Food security status and coping strategies among small-scale crop farmers in Volcanic Highlands in Rwanda

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ABSTRACT

This paper aims to determine the level of food security of small-scale crop farmers and to identify coping strategies for food security mostly adopted by small-scale crop farmers in the Volcanic Highlands in Rwanda. Data were collected using a questionnaire administered to a random sample of 401 small scale crop producers in the study area. CARI approach and descriptive statistics were used to analyse data. This methodology was chosen by the fact that it enables to have disaggregated food security indicators. Results show that 86.61% of the sample households are food secure, while 13.39% are food insecure. These results also indicate that spending savings is the most adopted stress-coping strategy among the livelihood-based coping strategies. The most adopted among consumption-based strategies are relying on less preferred or less expensive food, and reducing the quantities consumed by adults for children. The overall CARI console analysis shows that the majority of the sampled households are not food insecure, i.e. they are not vulnerable with respect to adopted strategies to cope with food shortage. Therefore, it is recommended that strategies should be initiated to increase crop productivity and output, to guarantee market access to small-scale farmers for stable agricultural prices and farm incomes, to enhance the livelihood diversification to cope with under-employment in the agricultural sector to benefit rural non-farm sources and to complement farm incomes.

Keywords: food insecurity, adaptation strategy, small farm holder, CARI, Rwanda

INTRODUCTION

Rwanda is a developing country with more than 51.5% of its total population employed in the agricultural sector as smallholder independent workers (NISR, 2018). With its annual rate of 2.6% of population growth (NISR, 2014), it is among the most densely populated countries in the world (NISR, 2016a). With an average of 0.7 hectare per farm household, 70% of farmers practice agriculture for self-consumption (Kadiri, 2018). Like in other developing countries, crop output and productivity are low, and farmers practice the simplest old-style methods and use simple tools (Todaro and Smith, 2012). Consequently, most famers (especially small-scale farmers) are suffering from hunger and malnutrition compared to other categories of the population. According to United Nations' experts (FAO et al., 2019), in 2018 "*More than 820 million people in the world were undernourished; [...] more than 700 million people were exposed to severe levels of food insecurity' and 'an additional 1.3 billion people, have experienced food insecurity at moderate levels.*" Such a situation is considered a puzzle while agriculture has been considered for long as a root activity of food security (Okello et al., 2017). Different factors such as price uncertainty, high transactions costs, highly imperfect access to information, limited access to credit and insurance, make the subsistence agriculture a highly risky and uncertain venture (Todaro and Smith, 2012).

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Farming in Rwanda is characterized by low yield due to limited use of improved seeds and other inputs, high risk of erosion with 90% cultivable land on steep slopes ranging from 5 to 55% (MINAGRI, 2013). Also, there is a high level of food insecurity ranging from 25 to 50% of households in some rural areas (NISR, 2016b). Household's access to adequate food must be influenced by shocks to the domestic harvest, such as periodic droughts and floods, as well as the small size of agricultural plots available to households for crop farming (NISR, 2016b). In order to maintain food security, different strategies (such as the strategic grain reserve) have been adopted in order to align actions relating to short-term seasonal food aid with long-term resilience strategies like distribution of small stocks to households. Therefore, there is a dual role of agriculture in food security in Rwanda. The 2016 crop competitiveness assessment revealed that the yields of several crops were less than half of their potential, because of prevailing agro-climatic conditions (MINAGRI, 2018). Consequently, agricultural innovation can help improve food security, increase agricultural yield and animal productivity, increase farmer incomes, and protect natural resources.

In Rwanda, agriculture plays a major role in food and nutrition security. The latter remains a big concern despite the substantial growth that the agricultural sector has experienced in recent years. Although the stunting of children has decreased at a considerable rate, its current status remains alarming: nowadays, 38% of children whose age is less than 5 years still suffer from this problem. In addition, 17.8% of children aged 6 to 23 months do not receive the minimum acceptable diet (NISR, 2016c). According to the CARI measure, 20% of Rwandan households are food insecure, the food consumption score increased from 65% in 2006 to 74% in 2015 (NISR, 2016b), even though a large part of the population remains dependent on rain-fed agriculture and self-consumption.

Few research on food (in)security in Rwanda focused on its determinants (Bidogeza et al., 2015; Habyarimana, 2015) and its causes (Nzabuheraheza and Nyiramugwera,

2017). There are few research works that calculated the food consumption score (FCS), the food expenditure share (FES) and the livelihood coping strategies consoles for farm households in the region of Volcanic Highlands in Rwanda. This region is generally considered food secure thanks to its potentials for food production. However, the disaggregated information on diverse categories of people is not available. Further, food production is not the only factor to affect the household food security, there are also factors related to food preparation and consumption (food absorption). Yet it has been reported that farming is characterized by a high level of food insecurity ranging from 25 to 50% of households in some rural areas in Rwanda (NISR, 2016b). Consequently, the documentation of the coping strategies for Rwandan households to improve food security is scarce. The purpose of this study is to assess the food security status among farm households in Rwanda. It aims specifically (1) to determine the level of food security of small-scale crop farmers in Volcanic Highlands in Rwanda, (2) to identify coping strategies for food security mostly adopted by small-scale crop farmers in Volcanic Highlands in Rwanda, and finally (3) to come up with practical solutions to enable sustainable food security among small-scale crop farmers in Volcanic Highlands in Rwanda.

For data analysis, we have adopted the consolidated approach to reporting indicators of food security (CARI) guidelines to quantitative data gathered using a questionnaire from 401 small-scale crop producers selected randomly in the region of Volcanic Highlands in Rwanda. This was supplemented with descriptive statistics that we have used mainly to present strategies adopted by farm households to cope with food problems.

The remainder of this paper contains four sections. The second section summarizes the literature review. The third section describes and explains the materials and methods. The fourth section presents the results, while the fifth is concerned with the discussion of the findings. The last provides the conclusion, which also deals with the policy recommendations.

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LITERATURE REVIEW

Food security has been defined as "*access by all people, at all times to sufficient food for an active and healthy life*" (Asogwa and Umeh, 2012). It embraces "*minimum availability of nutritionally adequate and safe food and an assured ability to acquire acceptable foods in socially acceptable ways*" (Nakabo-Ssewanyana, 2003). The inability of the poor to have access to needed food can be attributed to low income and food production (Asogwa and Umeh, 2012). Food insecurity indicates either a short-term shortage of acceptable foodstuffs for a suitable nutrition (transitory food insecurity), or a long-term shortage in food supplies (Asogwa and Umeh, 2012). Food insecurity of individuals or households can be affected by economic shocks through different channels. At both macroeconomic and microeconomic levels, various characteristics of food insecurity have been identified (GNAFC and FSIN, 2020). The factors such as "*high inflation or hyperinflation, significant currency depreciation, worsening terms of trade, high unemployment rates and loss of income, a significant contraction in exports and a critical decrease in investments and other capital inflows*" result in acute food insecurity. It was also reported that the increases in prices of staple grains, oil or agricultural inputs can affect food availability, food prices and incomes. On the other hand, different microeconomic factors that affect households' food insecurity are "*rising food prices, lack of income sources and consequent reduction in purchasing power*" (GNAFC and FSIN, 2020).

Many researchers have classified the determinants of food security into three groups, namely food availability, food access, and food utilization (Honddinott, 1999). In terms of Gross (1999), food security is considered a broader concept beyond food production and food accessibility that revolves around four components: food availability, food accessibility, nutritional factors, and stability of supply. Some researchers (e.g., Lovendal et al., 2005) reported that food security is determined by three main factors, namely (1) the aggregate availability of physical food supplies; (2) the household access to the food supplies though their own production, markets

(given sufficient purchasing power) or other sources; and (3) the appropriate use of food supplies to meet the dietary needs of individuals, households, and communities. According to Nord et al. (1999), food insecurity is closely linked to poverty. In contrast, there is no clear information on the effect of traditional income and poverty measures on food security (Bickel et al., 2000).

Following a persistent and deep gap between domestic economic growth and population growth, the increase in food production has been a priority (de Graff et al., 2011). Such a situation has been worsened by the marginally increasing food production in some underdeveloped areas (Paulino, 1987). This leads to food insecurity (Cambrezy and Janin, 2003) mainly because of uncertainties and environmental constraints (droughts, floods, cyclones) which can intervene in the emergence of food risk (Ringler et al., 2010). Another important factor is the poor access to financial resources (Musabanganji et al., 2015) since it would allow small farmers to pay for quality inputs (Oladeebo and Oladeebo, 2008) so as to increase productivity (Kelly and Murekezi, 2000).

The main objective of rural and agricultural development in developing countries is to achieve a gradual improvement in living conditions in rural areas by increasing the crop productivity, output and income of small farmers, by conjunction with real food security (Todaro and Smith, 2012). The importance of small-scale farming in socio-economic development is recognized around the world. According to Dixon et al. (2001), "*Small farmers produce most of the food in developing countries. However, they are generally much poorer than the rest of the population and their food security is more precarious than that of the urban poor. Most of the food in the developing world is produced by some 500 million smallholder farmers - men and women. And yet these peasants and their families suffer more from hunger than the poorest in urban areas; poverty is greater among them and access to basic social services more restricted.*"

Several research works have recently analyzed food security and coping strategies. Mulumeoderhwa et al. (2020) reported the sale of household assets, the

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reduction of the quantities consumed by adults for children, the reduction of the number of meals eaten per day, and deprive themselves of health services as the main strategies adopted by farmers in Minembwe highlands (South Kivu, Democratic Republic of Congo). In the same vein, Manlosa et al. (2019) identified capital asset substitution as coping strategy with negative effect on food security status in Ethiopia. Nakabo-Ssewanyana (2003) found out that raising incomes has an effective impact on the reduction of food insecurity, while parents' education is the main factor that affects significantly the long-term children's nutrition in Uganda. In Nigeria, a research on food security and coping strategies revealed that relying on less preferred and less expensive food, limiting the meal consumed by the adult, and borrowing food or money to buy food (Mukhtar, 2019), children eating first, leasing assets, relying on help from relatives and friends, and skipping meals (Mukhtar, 2019). A similar study in Afghanistan by Oskorouchi and Sousa-Poza (2020) showed that households adopted six coping strategies (skipping meals, using credit to buy food, choosing lower quality food, relying on community help, taking loans, and selling assets), whereby the most ones are the preference of lower quality and quantity diet as well as buying food on credit and taking loans. For farmers and farm households to stabilize their living conditions, it was recommended that farming should be a stable source of farmers' incomes for it to make sense and thus enable them to achieve healthy standard living conditions (Corselius et al., 2001).

Once the profitability of agricultural production is guaranteed, the famers' incomes would be stable (Miller and Jones, 2010; CIDSE, 2012; Sourisseau et al., 2015). Consequently, agricultural production will play its role in reducing the poverty (Dorward and Kydd, 2005; IFAD, 2013). This would also enable farmers to access a growing range of basic goods and services. Farmers would thus maintain a healthy standard of living and can meet the demand for additional investments that are the basis of the gradual return of resources (Corselius et al., 2001). Under all these conditions, agricultural production will maintain its qualification as a basic activity for food

security (Okello et al., 2017).

The response of agricultural profitability to an increase in production is still a concern. Even a small increase in the supply of agricultural products can cause prices to collapse, given the price inelasticity of demand for basic necessities (agricultural products) (Endres, 1987). An increase in agricultural production of 10% would result in a fall in agricultural prices of more than 10%! Several scenarios are possible to reduce this price reduction. Farmers can regroup or strengthen agricultural cooperatives to increase their influence in agricultural value chains (Miller and Jones, 2010; Ortega et al., 2019). On the government side, it should promote a shortening of agricultural value chains (Chiffoleau et al., 2016) and put in place storage facilities (Tesfaye and Tirivayi, 2018). This could allow the stability of food supply both during harvest periods and during production periods in order to limit the collapse of prices, which would allow the food system to fluctuate around equilibrium with minimal deviations (Day, 1999). It should also be pointed out in this case that a realistic reduction in the prices of agricultural products remains beneficial to the poor, both urban and rural, who have easy access to food (World Bank, 2008). In intent to achieve its role in farmer income stability and food security, Miller and Jones (2010) suggested that the agricultural value chain needs to be in a more holistic livelihood model.

MATERIALS AND METHODS

Study area

This study covers the agro-ecological zone of Volcanic Highlands, one of the 12 agro-ecological zones in Rwanda, namely Imbo, Impala, Kivu Borders, Congo-Nile Crest, Eastern Plateau, Central Plateau, Volcanic Highlands, Buberuka Highlands, Mayaga, Bugesera, Granitic Soils, and Eastern Savannahs (Rushemuka et al., 2014). The Volcanic Highlands (also called «Birunga») are known for their fertile soil (altitude of 1600 to 2500 m, with black volcanic soils, very permeable, well suited for agriculture) (Maniriho, 2013; NISR, 2014). The main crops encountered there are potatoes, vegetables (red

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onion, white onion, carrot, etc.), maize, beans, wheat, etc. (MINAGRI, 2018). The studied area, "Volcanic Highlands" in Rwanda, which extends into the Districts of Burera, Musanze, Nyabihu and Rubavu is presented in Figure 1.

Sources of data

Data used in this research were collected using a questionnaire from a random sample of 401 small-scale crop producers in the region of Volcanic Highlands in Rwanda. Data were collected on the model farm from each producer where a single crop (cropping system highly recommended by the authorities) is applied during the 2019 B growing season. The selection of model parcels focused on one or other of three criteria: (1°) either the holding is principal in terms of size, (2°) or principal in terms of production, (3°) or the parcel meets these two criteria simultaneously. The elements of the questionnaire focused on the socioeconomic characteristics of producers and their households, the size of the farm, information related agricultural production, cost, price and income, as well as the information about the farmers' welfare (food security, and coping strategies). The sample size was determined using the formula of Yamane (1967) as described by the equation 1.

$$n = \frac{N}{1 - N(e)^2} \quad \text{(Equation 1)}$$

where n is the sample size, N is the resident population size in the four districts surveyed (Burera, Musanze, Nyabihu, and Rubavu) based on the Fourth National Census of Population and Housing (N=1,403,248 inhabitants) (NISR, 2014), and e is the 5% error assumed.

Figure 1. Location of the study area on the map of Rwanda (Districts of Rubavu, Nyabihu, Musanze and Burera)

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Methods of data analysis

This study used the Consolidated Approach to Reporting Indicators of Food Security (CARI) Guidelines developed by the World Food Programme in 2015 for the analysis of food security (WFP, 2015). The CARI is a quantitative approach based on a single household-level survey dataset and its unit of analysis is the household. The approach combines food security indicators in a systematic and transparent way, whereby it classifies households into four descriptive groups: food secure, marginally food secure, moderately food insecure, and severely food insecure. The CARI methodology is designed to be used for food security assessments which aim to estimate the actual number of food insecure households in a target population. The method is suitable for national and regional assessments, as well as more specific locations, such as agricultural zones.

Following the CARI methodology, this study estimated two key dimensions of food security, namely the current status and the coping capacity. The first dimension (the current status) in this study encompasses food security indicator that measure the adequacy of households' current food consumption, known as food consumption score (FCS). The FCS was calculated using data on food items, their weight and days that household members have eaten these food items during the past 7 days. The FCS is translated into food consumption group (FCG), where the percentage of households in each of the four groups of food security stats is determined. Within the current status dimension, the 4-point scale indicator scores (food secure=1; marginally food secure=2; moderately food insecure=3; and severely food insecure =4) were considered. The FCS is computed using the equation 2 (WFP and UNICEF, 2016).

$$FCS = \sum_{i=1}^{9} c_i D_i \quad \text{(Equation 2)}$$

where c_i is the weight of a food item i (c_i equals 2 for cereals and tubers, 3 for pulses, 4 for milk and dairy products, 4 for meat and fish, 1 for vegetables, 1 for fruit, 0.5 for oil, fat and butter, 0.5 for sugar, salt and sweet, and 0 for condiments) and D_i the number of days that household members have eaten the food item i during the past 7 days.

Secondly, the coping capacity dimension uses domain indicators that measure households' economic vulnerability and asset depletion. In this study, the copying capacity domain was based on the combination of the data on livelihood coping strategies (for assets depletion, AD translated into percentage of households in the four groups of food security status) and economic vulnerability (for food expenditure share, FES translated also into percentages of households). Within each of the two domains (current status and coping capacity), the 4-point scale indicator scores (food secure=1; marginally food secure=2; moderately food insecure=3; and severely food insecure =4) were then averaged to establish the household-level summary indicators. These summary indicators were then averaged to establish household's overall food security classification. The summary of coping capacity S is the average of economic vulnerability and asset depletion, that is, S= (FES+AD)/2. The whole procedure of computing the food security indicators using CARI methodology is summarized in the Table 1.

To construct the overall food security outcome, as guided by CARI, the summary indicator of Current Status was calculated by averaging the household's console score (i.e. the 4-point scale scores) for the FCS. The summary indicator of Coping Capacity was calculated by averaging the household's console scores (i.e. the 4-point scale scores) for the livelihood coping strategies and the food expenditure share. Then the two summaries were averaged to get the household's overall food security outcome or Food Security Index. To get the entire number, rounding to the nearest number was made (this usually has to fall between 1 and 4 as indicated by CARI). Consequently, the overall food security index (FSI) is the average of FCG and S, that is, FSI= (FCG+S)/2. This number therefore, represents the household's overall food security outcome. This is the final output of the CARI and it represents the population's *overall food security status*. According to CARI, the console itself serves to provide a clear snapshot of the rates of the different types of a population's food insecurity at quick glance.

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Table 1. Summary on the computation of the food security index (CARI reporting console)

Domain		Indicator	Food security status			
			Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Current status	Food consumption	Food consumption score (FCS) / Food consumption group (FCG)	Acceptable: FCS>35 (%) $[FCG_1]$	NA	Borderline: 21<FCS≤35 (%) $[FCG_3]$	Poor: FFS≤21 (%) $[FCG_4]$
Coping capacity	Economic vulnerability	Food expenditure share (FES)	FES<0.50 (%) $[FES_1]$	0.50≤FES<0.65 (%) $[FES_2]$	0.65≤FES<0.75 (%) $[FES_3]$	FES>0.75 (%) $[FES_4]$
	Asset depletion AD	Livelihood coping strategy categories	No coping strategies employed (%) $[AD_1]$	Employed stress strategies (%) $[AD_2]$	Employed crisis strategies (%) $[AD_3]$	Employed emergency strategies (%) $[AD_4]$
	Summary of copping capacity	Summary of copping capacity	$S_1=[FES_1+AD_1]/2$	$S_2=[FES_2+AD_2]/2$	$S_3=[FES_3+AD_3]/2$	$S_4=[FES_4+AD_4]/2$
Food security index (FSI)			$FSI_1=[FCG_1+S_1]/2$	$FSI_2=[0+S_2]/2$	$FSI_3=[FCG_3+S_3]/2$	$FSI_4=[FCG_4+S_4]/2$

Source: Summarized and adapted from WFP (2015). Note: % stands for per cent. Details on the determination of FCS, FES, AD, and FSI are given in WFP (2015) and WFP and UNICEF (2016).

The CARI approach was supplemented with descriptive statistics, whereby the frequency and percentage of the households which adopted every strategy are presented. In this study, the attention was firstly paid to stress coping strategies (selling household assets, spending savings, selling more animals than usual, and purchasing food on credit or borrowing food). Secondly, the crisis coping strategies (harvesting immature crops, consuming seed stocks, and decreasing expenditures on farm inputs) were analyzed. Thirdly, the emergency coping strategies (begging, selling last female animals, and migration of the entire household) were assessed. Fourthly, the consumption-based strategies (relying on less preferred food or less expensive food, relying on food help from friends or relatives, reducing the quantities consumed by adults, and going the entire day without eating) were examined. Lastly, the other or miscellaneous strategies (long-term migration, reducing on-food expenditures, re-selling farm inputs, sending children to work for money, and sending children to work for food) were investigated.

RESULTS

The results on the socioeconomic characteristics of the respondents are summarized in Table 2. The descriptive statistics show that the size of lands allocated to crop farming is 3,221 square metres (or 0.32 hectares) on average for the 2019 B season. By sex, 208 crop producers in the study are men (52%) while 193 are women (48%). We have also noted that 74% of farmers practice crop rotation, while 26% do not. This is also confirmed by a producer in Kinigi, District of Musanze (anonymously named KM), who highlighted that farmers can produce potatoes at least over two consecutive growing seasons to maximize their turnover on production, especially when the first season has not been well remunerating. Crop rotation is therefore motivated much more by speculation than by logic on the order of crops.

The age of farmers is 41 on average, which shows that farmers are still physically strong and in principle have the experience required to do the job well. The ratio of production per unit of cultivated area, that is, the yield expressed in Kg per hectare, was estimated at 11,160 Kg per hectare. In addition, the area of cultivated land is very small and is equal on average to 3,221 square metres (equivalent to 0.32 hectares), which could significantly affect the level of income. It should also be noted that the crop growers have attended school and come from all levels of education. Any other detail can be read in Table 1.

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Table 2. Socioeconomic characteristics of crop producers in Volcanic Highlands in Rwanda

Qualitative variable	Frequency	Percentage	Cumulated pourcentage
Sex			
Male	208	51.87	51.87
Female	193	48.13	100.00
Level of education			
No formal education	64	16.12	16.12
Some primary education	83	20.91	37.03
Primary education completed	109	27.46	64.48
Some secondary education	25	6.30	70.78
Secondary completed	69	17.38	88.16
Technical and vocational	42	10.58	98.74
Some university	1	0.25	98.99
University completed	4	1.01	100.00
District			
Burera	101	25.19	25.19
Musanze	101	25.19	50.37
Nyabihu	100	24.94	75.31
Rubavu	99	24.69	100.00
Crop grown			
Potato	132	32.92	32.92
Bean	39	9.73	42.64
Maize	24	5.99	48.63
Wheat	1	0.25	48.88
Pyrethrum	1	0.25	49.13
Sorghum	14	3.49	52.62
Red onion	51	12.72	65.34
White onion	43	10.72	76.06
Carrot	46	11.47	87.53
Cabbage	50	12.47	100.00
Crop rotation			
Practiced	205	51.12	51.12
Scarcely practiced	90	22.44	73.57
Not at all practiced	106	26.43	100.00

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Table 2. Continued

Quantitative variable	Mean	Minimum	Maximum
Age	40.57	21	62
Cultivated land (m^2)	3,221	500	12,000
Production (kg)	3,897	40	15,000
Yield (kg/ha)	11,160	267	40,000
Gross income /ha (FRW)	1,182,085	16,000	6,732,000
Total cost/ha (FRW)	349,298	32,371	1,794,809
Net farm income /ha (FRW)	832,787	-1,218,809	6,280,033

Note : m^2 = square metre, kg = kilogrammes, ha=hectare, et FRW = francs rwandais. For quantitative variables, all amounts are rounded up to 1

The results from the CARI analysis (Table 3) show that 86.61% of the sample households are food secure, while 13.39% are food insecure. Although this is the first study to comprehensively analyze food security in its three domains (availability, access and vulnerability), its findings show that sampled farm households in the region of Volcanic Highlands in Rwanda are food secure. This derives from food consumption domain where 75.06% of sampled households are food secure while 24.94% are food insecure. As from economic vulnerability domain, 96.75% of households are food secure while 3.25% are food insecure; while from asset depletion domain, 98.16% are food secure while 1.84% are food insecure.

In intent of the details and for the sake of the supplement of livelihood coping strategy categories, the distribution of the sample households by each of the coping strategies adopted to deal with food shortage is presented. The frequencies and the percentages served to show the importance of each strategy as well as the severity of food shortage among the small-scale farmers in the study area. The results of this research (Table 4) show that, among the livelihood-based coping strategies, spending the savings (adopted by 359 households, that is 89.53%) is the most adopted stress-coping strategy. Harvesting immature crops (adopted by 110 households, 27.43%) was identified as the most adopted crisis-coping strategy. In addition, selling the last female animal (adopted by 6 households, 1.5%) was reported to be the most adopted emergency-coping strategy. This implies that the high number of households to adopt food-shortage coping strategies matches the less pressing situation of the food security.

Table 3. Food consumption, economic vulnerability, asset depletion and overall food security index among small-scale crop farmers in Volcanic Highlands in Rwanda

Domain	Indicator	Food security status			
		Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Food consumption	Food consumption group/score	Acceptable: 75.06%	Not applicable	Borderline: 21.45%	Poor: 3.49%
Economic vulnerability	Food expenditure share	92.02%	4.73%	2.00%	1.25%
Asset depletion	Livelihood coping strategy categories	7.42%	92.17%	0.41%	0.00%
Summary of copping capacity	Summary of copping capacity	49.67%	48.45%	1.21%	0.63%
Food security index		62.38%	24.23%	11.35%	2.04%

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For consumption-based strategies, the most adopted strategy is relying on less preferred or less expensive food (380 households, 94.76%), followed by reducing the quantities consumed by adults for children (40 households, 9.98%), reducing the number of meals eaten per day (29 households, 7.23%). The results indicate also that borrowing food or relying on help from friends or relatives (15 households, 3.74%), and going entire day without eating (5 households, 1.25%) are the least adopted strategy. As for the other (miscellaneous) coping strategies, the most adopted strategy is reducing non-food expenditures (315 households, 78.55%), followed by re-selling farm inputs (34 households, 8.48%), sending children to work for money (5 households, 1.25%), and the least adopted one is sending children to work for food (2 households, 0.5%).

Table 4. Coping strategies for food security problems among small-scale crop farmers in Volcanic Highlands in Rwanda

No.	Coping strategies for food security (N=401)	Frequency	Percentage
	A. Main livelihood-based coping strategies		
	Stress coping strategies		
1	Sold household assets/goods (radio, furniture, television, jewellery etc.)	8	2.00
2	Spent savings	359	89.53
3	Sold more animals (non-productive) than usual	259	64.59
4	Purchased food on credit or borrowed food	133	33.17
	Crisis coping strategies		
5	Harvested immature crops (e.g. green maize)	110	27.43
6	Consumed seed stocks that were to be saved for the next season	82	20.45
7	Decreased expenditures on fertilizer, pesticide, fodder, animal feed, veterinary care, etc.	67	16.71
	Emergency coping strategies		
8	Begged	4	1.00
9	Sold last female animals	6	1.50
10	Entire household migrated	2	0.50
	B. Consumption-based strategies		
11	Relying on less preferred, less expensive food	380	94.76
12	Borrowing food or relying on help from friends or relatives	15	3.74
13	Reducing the quantities consumed by adults for children	40	9.98
14	Reducing the number of meals eaten per day	29	7.23
15	Going entire day without eating	5	1.25
	C. Miscellaneous strategies		
16	Long term migration (more than 6 months)	0	0.00
17	Reducing non-food expenditures	315	78.55
18	Re-selling farm inputs	34	8.48
19	Sending children to work for money	5	1.25
20	Sending children to work for food	2	0.50

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DISCUSSION

The results of this study help to better understand the status of food security with detailed data on its variation across sampled farm households in the region of Volcanic Highlands in Rwanda. This is aligned with the recommendation from the recent works to disaggregate food security indicators so as to design precise and useful policy interventions (Tefera and Tefera, 2014).

From the analysis of overall food security status, the results show that 86.61% of the sampled households are food secure, while 13.39% are food insecure. When it comes to coping techniques, the results suggest that most households spend their savings (89.53%), sell more non-productive animals than usual (64.59%), buy food on credit or borrow food (33.17%), and sell household assets (2.00%) when they are overwhelmed by a food crisis. This entails that these strategies may have permitted to keep the standard conditions of nutrition of the adopters. However, given that they spent their savings, this will reversely affect their food production and food security status in the future since it will result in low level of investments and consequently low incomes. This contrasts Nakabo-Ssewanyana's (2003) remark that raising incomes has an effective impact on the reduction of food insecurity, and von Braun's (1992) view that private savings and investments improve household food security. They have also poor access to financial resources (Musabanganji et al., 2015), which limit them to pay for quality inputs (Oladeebo and Oladeebo, 2008) and thus achieve low productivity (Kelly and Murekezi, 2000). Consequently, the food security situation may continuously aggravate alongside the years (Mulumeoderhwa et al., 2020).

For the strategies adopted to cope with food crisis, the results of this study suggest that harvesting immature food crops is the most widely used approach (27.43%), followed by consuming seed stocks (20.45%), and finally, cutting input expenditures (16.71%). The adoption of harvesting immature crops as a coping strategy to food shortage is aligned with Olayiwola et al. (2017) and Reincke et al.'s (2018) confirmation who stressed that harvesting immature crops is one the most employed strategies for households to improve the transitory and chronic food insecurity. Also, harvesting immature crops will inevitably worsen future food security status of the sampled households.

Additionally, the results reveal that the most adopted consumption-based strategy is relying on less preferred or less expensive food (94.76%). This is supported by different researchers (Mukhtar, 2019; Mulumeodrehwa et al., 2020; Oskorouchi and Sousa-Posa, 2020) who reported that this strategy is one of the most adopted by households managing food shortfall in different African countries.

Concerning the other (miscellaneous) coping strategies, the most common approach is lessening non-food consumptions (315 families, 78.55%), followed by re-selling farm inputs (34 families, 8.48%), sending children to work for cash (5 families, 1.25%), and sending children to work for food was identified as the least adopted strategy (only 2 families, 0.50%). In this category, the most adopted strategy is reducing non-food expenditures. This is supported by Headey and Ecker (2013) who state that "*people may sacrifice non-food expenditure to maintain calorie consumption levels*".

Based on all the above, the results from the CARI console analysis further reveals that most of the sampled households are not food insecure. This involves that small-scale farmers' households are not vulnerable with respect to adopted strategies to cope with food shortage.

CONCLUSION

In developing countries, rural and agricultural development aims to achieve a continuing progress of living conditions in rural areas through high crop productivity, output and income of small farmers, and ultimately with real food security. Food security success depends on the suitability of aggregate accessibility of physical food supplies, access of farmers' households to the food supplies, and the appropriate reasonable utilization of food supplies to respond to nutritional requirements of consumers.

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The results on the socioeconomic characteristics of the respondents show that the size of lands allocated to crop farming is 0.36 hectares on average for the 2019 B season. Among 132 crop producers, 70 (52%) of them are men while 62 (48%) are women; 67% of crop producers practice crop rotation, while 33% do not. This reflects that crop rotation is motivated much more by speculation than by logic on the order of crops. The mean age of crop producers is 41 years, which shows that they are strong and experienced enough to do the farming job adequately. The ratio of production per unit of cultivated area, i.e. the yield expressed in kg per hectare, was estimated at 11,160 kg per hectare. In addition, the area of cultivated land is very small and is equal on average to 3,221 square metres (equivalent to 0.32 hectares), which could significantly affect the level of income. From the descriptive statistics, it should also be noted that the farmers have attended school and come from all levels of education.

The results from the CARI analysis show that 86.61% of the sampled households are food secure, while 13.39% are food insecure. In intent to present the details of livelihood coping strategy categories, the frequencies and the percentages show that, among the livelihood-based coping strategies, spending savings is the most adopted stress-coping strategy, harvesting immature crops is the most adopted crisis-coping strategy, while selling the last female animal is the most adopted emergency-coping strategy.

By importance, the adopted consumption-based strategies are ranged from relying on less preferred or less expensive food, followed by reducing the quantities consumed by adults for children, reducing the number of meals eaten per day, borrowing food or relying on help from friends or relatives, and going entire day without eating. Among other coping strategies, the most adopted strategy is reducing non-food expenditures, followed by re-selling farm inputs, sending children to work for money, and the least adopted one is sending children to work for food. From the above results, the overall CARI console analysis shows that most of the sampled households are not food insecure, i.e. they are not vulnerable with respect to adopted strategies to cope with food shortage. Therefore, it is recommended that strategies should be initiated to increase crop productivity and output, to guarantee market access to small-scale farmers for stable agricultural prices and farm incomes, to enhance livelihood diversification to cope with under-employment in agriculture sector to avail rural non-farm sources and to complement the farm incomes. Besides, considering that this study did not assess the great difference between the minimum and the maximum yields in the study area, further research on productivity growth as a way out of food insecurity using regression analysis could provide deeper explanations to this situation.

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