and marketing risks their potato farmers decreased by 196.20 Tshs.

Table 3: Multiple Regression results of Perceived effect of Climate risks, Pests-Diseases and Market Risks on Potato farm income

Risk	Variable	Coefficient	Std. Error	p-value
Perceived Climate related Risks	Frost bites	266801.48*	142188.00	0.061
	Low rainfall	579715.00**	198133.40	0.004
	Too much rain fall	93177.82	204870.90	0.650
Perceived Pests-diseases Risks	Bacterial wilt	-60022.80	199159.90	0.763
	Late blight	-317541.00	226715.70	0.162
Perceived Market Risks	Potato price volatility	522319.60**	208137.80	0.013
	Interaction effects	-196.20**	64.90	0.003
	_cons	-321883.00	1521335	0.833
	F-test			0.0036

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

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion:
Climatic risks (low rainfall and frost bite) and market risks (price volatility) have a positive and significant effect on potato farming enterprise among smallholder farmers in Tanzania.

4.2. Policy recommendations:
The study recommends that;
1. Potato smallholder farmers to invest/ hire irrigation facilities especially during low rainfall and frost bites incidences so that they able to take advantages of the low supply of potato in the market hence fetching higher potato market prices.

2. Potato smallholder farmers to observe price movement which follows a pattern of being high before the harvest, dropping at harvest time and rising again towards the end of the season. This information, could help potato smallholder farmers to plan when to plant and harvest potatoes and be able to have potatoes ready to sell when prices are good.

3. The government should come up with policies that help potato smallholder farmers to develop resilience mechanisms to manage potato price volatility. The polices should focus on developing Information Communications Technologies (ICT) related platforms such as (M-Kilimo) with the purpose of improving the

content and speed of disseminating market information such as potato price volatility

Further research

The study considered perceived effect of production and market risks on potato farm income and not the quantitative effects of these risks. Therefore, a quantitative study on the effect of production and market risks on potato farming enterprise would be of interest.

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