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The Perceived Effectiveness of Risk Reduction Strategies Adopted by Smallholder Horticultural Farmers in Nabuyonga Sub Catchment, Mbale City, Uganda

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abstract

Smallholder horticultural farmers face a mix of inter-related risks and challenges which jeopardize their livelihoods, food security and nutrition, thereby rendering them increasingly vulnerable to a spectrum of emerging climatic, health, price and financial risks. This study thus, aimed at contributing to a better understanding of the risks faced and the perceived effectiveness of the risk reduction strategies adopted by smallholder farmers in pursuit of an enhanced urban food system resilience in Mbale City, Eastern Uganda. A multi-level sampling criteria in which households that practiced horticulture were purposively selected from the lists obtained from the Mbale City Production office. Thereafter, seventy-seven households were randomly selected from the lists for the study. Data were collected by way of household interviews, focus group discussions, key informant interviews and field observations. The data were analyzed using both descriptive and inferential statistics notably, independent t- tests and analysis of variance. The results revealed that significant risks such as floods and dry spells (88.3%) which mainly affected tomato gardens (72.7%), followed by counterfeit inputs (83%), price fluctuations (76.8%), health risks (particularly COVID19) (71%) and stealing of already grown crops (66.2%). It was established that effectiveness of adopted risk reduction strategies was significantly influenced by education levels, income sources and gender (p-value < 0.005). The study recommends several interventions including the exploration of low-cost technologies by smallholder farmers, enhancement of stakeholder engagements, improved logistical support and facilitation of agricultural extension officers as well as, investing in affordable storage facilities. If implemented through a coordinated process, these recommendations could significantly enhance agricultural productivity, value addition and sustainable livelihood opportunities while concurrently promoting the economic prosperity of the wider Mbale City region.

Introduction

Agriculture remains the main source of food, employment, and income for most rural population (Makate et al., 2019) and smallholder farmers play a pivotal role in ensuring urban food supply, accounting for an estimated 50 – 70% of global food production, and particularly in sub–Saharan Africa (Giller et al., 2021; Herforth et al., 2020). Smallholders' contribution to a stable and functioning urban food shed is even projected to increase in the coming decades (Jennings et al., 2015), partly attributable to the expected growth in the proportion of urban population and the attendant food demand (Giller et al., 2021; Fanzo et al., 2020; Jennings et al., 2015). Therefore, increasing smallholder farmers' productivity in Sub Saharan Africa through agricultural transformation is critical to ensuring sustainable and secured urban food systems (Giller et al., 2021; Caron et al., 2018;) as well as achieving the hunger, food security and nutrition targets of SDG2 (Fanzo et al., 2021; FAO, IFAD, UNICEF, WFP and WHO. 2020; AgriFoSe2030, 2020).

Globally, horticultural farming is essential because it contributes to feeding the over 811 million people who could potentially go hungry more so in urban areas where poverty among the 9.9% low-income earners predisposes them to food insecurity, despite reported progress in global food production over the last decade (Cahiers et al., 2020). For instance, as reported by (Kansiime et al., 2021), between 2019 and 2020, the number of undernourished people were as many as 161 million, a crisis driven largely by conflict, climate change and other risks in the agricultural supply chain.

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Risks come from different sources and are experienced at differing degrees across geographic and political scales. Sources of risks have previously been classified into market risk (output and input price fluctuation, market shocks), financial risk (loans and credits), production risks (weather-related risk, pests and diseases (bio-security threats), technology change, and yields), institutional risk (regulations, legal, and environment and tax policy), human resource risk (physical and mental health) (Calicioglu et al., 2019: Duong et al., 2019) and the health risk; For instance, the COVID-19 pandemic which spread extensively and rapidly across the world since late 2019 has had profound implications on the socio-economic situations of the people especially for food security and nutrition (Kassegn & Endris, 2021).

Smallholder horticultural production is faced with multiple uncertainties, particularly risky events related to weather, market development and other hazards that cannot be controlled by the smallholder farmers but have a direct influence on the returns from horticultural farming. These include risks, such as climate and market volatility, pests and diseases, extreme weather conditions, and an ever-increasing number of protracted crises and conflicts (Calicioglu et al., 2019). In this context, smallholder farmers have to manage the risks partly as a whole farming business management (Azunre et al., 2019). Snapp et al., (2018) further indicate that between 2005 and 2015, natural disasters cost the agricultural sectors of developing countries' economies a staggering $96 billion in damaged or lost crop and livestock production, $48 billion of which occurred in Asia. Drought, which has battered farmers globally, was one of the leading culprits, with a documented 83% all drought-caused economic losses being absorbed by agriculture to the tune of $29 billion.

Across the tropics, smallholder farmers already face numerous risks in their agricultural production, including pest and disease outbreaks, lack of enough market for their produce, extreme weather events, market shocks among

others, and these often undermine their household food and income security (Harvey et al., 2014). A sustainable food system delivers food security and nutrition for all in such a way that the economic, social, and environmental bases to generate food security and nutrition for future generations are not compromised (Balineau & Kessler, 2021). Therefore, because smallholder farmers typically depend directly on agriculture for their livelihoods, and have limited resources and capacity to cope with shocks, any disruption in agricultural productivity can have significant impacts on their food security, nutrition, income and well-being (Mapfumo et al., 2013).

According to (Dijkxhoorn et al., 2019; Agri Links, 2022), Uganda is the second largest producer of fresh fruits and vegetables in Sub Saharan Africa after Nigeria. It is further estimated that Uganda, produces about 5.3 million tonnes per year. Most of the fruits and vegetables produced in Uganda are by smallholder farmers and are also consumed locally (Cultiv Aid, 2021). However, the smallholder farmers are chronically food insecure and have limited access to basic services, such as improved water sources and electricity. These farmers also face a mix of interrelated risks and challenges which threaten their livelihoods, food security and nutrition, and they have also become increasingly vulnerable to a spectrum of emerging climatic, health, price, and financial risks and challenges. Dijkxhoorn et al. (2019) and Mugagga et al. (2020) suggest an adaptation to the resultant effects by the smallholders as a novel way of reducing the spread of the associated risk.

Mbale City is the main administrative, commercial and agricultural hub of Mbale District and the surrounding areas. Therefore, understanding the vulnerability of farmers to risks is particularly important. Moreover, smallholder horticultural farmers constitute approximately 70% of the farming population. Owing to its relatively high fertility when compared to other places along the Nabuyonga river system, Nabuyonga valley is the most inhabited and utilized for small-scale farming (Mugagga et al., 2010; Mackay et al., 2022). However, there are continuous risks that arise from production, credit, personal, political and economic aspects (CultivAid, 2021). Not only does the exposure to such risks endanger already fragile food production systems, but also the mere likelihood of their occurrence makes some of the smallholder farmers risk-averse and likely to pursue more subsistence-oriented activities, thus, causing smallholder poverty to persist (Dercon et al., 2009). However, smallholder horticultural farmers have adopted coping strategies such as, continuous irrigation, construction of trenches to drain excess water in times of floods, purchase and use of pesticides among others; whose effectiveness is not well documented. For instance, previous studies such as Aguilar et al. (2022) propose a projected increase in the vulnerability of smallholder farmers to be caused by climate-related risks; . Not only the above, but also, Mugagga et al. (2020) investigated the role of institutional factors affecting adaptation to climate change among smallholder Irish potato farmers in South Western Uganda; whereas, Rose & Chilvers (2018) documented the factors affecting vulnerability elements affecting smallholder farmers dealing with climbing beans. However, there is still paucity of information about the vulnerability of smallholder horticultural farmers to a range of risks within the Mbale City Region, yet, smallholder farmers have been noted to be critical in ensuring a sustainable urban food shed. This study thus, aimed at contributing to an understanding of the risks faced and the perceived effectiveness of the risk reduction strategies adopted by smallholder farmers in the pursuit of an enhanced urban food system resilience in Mbale City, Eastern Uganda.

Conceptual framework

The Farm Systems Analysis framework (FSA), a widely used analytical framework in understanding decision making processes at the farm household level, was adopted and modified for this study. Livelihood assets can help examine a household's capabilities to act and adapt to shocks (Aguilar et al., 2022). The unit of analysis was the household whose characteristics were broken down into internal conditions (including socio-economic conditions, and bio-physical conditions) as well as external conditions (including technical conditions, market and market information, support services from extensional workers and policy and incentives). The levels of adequacy and sufficiency of the household characteristics influence the exposure of the smallholder horticultural farmers to risks. The risks were categorized in terms of production, technical, health, human and market risks. When the smallholder farmers are exposed to the risks, they will, internally or externally, come up with adaptive mechanisms in the form of risk reduction strategies such as irrigation, early planting, installation of early warning systems and among other interventions. – The effectiveness of the adaptive measures is influenced by the household sensitivity to the shocks in terms of anticipation of and response to the agricultural risk, with a resultant increase or decrease in the vulnerability of the farm household, thereby affecting the whole food shed.

Study Area

The study was carried out in the Nabuyonga micro catchment, purposefully targeting the parishes of Nabuyonga, Namatala, Namakwekwe, Boma, Lwasso, Doko, Bumboi and Namalogo where smallholder horticulture is evidently practiced along the banks of River Nabuyonga.

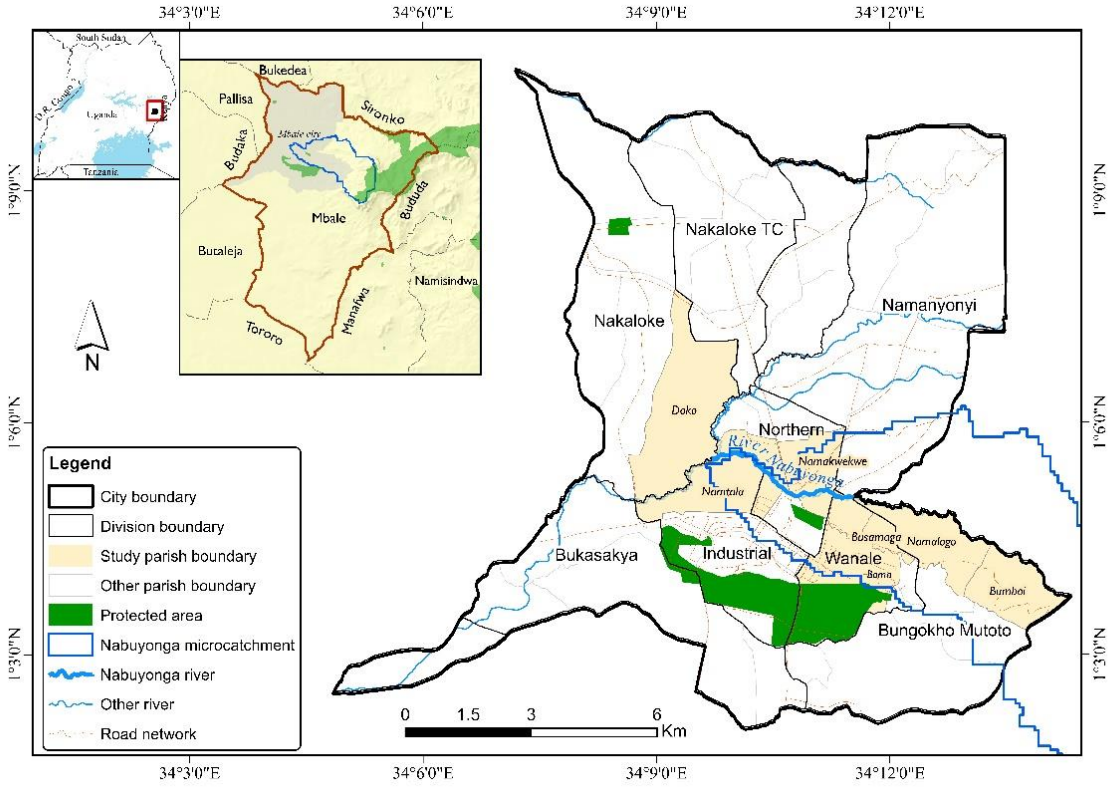

Figure 1: Location of the study sites within the Nabuyonga micro catchment in Mbale City. In set is Mbale District and the surrounding districts.

River Nabuyonga is located in Mbale City which is the main administrative, commercial and agricultural hub of Mbale District and the surrounding areas. Mbale City is found in Mbale District which is bordered by Sironko District to the north, Bududa District to the northeast, Manafwa District to the southeast, Tororo District to the south, Butaleja District to the southwest and Budaka District to the west, Pallisa and Kumi Districts in the northwest. The climate of Mbale City is influenced by its proximity to the equator and its position at the foot of Wanale ridge. The climate is warm and humid without extremes. Rainfall is fairly distributed ranging between 1250 millimeters and 1750 millimeters per year, and this rainfall pattern is sufficient to sustain growth of annual and perennial food crops that support the urban population. The city experiences a high amount of rainfall during the months of March to May and October to November

Research Design
A descriptive survey design was employed to assess the risks faced by the smallholder horticultural farmers. Exploratory and interpretive research designs were followed to evaluate the effectiveness of risk reduction strategies adopted by the small holder horticultural farmers.

Sampling framework, techniques and sample size
This study employed both probability and non-probability sampling techniques. To ensure representativeness, probability sampling techniques included simple and stratified random sampling which were used to select smallholder horticultural farmers in the study area. Purposive sampling of key informants were the non- probability sampling techniques that were employed to select traders, consumers, production officer- Mbale City and Agricultural Extension Officers. Taking households as the unit of analysis and basing on records obtained from the Office of Production at Mbale City, seventy-seven (77) households involved in smallholder horticultural farming were purposively selected for the study. Forty-two (42) First order respondents were randomly selected from the lists of farmers and contacted through phone calls and thirty-five (35) second order respondents were obtained through snow balling.

Data collection and instruments
Primary data were collected using household surveys by way of questionnaires, key informant interviews and field observations. Qualitative data was collected through Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). The data collection tools were tested for reliability using Cronbach's alpha measurement to demonstrate internal consistency. An item is considered reliable with Cronbach's alpha score greater than 0.6, and the tool scored a Cronbach's alpha of 0.764. To ensure validity of the study and reliability of questions in the data collection instruments, a pilot study was conducted before embarking on the field survey.

Household surveys
A survey of the selected households that practiced horticulture was conducted using questionnaires that were loaded onto Tablets using Kobo Toolbox Software (https://kf.kobotoolbox.org/#/formsto) and open Data Kit (ODK) applications. The questionnaire, largely containing close-ended questions, delved into the socio-demographic characteristics of the households, the risks faced at household level as well as the perceived effectiveness of the risk reduction strategies that the households adopted.

Focus group discussions
Focus Group Discussions were conducted with members of the Nabuyonga Horticultural Farmers Association, Malo Farmers' Group, Elgon Integrated Urban Farmers Association and Lwasso Gravity Irrigation scheme. The meetings were held at convenient venues and at times chosen by the respondents. Each discussion had an average of 10 participants, andlasted one hour.

Key informant interviews
Key informant interviews were conducted with various respondents (including, Agricultural Extension Officers, Market Leaders, the Farm Manager, Uganda Prisons Service (Malukhu Farm), Model Farmers and the Local Leaders to collect qualitative information. At most, the key informants were interviewed from their places of work in order not to disrupt their routines. These interviews generated in-depth information that enabled understanding of the horticultural policies and bye-laws put in place in favor of the Smallholder farmers and effectiveness of the risk reduction strategies adopted by the Smallholder horticultural farmers in the study area.

Field observations
Field observations and documentation through photography were used to document activities and discern risks that were encountered as well as risk reducing interventions that were adopted by the horticultural farmers.

Data analysis
Quantitative data were analyzed using SPSS (ver25). To explore the nature and trend of risks and evaluate the effectiveness of risk reduction strategies adopted by the farmers, the data were analyzed using descriptive statistics of mean, frequencies, standard deviation and percentages. Inferential statistical tests such as t- tests and one-way analysis of variance (ANOVA) were performed to establish linkages between particular risks and the adopted risk reduction strategies and summarized based on the aggregated data from descriptive statistics. A Likert scale with scores ranging from Strongly Disagree (2), Disagree (4), Moderately Agree (6), Agree (8) to Strongly Agree (10), coupled with observation of the respondents' body language were used to categorize the perceptional responses regarding the risks faced and the attendant risk reduction strategies.

Findings
Socio-demographic conditions of the respondents
At the onset, it was critical to understand the socio-demographic characteristics of the respondents as this plays a key role in individual and household farming decisions. For this study, both internal and external conditions were analyzed.

As presented in Table 1, a total of seventy-seven (77) smallholder horticultural farmers participated in this study; of which 48 (62%) were male and 29 (38%) were females. Most of the respondents were in the productive age groups ranging between 25 years to 54, most of whom were married (78%). Forty-six percent of the respondents had attained secondary level education, while 30% had primary level education. There was near parity between those who had never attained any education and those who had attained tertiary or university level education.
More than half of the respondents (51%) reported a farming experience of over 16 years. Majority (51%) of the farmers reported that they were hiring the farming plots, while 39% owned the land on which they farmed. The most commonly grown horticultural crops included tomatoes, cabbages and Sukuma-wiki (collard green- brassica raphanus). Forty-nine percent reported that income from horticulture contributed between 30 and 50% of their incomes, while 44% attributed 20% of their incomes to gains from horticulture.

External conditions that characterize smallholder horticultural farming activities in Nabuyonga Valley
Smallholder farming activities are characterized by a range of external conditions. Findings from the study reveal that the most dominant means of transport used by farmers is manual or human labour, followed by use of motorcycles and middlemen buying horticultural produce from gardens. Scale of market for the smallholder farmers was generally local (within Mbale City), although, some also sold their produce in other cities within Uganda (14%) and a few targeted the international market (7%). Community radios were the main sources of information about horticultural market (8%). Most of the farmers relied on fellow community members, cooperative associations for financial support and technical support in case of pest and disease outbreaks. Regarding problem solving, results indicate that smallholder farmers mainly consult fellow farmers for solutions in case of any pest and disease outbreak. The two main sources of inputs for majority of horticultural farmers are input dealers and suppliers (68.80%) and self/individual saving of inputs that indicated 66.20%.
As depicted in Figure 2, the two technical information sources of the smallholder farmers included introduced and indigenous ones. For the introduced sources, most farmers obtain technical information from innovative farmers (65.3%), living within the catchment and agricultural extension officers delegated from the city offices. (23.6%). More than three quarters of farmers attained technical information from indigenous sources including fellow farmers (84.7%) and family (37.5%).

Risks faced by smallholder horticultural farmers in Nabuyonga Valley
As already pointed out, the risks faced by smallholder farmers were categorized into production and technical, health, market, financial and human risks. The responses were categorized on the basis on a Likert scale ranging from Strongly Disagree (SD) (2), Disagree (D) (4), Moderately Agree (MA) (6), Agree (A) (8) to Strongly Agree (SA) (10), coupled with observation of the respondents' body language. which were used to categorize the perceptional responses regarding the risks faced by the smallholder horticultural farmers. The results are presented in Table 2.

Table 1: Socio demographic status of the respondents.

Internal conditions	Categories	Frequency	Percentage
Sex	Female	29	38
	Male	48	62
Age (years)	Less than 24	3	4
	25 – 34	20	26
	35 – 44	25	33
	45 – 54	22	29
	55 and above	7	9
Marital status	Single	7	9
	Married	60	78
	Divorced / Separated	1	1
	Widowed	9	12
Education level	No formal education	10	13
	Primary Level	23	30
	Secondary	35	46
	Tertiary/university	9	12
Horticultural farming experience in the area (years)	1 - 5	8	10
	6 - 10	21	27
	11 - 15	9	12
	16 and above	39	51
Percentage of income from the horticultural value chain	Below 20%	31	44
	30 - 50%	34	49
	60 - 80%	4	6
	90 and above	1	1
Nature of land ownership	Self-owned	30	39
	Hire	41	53
	Both	6	8
Horticultural crops	Tomatoes	56	73
	Onions	14	18
	Cabbages	49	64
	Sukuma-wiki (collard green- brassica raphanus)	41	53
	Carrots	3	4
	Green pepper	7	9
	Peas	2	3
	Nakati (ethiopian eggplant - solanuma-ethiopicum)	3	4
	Irish potatoes	2	3
	Other	32	42

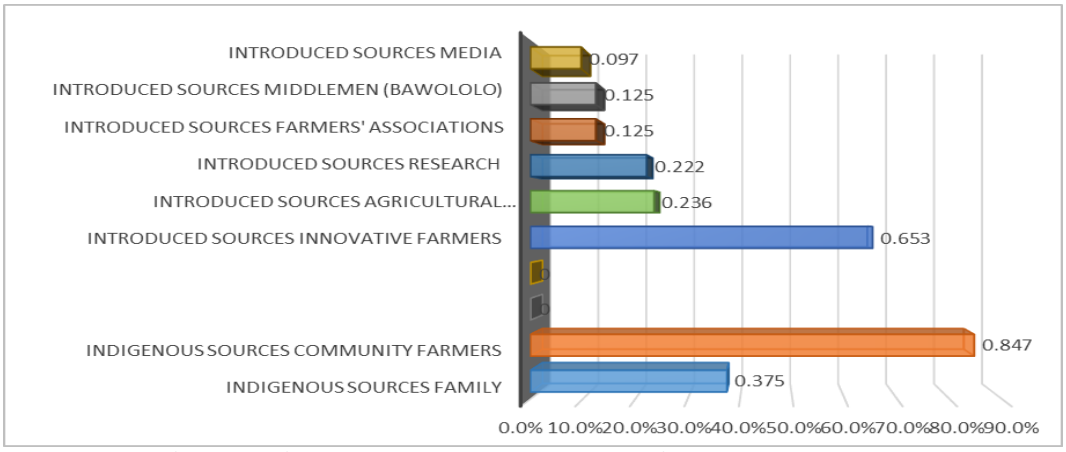

Figure 2: Sources of technical information used by the Smallholder Farmers for improvement in skills and productivity.

Table 2: Risks faced by smallholder horticultural farmers.

Perceptual statement	Level of Agreement (%)						
Production and Technical Risks	**SD**	**D**	**MA**	**A**	**SA**	**Mn**	**SD**
Flash floods and dry spells greatly affect the horticultural farms and output.	0	0	3	9	88*	5	0
Post-harvest losses affect the quality and quantity of horticultural crops grown.	0	1	4	42	53	5	1
Counterfeit inputs on the market greatly impact the quality of horticultural crops harvested.	0	0	9	8	83	5	1
Inputs from Government organizations are not served in the rightful seasons.	3	0	17	20	61	4	1
Technical services from agricultural officers have not improved farmer's skills and knowledge.	58	8	4	17	13	2	2
To be a farmer, one must own land.	73	21	3	0	4	1	1
Health Risks							
COVID- 19 resulted into over production.	0	0	3	26	71*	5	1
Restrictions in movement (transport) disrupted the horticultural value chain.	1	1	7	60	31	4	1
Manpower and people with expertise were lost due to COVID -19.	4	9	66	20	1	3	1
Financial Risks							
Fear of high interest rates retards more horticultural investments.	0	8	33	35	25	4	1
Unfavorable and ever rising taxes discourage farmers to take produce to the market places	0	9	38*	27	27	4	1
Market Risks							
Price fluctuations due to change in seasons greatly affects farmers' profits.	0	9	13	1	77*	5	1
Less improved technologies reduce the quality and quantity of the horticultural yields.	0	0	13	38	49	4	1
Middle-men greatly influence the prices of horticultural produce.	1	0	18	17	64	4	1
Human Risks							
Fellow farmers sabotage and steal already grown horticultural crops on farms.	1	4	12	17	66	4	1
Individual interests within farmers also retards horticultural agriculture.	0	1	5	35	58*	5	1

Plate 1: A tomato garden washed away by a flood.

For the production and technical risks, 88% of the farmers strongly agreed that flash floods and dry spells greatly affect their horticultural farms and output. Majority of the farmers (53%) strongly agreed that post-harvest losses affect the quality and quantity of horticultural products. However, 83% of the smallholder farmers strongly agreed that counterfeit inputs on the market greatly impact the quality of horticultural crops harvested. Sixty-one percent of the respondents consider and strongly agreed that inputs from Government Programmes like Operation Wealth Creation (OWC) were not timely delivered. With practice and problem solving, 58% of the respondents strongly disagreed that the technical services from agricultural officers have not improved / increased farmer's skills and knowledge. Seventy-three percent (73%) of the smallholder farmers strongly disagreed to owning land as a definition of a farmer, confirming the bigger percentage of land hired at 53% in the internal characteristics of the farmer.

For the health risks, 71% of smallholder horticultural farmers strongly agreed that COVID 19 outbreak resulted in over production which retarded the market of the horticultural produce; 60% agreed that restrictions in movement (transport) disrupted the horticultural value chain and 66.20% of the respondents moderately agreed to the loss of manpower and expertise to COVID 19.

With the financial risks, 35% of the smallholder horticultural farmers agreed that the fear of high interest rates retards more horticultural investments, while another 38% moderately agreed that the unfavorable and ever rising taxes discourage farmers from taking produce to the market places.

Responses in connection with market risks indicated that smallholder horticultural farmers strongly agreed that price fluctuations due to change in seasons greatly affects farmers' profits, less improved technologies reduce the quality and quantity of the horticultural yields and that middlemen greatly influence the prices of horticultural produce at 77%, 49% and 64% respectively.

With human risks, smallholder farmers strongly agreed to fellow farmers sabotaging and stealing already grown horticultural crops on farms at 66% and individual interests within farmers that retard horticultural farming at 58%.

As will be presented below, discussions with key informants (particularly, Model farmers and market leaders) also confirmed the above risks faced by smallholder farmers. For instance, smallholder farmers from Namakwekwe indicated that the major risks they encountered were dry spells, pests and diseases that destroyed several crops.

Smallholder horticultural farmers from Doko- Malukhu prisons, indicated that the major risks were the changing seasons in the form of dry spells and floods that destroyed horticultural gardens, pests and diseases and exploitation by middlemen who buy cheaply from the garden in bulk and sell at exorbitant prices in markets.

The main risks that caused inconsistencies in the in and out flows (food shed) of the horticultural crops were change in seasons (drought) and price fluctuations resulting from differences in demand and supply. From the KII with vendors, it was revealed that the inconsistencies in food flows are caused by difference in seasons, floods, dry spells and poor transport infrastructure in farmlands upstream leading to delays of horticultural crops to reach the markets resulting in price fluctuations and exploitation of the smallholder farmers.

A local leader in Bumboi emphasized that *across the parishes in the valley (Lwasso and Nabuyonga), roads are in a poor state and unevenly distributed, with many farming areas lacking roads that connect them to the main city* he added that *even the main roads are often accessible only during the dry season*.

Plate 2: Middle men buying tomatoes in bulk at Malukhu prisons

Plate 3: Logs (middle ground) put across the river for farmers to access their gardens and take produce to the market.

Table 3a: Risks faced by smallholder farmers versus household internal conditions.

Risk	Social demographic characteristics		Mean	Std deviation	*p-value*
Production Risk	Sex	Female	3.6	0.3	0.051*
		Male	3.7	0.4	
	Education Level	No formal education	3.6	0.2	0.382
		Primary Level	3.7	0.4	
		Secondary	3.6	0.4	
		Higher	3.8	0.4	
	Land ownership	Self-owned	3.7	0.4	0.594
		Hire	3.7	0.4	
		Both	3.6	0.4	
	Household size	Below 5	3.7	0.3	0.073
		5 to 9	3.7	0.4	
		10 and above	3.4	0.4	
	Income source	Casual/business	3.6	0.3	0.680
		Agriculture	3.7	0.4	
		Formal	3.7	0.4	
Health Risks	Sex	Female	4	0.3	0.474
		Male	4	0.4	
	Education Level	No formal education	4.1	0.2	0.088
		Primary Level	3.9	0.4	
		Secondary	4	0.3	
		Higher	3.9	0.3	
	Land ownership	Self-owned	4	0.4	0.718
		Hire	3.9	0.3	
		Both	4	0.2	
	Household size	Below 5	3.9	0.4	0.747
		5 to 9	4	0.3	
		10 and above	3.9	0.4	
	Income source	Casual/business	3.8	0.4	0.056
		Agriculture	4	0.3	
		Formal	3.9	0.4	
Financial Risks	Sex	Female	3.5	1	0.107
		Male	3.9	0.8	
	Education Level	No formal education	3.6	1	0.132
		Primary Level	3.9	0.8	
		Secondary	3.5	0.9	
		Higher	4.4	0.8	
	Land ownership	Self-owned	3.7	0.7	0.170
		Hire	3.9	0.9	
		Both	3	1	
	Household size	Below 5	3.9	1	0.581
		5 to 9	3.8	0.7	
		10 and above	3.4	1.1	
	Income source	Casual/business	3.4	0.8	0.166
		Agriculture	3.9	0.9	
		Formal	4	0.7	

Table 3b: Risks faced by smallholder farmers versus household internal conditions.

Risk	Social demographic xtics		Mean	Std deviation	*p-value*
Market risks	Sex	Female	4.4	0.7	0.726
		Male	4.4	0.6	
	Education Level	No formal education	4.5	0.5	0.082
		Primary Level	4.6	0.5	
		Secondary	4.2	0.7	
		Higher	4.6	0.5	
	Land ownership	Self-owned	4.5	0.5	0.663
		Hire	4.4	0.6	
		Both	4.2	0.7	
	Household size	Below 5	4.4	0.6	0.158
		5 to 9	4.5	0.5	
		10 and above	4	1	
	Income source	Casual/business	3.8	0.4	0.036*
		Agriculture	4	0.3	
		Formal	3.9	0.4	
Human risks	Sex	Female	4.4	0.9	0.286
		Male	4.5	0.5	
	Education Level	No formal education	4.6	0.5	0.058
		Primary Level	4.7	0.5	
		Secondary	4.2	0.8	
		Higher	4.7	0.4	
	Land ownership	Self-owned	4.6	0.5	0.430
		Hire	4.4	0.8	
		Both	4.7	0.4	
	Household size	Below 5	4.5	0.8	0.287
		5 to 9	4.5	0.5	
		10 and above	4.1	1.2	
	Income source	Casual/business	3.9	1	0.000*
		Agriculture	4.7	0.4	
		Formal	4.6	0.4	

Focus Group Discussions were conducted with members of the Nabuyonga Horticultural Farmers Association, Malo Farmers' Group, Elgon Integrated Urban Farmers Association and Lwasso Gravity Irrigation scheme. From the discussions, it was revealed that the most risks faced included; weather instabilities in form of floods in and dry spells, over production leading to low prices due to the high supply against low demand since a lot of produce was on the market, exploitation by the middlemen, theft of crops, expensive and counterfeit inputs, pests and diseases, poor transport infrastructure to access the gardens during the production processes especially during harvesting time. The farmers further indicated that the fear of high interest rates limits them from accessing credit facilities/loans from financial institutions and the expensive land rented for agriculture also limits them from accessing more land for more horticultural production.

Analysis of data from the household survey revealed that on an average, males were more affected by the aforementioned production and technical risks than their female counterparts. One probable reason for this is that compared to females, males had invested more in the horticultural food production. There was no significant difference in relation to financial and human risks with socio-economic conditions of the farmer households. Results from the statistical analysis were not significantly different at ($p>0.05$) for the variables which indicated that production and technical, health, financial, market and human risks do not vary with education level, land ownership and household size. However, for market and human risks, the results indicated a significant difference by source of income at 0.032 and 0.000 respectively.

Perceived effectiveness of risk reduction strategies adopted by smallholder horticultural farmers in Nabuyonga Valley

Like it was done with the risks faced by the farmers, responses regarding the perceived effectiveness of the risk-reduction strategies were also categorized based on a Likert scale ranging from ranging from Strongly Disagree (SD) (2), Disagree (D) (4), Moderately Agree (MA) (6), Agree (A) (8) to Strongly Agree (SA) (10), coupled with observation of the respondents' body language. Table 4 presents the results.

For the production and technical risks, 77% of the smallholder farmers strongly agreed that restoration of riparian areas through activities like dredging, snagging, construction of levee embankments, sills and weirs, planting of riparian vegetation has reduced floods along the Nabuyonga stream. Sixty-six percent of the smallholder horticultural farmers agreed that early warning systems (such as timely weather information disseminated on local media) which have helped with flood risk control, 58% strongly agreed that early planting has enabled farmers to farm, especially during short rain seasons, 84% strongly agreed that smallholder horticultural farmers practice irrigation as a remedy for continuous and sustainable water supply in horticultural activities, 49% of the smallholder farmers strongly disagreed that strict monitoring and supervision of extensional agricultural officers has pushed them to the fields, 56% agreed that improvement in storage for quality horticultural products has improved the value addition in the horticultural value chain.

While 52% agreed that setting laws and arresting individuals that sell counterfeit agricultural inputs has not been done, 66% of the smallholder farmers strongly agreed that engagement in farmer workshops enhanced the farmers' improved knowledge and skills in the production process. Seventy-four percent strongly agreed that efficient utilization of land in small spaces through application of technologies for urban farming had increased horticultural yields.

For the health risks, 51% of the smallholder farmers strongly agreed that improved post handling storage facilities were adopted by farmers in the horticultural agriculture sector, while for the financial risks, 41% of the smallholder farmers agreed that formation of agricultural credit and insurance by financial institutions had helped smallholder horticultural farmers acquire capital for investment in their horticultural gardens and 64% somewhat agreed that Subsidization and reduction of taxes on bulk horticultural crops had encouraged farmers to formulate groups for collective benefits. Responses in regard to market risks indicated that 66% of the smallholder horticultural farmers strongly agreed that formation of farmer groups had been of help in acquiring a common favorable market for the horticultural crops.

In order to gain an insight into the effectiveness of risk reduction strategies adopted by the smallholder horticultural farmers and household characteristics, the statistical analysis by way of independent t- tests and one-way analysis of variance tests (ANOVA) were performed. As presented in Table 5, results indicate a significant mean difference ($p < 0.05$) between gender and production and technical risks. This depicts that male smallholder farmers had adopted effective risk reduction strategies with regard to production and technical risks. The statistical test however indicated no significant mean differences ($p > 0.05$) between variables. For instance, production, and technical risks against household size and income source; health risks against gender, education level, duration in the area, household size and income source; financial risks against gender, duration in the area, household size and income source; market risks against gender, education level, duration in the area and household size.

Discussions with key informants (such as model farmers, horticultural farmer groups and market leaders) also confirmed the effectiveness of risks reduction strategies adopted by smallholder farmers. From these interactions, it was shown that risk reduction strategies adopted by for instance, the market leadership committee, included organizing training sessions for farmers to improve knowledge and skills on post-harvest handling processes. The market leaders also emphasized that management of risk through construction of stores (e.g. by NGOs such as The International Fertilizer Development Centre (IFDC)) had helped to store the buffer stock.

Plate 4: An onion store for buffer stock

Table 4: Perceptual statements indicating effectiveness of risk reduction strategies adopted by smallholder farmers.

Perceptual Statement	**Level of agreement (%)**						
Production and technical Risks	**SD**	**D**	**MA**	**A**	**SA**	**Mn**	**SD**
Restoration of riparian areas has reduced floods along the Nabuyonga stream.	0	1	1	21	77	5	1
Early warning systems have been installed and these have helped with floods risk.	4	4	14	66	12	4	1
Early planting in seasons has enabled farmers to exhaust the seasons.	1	3	1	38	58	4	1
Farmers practice irrigation for continuous for sustainable water supply in horticultural activities.	0	0	0	16	84*	5	0
Strict monitoring and supervision of extensional agricultural officers has pushed them to the fields.	49	21	0	17	13	2	1
Improvement in storage for quality has improved the value addition in the horticultural value chain.	1	1	10	56	31	4	1
Setting laws and arresting those individuals that sell counterfeit agricultural in-puts has not been done.	10	3	13	52	22	4	1
Engagement in farmer workshops encouraged farmer trainings for improved knowledge and skills in the production process.	0	0	13	21	66	4	1
Efficient utilization of land in small spaces through application of technologies for urban farming has led to increase in horticultural yields.	0	0	5	21	74	5	1
Health Risks							
Improved post handling storage facilities were adopted by farmers.	4	33	7	51*	4	3	1
Financial Risks							
Formation of agricultural credit and insurance by financial institutions has helped smallholder horticultural farmers acquire capital for investment.	0	9	19	41	31	4	1
Subsidization and reduction of taxes on bulk horticultural crops has encouraged farmers to formulate groups for collective benefits.	0	16	64*	4	16	3	1
Market Risks							
Formation of farmer groups has been of help in acquiring a common favorable market.	0	0	14	18	66*	5	1

Irrigation, construction of trenches and diversification of crops were the other risk reducing practices that were undertaken by the farmers because they would keep the production processes ongoing throughout the seasons.

In summary, risks that affect smallholder horticultural farmers and stood out include technical and production risks including floods and dry spells, pests and diseases, market risks and exploitation of farmers by middlemen. The most visible risk reduction strategies adopted by smallholder horticultural farmers were continuous irrigation, construction of trenches to drain away excess water during wet seasons in areas and mulching of horticultural farms to keep water in the soil especially during the dry seasons. Farmers have mobilized themselves into groups that have helped in enhancing their adaptive capacities as well as improving their mitigative potentials towards adverse risks. They have also diversified their crops and farming practices in response to changing circumstances. The implications of these findings are discussed in the next section.

Plate 5: Trenches constructed to drain away excess water and to hold water during the dry season.

Table 5a. The relationships between perceived effectiveness of the risk reduction strategies and internal conditions of smallholder farmers' households.

Risk	**Social demographic**		**Mean**	**Std deviation**	***p-value***
Production Risk	Sex	Female	4	0.4	0.036*
		Male	4.2	0.3	
	Education Level	No formal education	4.1	0.3	0.006*
		Primary Level	4.2	0.3	
		Secondary	4	0.4	
		Tertiary/University	4.4	0.4	
	Horticultural farming experience in the area (years)	1 - 5 years	3.8	0.4	0.053*
		6 - 10 years	4.1	0.4	
		11 - 15 years	4.2	0.3	
		16 years and above	4.2	0.3	
	Household size	Below 5	4.1	0.4	0.271
		5 to 9	4.2	0.3	
		10 and above	3.9	0.5	
	Income source	Casual/business	4	0.4	0.168
		Agriculture	4.2	0.3	
		Formal	4.1	0.4	
Health Risks	Sex	Female	3	1.1	0.258
		Male	3.3	1.1	
	Education Level	No formal education	3.2	1.2	0.702
		Primary Level	3.3	1.1	
		Secondary	3	1.1	
		Higher	3.5	0.9	
	Horticultural farming experience in the area (years)	1 - 5 years	3	0.9	0.503
		6 - 10 years	2.9	1.2	
		11 - 15 years	3.6	0.7	
		16 years and above	3.3	1.1	
	Household size	Below 5	3.4	1	0.479
		5 to 9	3.1	1.1	
		10 and above	2.8	1	
	Income source	Casual/business	3.3	1	0.683
		Agriculture	3.2	1.1	
		Formal	2.9	1.1	

Table 5b. The relationships between perceived effectiveness of the risk reduction strategies and internal conditions of smallholder farmers' households.

Risk	Social demographic		Mean	Std deviation	*p-value*
Financial Risks	Sex	Female	3.5	0.9	0.379
		Male	3.8	0.8	
	Education Level	No formal education	4.1	0.6	0.015*
		Primary Level	3.8	0.8	
		Secondary	3.2	0.8	
		Higher	4.4	0.7	
	Horticultural farming experience in the area (years)	1 - 5 years	3.6	1.1	0.912
		6 - 10 years	3.7	0.9	
		11 - 15 years	3.9	0.9	
		16 years and above	3.7	0.8	
	Household size	Below 5	3.9	0.9	0.302
		5 to 9	3.7	0.8	
		10 and above	3.2	0.8	
	Income source	Casual/business	3.6	0.8	0.484
		Agriculture	3.6	0.9	
		Formal	4.1	0.9	
Market risks	Sex	Female	4.5	0.7	0.832
		Male	4.5	0.8	
	Education Level	No formal education	4.5	0.7	0.827
		Primary Level	4.6	0.7	
		Secondary	4.4	0.8	
		Higher	4.7	0.7	
	Horticultural farming experience in the area (years)	1 - 5 years	4	0.9	0.116
		6 - 10 years	4.5	0.7	
		11 - 15 years	4.3	0.9	
		16 years and above	4.7	0.7	
	Household size	Below 5	4.5	0.7	0.975
		5 to 9	4.5	0.8	
		10 and above	4.5	0.8	
	Income source	Casual/business	4.2	0.8	0.009*
		Agriculture	4.7	0.7	
		Formal	4.2	0.8	

Discussion

Risks faced by smallholder horticultural farmers

Smallholder horticultural farmers are frequently subjected to extreme weather events, resulting in yield loss, and the damage of agricultural fields, roads and homes (Dijkxhoorn et al. (2019) and Mugagga et al. (2020). Floods and dry spells are prominent in Mbale and have great impact on the smallholder farmers including retardation of crop yields, food shortage, further plunging farmers into poverty. Generally, Mbale City has experienced disastrous impacts from a combination of droughts and floods. For instance, the heavy rains that occurred on the night of 31st July 2022 caused floods around the whole City with horrific damage experienced in low lying areas such as the Nabuyonga valley. Reports from the Office of the Prime Minister and Mbale City Disaster Management Committee, indicated that the floods affected an estimated population of 18,102 people and over 7,000 farm structures were destroyed (OPM, 2022).

Smallholder horticultural farmers are particularly vulnerable to any reduction in crop productivity for varied reasons as asserted by (Harvey et al., 2014). First, they cultivate on very small pieces of land (less than 2 ha) (Mugagga, 2013). Some work from verandas due to lack of land, allocate most of the land (whether or hired) to crop production for household consumption and obtain low crop yields resulting from a number of risks, which makes it insufficient to meet household needs. During the focal group discussions, smallholder farmers reported obtaining seeds from the Operation Wealth Creation (a government poverty reduction programme) which are delivered during offseason or sometimes fake. Furthermore, they indicated that inputs are so expensive and there are a lot of counterfeits on the market and that the use of the counterfeit products retards their crop productivity. Harvey et al. (2014) reported that the low yields probably reflect the limited use of inputs (fertilizers, pesticides, improved seed varieties), the use of low technology practices, adoption of better farming and sustainable methods and land degradation—all of which have been identified as constraints to agricultural productivity elsewhere.

Another factor that increases smallholder farmer vulnerability in the Nabuyonga valley is the inadequate physical infrastructure such as roads which hinder effective connection between their gardens and the markets remoteness. This consequently affects the quality of the produce due to the short shelf life of most horticultural products and ultimately the price. The poor road infrastructure does not only affect the quality of the produce that reaches the final consumer, it also affects the price of inputs such as seeds, fertilizer, pesticides and herbicides, because the agro input dealers hike prices citing the poor infrastructure that affects transport costs. They experience exploitation by middlemen who buy cheaply in bulk and sell at high prices to consumers.

The lack of access to capital through financial and credit facilities is another factor that exacerbates the smallholder horticultural farmers' vulnerability. The few that could potentially benefit from such facilities are deterred by the high interest rates in most of the commercial banks. Moreover, without functional agricultural insurance markets, smallholder farmers often rely on informal support systems, borrowing money or inputs from fellow farmers (Harvey et al., 2014).

Limited access to timely and accurate information such as markets, seasonal weather forecasts and early warning systems to support decision making regarding the type of crop to plant, the timing of the planting and management strategies were also noted as key precursors for the vulnerability of

smallholder horticultural farmers. Only 17% of the farmers reported receiving technical/advisory services from the agricultural extension Officers. This low statistic could, in part, be attributed to the limited facilitation by way of transport facilities for the few Officers to traverse all areas. The extension Officers that were interviewed expressed the limited funding as a key deterrent to their effective delivery. The same was also echoed by the local leaders who cited limited budgetary allocations to the sector as key factors for the observed trends.

Inequity in access and control of productive resources such as land is an element that warrants discussion (Meinzen-dick et al., 2014). Discussions with farmers revealed that that children and women farmers barely own land, but rather they act as labor on family farms, doing all the hard work in the food system but during the harvest times the men take over and collect the money from the produce to plan better. This gender inequality has led to inefficient allocation of resources, which in turn means reduced horticultural productivity. Meinzen-dick et al. (2014) further emphasize that lower productivity persists in female-owned plots and female-headed households in Uganda, hence closing this gender gap will result in not only reducing women's vulnerability alone, but he entire society (Fabiana Meijon Fadul, 2021).

Effectiveness of risk reduction strategies

The most visible risk reduction strategies adopted by smallholder horticultural farmers were continuous irrigation, construction of trenches to drain away excess water during wet seasons in areas and mulching of horticultural farms to keep water in the soil especially during the dry seasons. Elsewhere, mulching has been noted to reduce runoff and keep water in the soils for continuous cultivation (Shirish et al., 2013).

Diversification of crops for self-sustenance was one of the strategies that has been adopted by smallholder horticultural farmers (Adnan et al., 2020). The farmers also engage in agroforestry, where they integrate horticultural crops with specific tree species, as a way of mitigating the flood and drought risk as well as the potential effect of pests and diseases. However, as confirmed by other scholars (Duong et al., 2019), owing to the individualized, uncoordinated and scattered interventions, the impact towards say attenuating floods is not effectively realized.

Existence and formation of farmer groups, for knowledge sharing, saving and collective market bargain, was another interesting risk reduction strategy adopted by smallholder horticultural farmers. This resonates with studies of Sibiko (2012), who noted that many farmers use group savings to pull resources with essence of reducing vulnerability in case of a dry spell. This social capital is important since it allows interaction among farmers and it empowers them to achieve their goals. Furthermore, findings from (Sibiko, 2012) also indicated that with farmer groups, new users learn from the other members in the social network, hence, generating significant technology spillovers and improving their allocative efficiency.

In a nutshell, smallholder farmers urgently need better access to efficient risk management tools and strategies to increase their resilience to a spectrum of risks. Initiatives such as agricultural insurance can help farmers take productivity enhancing risks. In the face of volatile crop prices, following studies made by Gomez (2020), collaboration is needed among the private sector, state and non-state actors to design innovative and flexible market-based price stabilization tools such as hedging in future markets that are suitable for smallholder farmers (Adnan et al., 2020).

Conclusions

Smallholder horticultural farmers in the Nabuyonga sub catchment are highly vulnerable to a range of production, technical, human, market, health and financial risks, which are disproportionately exacerbated by climate related vagaries such as floods, droughts, pests and diseases. Interventions such as seed provisions through government programs like Operation Wealth Creation (OWC) are ineffective given the discrepancy between seasonality and supply time and limited access to extension services. Whereas risk reducing strategies like irrigation, construction of trenches, formation of farmer groups and others have the potential of reducing the impacts on horticultural farmers' livelihoods, the fact that most of them have limited access to resources and act individually renders such interventions less effective, at sub catchment level.

Recommendations

Smallholders require options that are relatively low-risk, and provide short-term returns on investment. Consequently, building resilient systems is key, both from the perspective of risk management and sustainability. This requires investments beyond plot-level technologies into policy and other institutional issues that can enable adoption and reduce smallholder risk (Vanlauwe et al., 2014). In light of the above, the following recommendations are made to ensure that smallholder farmers are able to manage the risks they face in the long run to enhance the resilience of the Mbale City Region's Urban food system:

New technologies should be explored, evaluated and adopted by smallholder horticultural farmers like small-scale low-cost irrigation system especially in areas further away from River Nabuyonga to enable continuous production throughout the year. This is particularly with an adoption of gravity fed irrigation models especially those upstream.

Enhancement of stakeholder engagements by government through the ministry of agriculture, animal, industry and fisheries should be done to enable participation of all parties within the horticultural value chain to develop support and make decision together towards better mitigation strategies and timely knowledge skills and better manage the risks. This implies that the voices of smallholder farmers in governance matters need to be heard, respected and considered by all stakeholders in Uganda.

Better support from government in the form of logistical and operational funds should be given to agricultural extension officers from respective local government to enable them equip smallholder horticultural farmers with regular and adequate and timely knowledge/ skills to better manage agricultural skills.

Exploring and investing in affordable storage facilities should be done by the smallholder farmers to enable them better store their bumper produce so as to improve post-harvest handling and value addition for quality and better prices.

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Declaration of interest statement

No conflict of interest is affirmed.

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