IJFAEC
International Journal of
Food and Agricultural Economics

SMALLHOLDER FARMERS' OUTSIDE SUPPORT AND ITS EFFECT ON ADOPTION OF RADICAL TERRACES AND FOOD SECURITY

Emmanuel Murwanashyaka
University of Nairobi, Department of Sociology and Social Work, Kenya
Email: emmamurwa@gmail.com ORCID ID: orcid.org/0000-0003-1113-9254

Preston Orieko Chitere
University of Nairobi, Department of Sociology and Social Work, Kenya
Email: pchitere@uonbi.ac.ke ORCID ID: orcid.org/ 0000-0002-1918-1492

James Gichuru Kariuki
University of Nairobi, Department of Sociology and Social Work, Kenya
Email: jgkariuki@uonbi.ac.ke ORCID ID: orcid.org/0000-0002-9061-422X

Abstract:

   Radical terraces are innovative farming techniques promoted for increased agricultural yield. However, some terraces have not been fully exploited due to the farmers' limited supports. This has a great impact on Rwanda's farming productivity where food security is still a crucial problem. This study, therefore, assessed the contribution of farmers' outside support on the adoption of radical terraces for food security in Nyamagabe District, Rwanda. A descriptive correlational research design was adopted. Outside support and adoption-diffusion of innovations perspectives guided this study. Cluster and purposive sampling techniques were used to sample 192 farmers and 19 key informants. Data was collected using a questionnaire, interview guide, direct observations, and documentation. Quantitative data were analyzed using descriptive and inferential statistics of Pearson correlation coefficient and chi-square while thematic analysis was used for qualitative data. Findings revealed that outside support influenced the adoption of radical terraces and food production and security. Furthermore, many smallholder farmers had been supported and improved their food production and security after they adopted radical terraces. It was concluded that the outside support significantly influenced farmer's adoption and food production and security. Both local and national government and development partners such as NGOs should support the farmers with low-interest credits to enable them to invest in the farms. Also, the local, and national government of Rwanda and its development partners should support the farmers with farming inputs like lime, fertilizers, farm yield manure and wheat and distribute them to farmers in time for better use of radical terraces.
Keywords: *Adoption, food security, outside support, radical terraces, smallholder farmer.*
JEL Codes : *O33, Q12, Q13, Q14, Q15, Q16, Q18, Q25*

1. Introduction

Just like in most of the developing countries, Rwanda's economy is still largely agrarian with small-scale subsistence farmers producing most of the agricultural output (Republic of Rwanda [RoR], 2014). Approximately 80% of Rwanda's population depends on agriculture which holds potential for expansion. Agriculture leftovers the most important sector of the Rwandan economy but then also one of its greatest challenges (RoR, 2014). However, over the years, agricultural growth has been on the decline; it was 0.5% in the 1980s and 3.9% in the 1990s, 9% in the 2000s, 8% in 2010 and 8.7% in 2015 (NISR, 2017). The vast majority of farmers are engaged in subsistence agriculture conducted on small family plots. For World Bank (2014, p. 2) "Rwandan agriculture is characterized by small production units that average 0.33 ha in size".

In Rwanda, farm production is deemed inadequate to support households as well as deteriorating soil fertility, which is a hindrance to increasing food production (Alinda p. & Abbott, p., 2012). The public policy in Rwanda is committed to addressing these challenges of production that lead to food shortage, stunting of growth of children and their malnutrition. To address these challenges, the government of Rwanda in 2004 prepared the National Agricultural Policy (NAP) whose aim was to ensure increasing farm productivity and relied on the modernization of agriculture (RoR, 2004).

However, some factors that constrain the implementation of this policy include the absence of linkages between administration and extension services of the Ministry of Agriculture (MINAGRI); misinterpretation of the policy by various actors; lack of a clear extension system; the malfunction of training and extension services; ignorance (Ubujiji) resulting from insufficient training and information for a certain percentage of the population; the imbalance between research and transfer of technologies; the long practice of subsistence farming and shortage of financial resources (RoR, 2004). These factors contributed significantly to the level of current household food insecurity. In 2016, the "Comprehensive Food Security and Vulnerability Analysis (CFSVA)" found that 80% of all households in Rwanda had an adequate diet and only spent a low percentage of their budget to cover their food needs. These statistics translate to approximate 1,963,975 households being food secure. Among these food secure households, 979,045 households are marginally food secure; this means that they are at high risk of becoming food insecure. From the CFSVA 473,847 households are considered food insecure with 63,696 of them being severely food insecure (NISR, 2016).

Tackling food insecurity must include decentralized ownership and multi-sector planning with support from development agencies and its collaborative interventions (RoR, 2014). In this context, radical terraces are focused on a need for support from external agencies for transforming agriculture and producing food efficiently. For RoR (2012), radical terrace refers to an adaptation technology of landscaping a portion of sloppy land into successively receding flat surfaces which look like steps, for more effective farming.

Mupenzi et al (2014), revealed that radical terraces had the potential to increase farm productivity. However, since 1980, erosion has been affecting agricultural activities (RoR, 2015). Land degradation through erosion is a significant issue in Rwanda as it affects food security, agricultural productivity as well as the quality of life for resource-poor farmers (RoR, 2010). To mitigate the problems, radical terraces which were among the strategies seek to protect land for increasing farm productivity through mobilization of the population living in highlands (Mupenzi et al., 2014). The project of radical terraces has as such been implemented in the Nyamagabe district to improve soil fertility and food production. Moreover, new terraces should be protected and carefully maintained, radical terraces require regular care and maintenance for promoting food security but require outside support for their construction and use.

1.1 Objectives and Research Questions

The main objective of this study was: "To assess the contribution of outside support on the adoption of radical terraces and food security in Nyamagabe district". To achieve this main objective, the study was guided by three research questions namely: a) What is the contribution of outside support to the adoption of radical terraces? b) What was the farmers' level of adoption of the radical terraces, food production and security situation? c) What is the relationship between the farmers' outside support, adoption of radical terraces, food production and food security?

1.2 Rationale

Food is a basic human need and its necessity in human life has driven people to engage in activities of producing it by exploiting the environment (Ndagi, J.M., 2017). The efforts of smallholder farmers in Rwanda to restore soil fertility are inadequate since few farmers can afford to exploit radical terraces and use inorganic chemical fertilizers (RoR, 2014). In this regard, the government and other agencies mobilize people to participate in adopting radical terraces to ensure food security. Radical terraces are innovative techniques in the agricultural sector that should be promoted by local farmers and development agencies that provide support to those farmers for food production. Moreover, it was revealed that radical terraces have a positive impact to ensure food security sustainably (Mupenzi et al., 2014). Currently, 80 % of all households in Rwanda have an adequate diet and utilize a small share of their budget to cover their food needs. Thus, 979,045 households in Rwanda were at high risk of becoming food insecure with 473,847 of them being considered as food insecure and 63,696 of these being severely food insecure (NISR, 2016). In so doing, radical terracing is among the strategies taken to ensure the food security of the population living in the highlands (Mupenzi et al., 2014). Moreover, from 2008-2018, 7,236 ha of radical terraces were developed as agricultural technology in Nyamagabe district. The total cost was estimated at $7,236,000 (Nyamagabe district, 2018). Despite this effort, some of the terraces are in a deplorable state of disrepair particularly due to lack of use and maintenance. The land covered by radical terraces is not being fully exploited and this has a great impact on Rwanda's agricultural productivity and food security and to a certain extent, food security is still a big problem. Whereas farmers of the district have adopted hectares of radical terraces, the district is most affected by food shortage. Consequently, some areas in Nyamagabe District have been experiencing serious food shortage where 42% of the households of this district are food insecure. This percentage ranks the district the highest in food insecurity in Rwanda (NISR, 2016). In this study, the primary interest was to assess the effect of outside support on farmers' adoption of radical terraces.

2. Theoretical Perspective

2.1 Farmer's Outside Support Perspective

Bandeth, R. (2010) found that the FWUC obtained a lot of funding from the government, non-governmental organizations, and local authorities. Despite this government did not have enough resources to invest in the agricultural sector. In so doing, ActionAid International Secretariat (2015) found that African governments were not investing enough in agriculture to respond to the expenditure levels outlined in their implementation and policy plans. This meant the governments in Africa were far from fulfilling the 10% investment commitment of the national budget to the agricultural sector. It was found that the highest proportion of the agriculture budget was spent on recurrent costs including salaries and other administrative

costs. For instance, Kenya, Uganda, and Zambia spend 23-27% of their agricultural sector budgets on salaries and administration.

Yuliatia Y. & Iskaskara, R. (2016) stressed that a major strength of the strategy was the provision of nutritious food for the family. Thus, Garnevska et al. (2011) found that success was influenced by government-funded policies such as free registration, free training, and easy access to capital and financial support to farmers. Anandajayasekeram et al. (2008) found that the Training and Visit (T&V) program was one of the best known agricultural practices that had been taken up in East African countries for supporting the development of state extension services to farmers. In so doing, the role of government in small-scale farming development was not limited to training and visits but also went to the use and subsidies of the inputs. Musabanganji et al. (2016) studied the intensification of smallholder agriculture in Rwanda. They found that inputs use by smallholder farmers had increased markedly and subsidies for inputs had been introduced and circulated ranging between 15% and 35% for fertilizers and between 50% and 80% for better-quality seeds.

For the developing agricultural sector in Africa, the outside support comes from government support of recurrent costs (salaries and other administrative costs) and not for improving the competence of smallholder farmers for overcoming issues of food production and security. Most studies were carried out on the role of radical terraces on soil management and conservation what has been overlooked is farmers' outside support for the adoption of radical terraces for food production and security at different levels. Moreover, there no available sociological study related to outside support in the adoption of radical terraces projects for producing food. This study filled this knowledge gap by evaluating the contribution of outside support to the farmers' adoption of radical terraces.

2.2 Adoption and Diffusion of Farm Innovation Perspective

Adoption is considered as the integration of innovation into a farmer's ongoing operation through repeated and continuous use (Peshin et al., 2014) while diffusion is the process by which members of a certain community adopt an innovation. The idea of the process is to change the backward mindset posture of enclosed typical rural communities for development through innovative means (Bonye et al., 2013). For Rogers (2003) the diffusion of innovation is a societal process that involves interpersonal communication in which partakers generate and share information among them for building up a common understanding. The Adoption-diffusion model is an exclusive form of communication connected to innovative ideas (Tomas-Simin & Jankovic, 2014). The diffusion theory is meant to lead to community acceptance of innovative ideas and practices in subsistence as well as modern agriculture. Some factors affect the adoption of an innovative idea. According to Chimoita, E. L. (2017), diffusion of innovation theory refers to a process of passing on a new idea among community members in their groups or communities or over a given time by focusing on awareness, knowledge, attitude change, and decision-making process that directs to the adoption and non-adoption of an innovation. In this regard, Turner et al. (2017) asserted that farmers willingly adopt new ideas which are perceived to be easier to comprehend more than innovations that require the acquisition of skills and understanding.

Adoption and diffusion perspective was used in this study because it is assumed that farmers experiencing difficulties to adopt new farming practices of radical terraces, would be impelled by the inability to be involved in the use of radical terraces to reduce the risk and effort of performing it alone and as a way of maximizing gains from the use of radical terraces.

3. Research Methods

The study conducted in Nyamagabe district, Rwanda. The selection of this district was based on its geographical aspect of being a highlands and hilly region with infertile soil exposed to high excessive erosion. Moreover, in the 1980 and 1990s, some of its inhabitants died from hunger while many others migrated to other areas in search of food and fertile lands (Murwanashyaka, E., 2013). To this effect, the introduction of radical terraces was among the strategies for increasing households' agricultural production and ensuring food security. Furthermore, the district had 42% of the households which were food insecure (NISR, 2016) and this made Nyamagabe district among the highest food insecure districts in Rwanda.

Nyamagabe district had 17 sub-administrative entities known as sectors out of which radical terraces had been constructed in four (4) which we selected for this study. These were Buruhukiro, Gatare, Kibilizi and Nkomane sectors. Sectors are divided into cells which are in turn divided into villages. In consultation with cell leaders, we purposively selected two cells and three villages from each selected sector. At the village level, in consultation with the village heads, we purposively sampled eight (8) smallholder farmers' households which owned land and had constructed radical terraces and using them in their farming activities. Consequently, this helped the researcher to get 192 heads of households as the number of the sampled farmers.

Besides, 19 Key Informants who were persons directly or indirectly involved in radical terraces were purposively sampled at district, sector, and cell levels. They included the Mayor of the district (1), District vice Mayor in charge of economic development (1), District planner (1), District Agronomist (1), Representatives NGOs working in the agriculture sector (2); Representative of RAB in Nyamagabe Station (1); Farmer field school representatives of cells (4); Sectors agronomists (4); Representatives of agricultural cooperative (4).

Techniques of data collection which were face-to-face interviews using an open- and close-ended questionnaire as well as direct observation and documentary sources were used. Quantitative data were analysed using frequency tables, percentages and inferential statistics such as Pearson correlation and bivariate regression analysis at 0.05 level of significance. The Statistical Package for Social Science (SPSS) version 23 was used for analysing empirical data tabulated in contingency tables. The content analysis of narratives was used to analyse qualitative data.

4. Results of the Study

4.1 Contribution of Outside Support to the Adoption of Radical Terraces

The first objective was to assess the contribution of outside support to the adoption of radical terraces. Indicators like types of agencies, benefits provided, farmers' use of the support were assessed.

Type of agencies that provided support to the farmers: Table 1 shows three agencies that supported the farmers which were: Government that supported (50.0%), NGOs (44.3%), and PSF (5.7%) of the farmers. However, as noted by some farmers during their interviews, there were challenges related to agency support including high interest rate; delay in providing improved seeds, lime, manure, and fertilizers; lack of follow up on supported projects and crop diseases.

Benefits reported by the farmers from the Agencies: Asked whether they had been supported with credit by development agencies, 69.3% of the respondents confirmed that they had been loaned while the remainder had not. This implied that nearly a third of the farmers used their resources for meeting the costs of adopting terraces and farming. A key informant at the sector level (Agronomist Nkomane) reported the following:

"*NKUNGANIRE is a national program whereby the price of agricultural inputs is subsidized for some crops and farmers pay a certain percentage of the total price and the government pays the remainder. It also aims at supporting farmers as they transition from traditional agriculture methods to modern techniques to ensure optimum land use*"

Another key informant at the sector level (Agronomist Kibilizi) highlighted agencies that provided support:

"*Those agencies include LWH, MINAGRI and WORLD VISION. Owners of terraces constructed by LWH had an organized cooperative that was assisted to construct post-harvest facilities*."

Other NGOs that provided support as confirmed by the key informant at the district level (agronomist):

"*Farmers get the support of constructing radical terraces from the government, they are provided start-up kits composed of organic manure, lime and improved seeds. Non-Governmental Organizations like Hinga Weze, ENERGIE VERTE et ELEVAGE and UNICOOPAGI supported the actions.*"

Table 1. Farmers' Outside Support by Development Agencies

		Number	Percent
Amount of financial support /credit	None	134	69.8
	<=400,000	31	16.1
	400,001 - 1,000,000	9	4.7
	1,000,001+	18	9.4
	Total	**192**	**100.0**
Types of agencies providing support	None	134	69.8
	B.P.R	6	3.1
	RAB	1	0.5
	SACCO	30	15.6
	TUBURA	9	4.7
	V.U.P	10	5.2
	Vision finance	2	1.0
	Total	**192**	**100.0**
Farmers use of the support/credit in	None	149	77.6
	Terraces	16	8.3
	Crops	12	6.3
	Livestock	9	4.7
	Others	6	3.1
	Total	**192**	**100.0**
Development agencies provided other support	Government	96	50.0
	NGO	85	44.3
	PSF	11	5.7
	Total	**192**	**100.0**

When we asked farmers about the type of support they were given by the agencies, they responded as 30.2% got support in the form of credit compared with 39.1% who did not. In other words, many farmers did not get credit from the agencies. Table 1 also shows that some respondents got credit from different financial institutions as follows: Umurenge SACCO (15.6%), VUP (5.2%), TUBURA (4.7%), BPR (3.1%), Vision Finance (1.0%), and RAB (0.5%). A key informant at sector level (FFS Nkomane) reported as follows:

"TUBURA provided agricultural credit in the form of fertilizers, improved seeds and lime. The Financial institution like SACCO (Savings and Credit Cooperatives) can give a farmer credit of 100,000 or 200,000 to reimburse other credits or solve farm needs."

The amount of financial support in terms of credit received by farmers from financial agencies is presented in table 1. About 16.1% received below 400,000frws, 9.4% received 1,000,001frws and above, and 4.9% received between 400,001-1,000,000frws.

Farmers' Use of the Credit: Table 1 shows that some farmers received credit from financial institutions not only for exploiting radical terraces but also to solve other problems they encountered in their daily life. This was indicated by the fact that only 8.3% of the respondents used the credit for radical terraces, 6.3% for crops, 4.7% for livestock, and 3.1% for others uses.

Furthermore, respondents who confirmed to have used the credit in improving radical terraces realized the benefits like to prepare and get radical terraces; to build community postharvest infrastructure stores; to get lime, fertilizers, seeds, improve production and to become a member of cooperatives. However, during the interview, farmers who had not used the loan for improving radical terraces gave their reasons which included, they could not be able to pay back the loan; did not have access to where credit was offered and was ignorant of its availability.

The key informant at the district level (FED) emphasized the support provided to farmers by the government:

"*For new radical terraces constructed by the district, farmers are provided with all the necessities like inorganic fertilizers, pesticides and improved seeds to motivate and encourage them for exploitation but in general His Excellence, the President of the Republic of Rwanda has provided support of 50% of the cost of lime distributed to farmers.*

4.2 Farmers' Adoption of Radical Terraces and Their Food Security

Level of adoption of radical terraces: The second objective was to highlight farmers' level of adoption. To categorize this variable of adoption of radical terraces, we gave scores that ranged from a minimum of 0 to a maximum of 3 for each of its indicators based on the weight the indicator had in this study. Scoring for all the adoption indicators had a minimum of 0 to 41 total scores and based on this range, we created three categories of this variable: Low adoption (0-20) Medium adoption (21-27) and high adoption (28-41) scores. Table 2 shows that the level of adoption of radical terraces was high adoption (81.8%), medium adoption (17.7%), and low adoption (0.5%).

Table 2. Respondents' Level of Adoption of Radical Terraces

Level of Adoption of Radical Terraces	Number	Percent
Low adoption	1	.5
Medium adoption	34	17.7
High adoption	157	81.8
Total	**192**	**100.0**

Level of farmer's food production: Also, this study seeks to highlight the level of farmers' food production. To be able to create categories of this variable, we gave 0 scores for each of the indicators up to a maximum of three (3) scores based on the weight the indicators had in this study. Scoring for food production had 51 total scores, with scores categories of low production (0-20), medium (21-30) and high (above 31). The level of food production was high (19.3%), medium (76.6%), and low adoption (4.2%) as presented in Table 3.

Table 3. Respondents' Level of Food Crop Production

Level of adoption of crop farming	Number	Percent
Low food production	8	4.2
Medium food production	147	76.6
High food production	37	19.3
Total	**192**	**100.0**

Level of farmer's food security: We developed a scoring system which we used to create categories of this variable. We gave a 0 score for each of the indicators up to a maximum of three (3) scores based on the weight the indicator had in this study. The scores ranged from 0 to 18.0 in total and helped us to create categories of low food security (0-5) medium (6-9) and high food security (10-18). Table 4 shows that the level of the farmers' food security was reported at high food security (1.0%), medium food secure (73.4%), and low food secure (25.5%).

Table 4. Respondents' Level of Food Security

Level of food security	Number	Percent
Low food secure	49	25.5
Medium food secure	141	73.4
High food secure	2	1.0
Total	**192**	**100.0**

4.3 Relationships between the Variables of Study

Support by development agencies was measured in terms of the year the support was provided, amount of financial support, types of agencies that provided the support and farmers' use of the support. In these regards, the study tested a number of hypotheses at the 0.05 level of significance.

4.3.1 Relationship between Adoption and Outside Support

H1: Farmers' adoption of radical terraces is positively influenced by the support they had received from outside agencies; HO: Farmers' adoption of radical terraces was not associated with the support they got from outside agencies. Table 5 shows the cross-tabulations.

Year support was provided: The Pearson Chi-square test ($\chi2=13.232$, df=8, p=0.104) indicated that the period of support did not influence the farmers' adoption of terraces. Those who received the support later adopted terraces in more-or-less the same level as those who got it earlier.

Types of agencies: The Chi-square test ($\chi2=9.028$, df=12, p=.701) showed that there was no relationship between types of agencies that provided support and adoption. That is, there was no difference in adoption by farmers who had accessed different agencies.

Amount of financial support: At P>0.023, financial support significantly influenced the farmers' adoption of radical terraces ($\chi2=23.591$, df=12, p=.023). This implied that farmers who had received a larger amount of credit adopted terraces more than those who had received less.

Farmers' use of support/credit: There was no significant association was found between farmers' use of the credit and adoption ($\chi2=8.811$, df=8, p=0.358). This meant that the adoption of radicle terraces did not differ among farmers based on the manner they used their support.

Table 5. Outside Support by Adoption of Radical Terraces

	Adoption of Radical Terraces			
	Low Adoption	**Medium Adoption**	**High Adoption**	**Total**
	n	**n**	**n**	**N**
Year of receiving support				
None	8	114	12	134
Before 2005	0	3	1	4
2006-2010	1	1	2	4
2011-2015	0	5	1	6
2016-2019	1	36	7	44
Total	10	159	23	192
χ2=13.232,df=8, p= 0.104				
Amount of financial support /credit				
None	8	114	12	134
<=400,000	0	26	5	31
400,001 - 1,000, 000	0	8	1	9
1,000,001+	2	11	5	18
Total	10	159	23	192
χ2=23.591, df=12, p=.023				
Types of agencies providing support				
None	8	114	12	134
B.P.R	1	4	1	6
RAB	0	1	0	1
SACCO	1	22	7	30
TUBURA	0	8	1	9
V.U.P	0	8	2	10
Vision finance	0	2	0	2
Total	10	159	23	192
χ2=9.028,df=12, p=0.701				
Farmers use of the support/credit in				
None	8	125	16	149
Terraces	1	11	4	16
Crops	0	12	0	12
Livestock	1	7	1	9
Others	0	4	2	6
Total	10	159	23	192
χ2=8.811,df=8, p=0.358				

The H1 hypothesis was partially accepted about the amount of financial support/credit the farmers had received. That is farmers who received larger amounts adopted terraces better than those who got fewer amounts. The Null hypothesis is accepted with year support was received, types of agencies that provided the support and farmers' use of the support.

4.3.2 Relationship between Food Production and Outside Support

H1: There exists a positive association between outside support and farmers' food production. HO: There is no association between outside support and farmers' food production. Table 6 presents the cross-tabulations.

Table 6. **Outside Support by Food Production**

	Farmers' Food Production			
	Low Food Production	Medium Food Production	High Food Production	Total
	n	n	n	N
Year of receiving support				
None	6	101	27	134
Before 2005	0	3	1	4
2006-2010	0	3	1	4
2011-2015	0	5	1	6
2016-2019	2	35	7	44
Total	8	147	37	192
χ2=1.213,df=8, p=0.997				
Amount of financial support /credit				
None	6	101	27	134
<=400,000	1	25	5	31
400,001 - 1,000, 000	0	7	2	9
1,000,001+	1	14	3	18
Total	8	147	37	192
χ2=0.969,df=6, p=0.987				
Types of agencies providing support				
None	6	101	27	134
B.P.R	0	5	1	6
RAB	0	0	1	1
SACCO	1	23	6	30
TUBURA	1	6	2	9
V.U.P	0	10	0	10
Vision finance	0	2	0	2
Total	8	147	37	192
χ2=9.535,df=12, p=0.657				
Farmers use of the support/credit in				
None	6	118	25	149
Terraces	2	10	4	16
Crops	0	10	2	12
Livestock	0	5	4	9
Others	0	4	2	6
Total	8	147	37	192
χ2=9.384,df=8, p=0.311				

Period of farmer support: The Pearson Chi-square test was ($\chi2=1.213$, df=8, p=0.997) and showed that there was no association between the period of support and farmers' food

production. That is, farmers who had been supported for a longer period produced more food crop in their radical terraces than those in a reverse situation.

Table 7. Outside Support by Food Security

	Food Security			
	Low Food Secure	Medium Food Secure	High Food Secure	Total
	n	n	N	N
Year of receiving support				
None	33	100	1	134
Before 2005	3	1	0	4
2006-2010	0	4	0	4
2011-2015	0	6	0	6
2016-2019	13	30	1	44
Total	49	141	2	192
χ2=10.039,df=8, p=0.262				
Amount of financial support /credit				
None	33	100	1	134
<=400,000	10	20	1	31
400,001 - 1,000, 000	2	7	0	9
1,000,001+	4	14	0	18
Total	49	141	2	192
χ2=2.953,df=6, p=0.815				
Types of agencies providing support				
None	33	100	1	134
B.P.R	1	5	0	6
RAB	0	1	0	1
SACCO	7	22	1	30
TUBURA	2	7	0	9
V.U.P	4	6	0	10
Vision finance	2	0	0	2
Total	49	141	2	192
χ2=9.601,df=12, p=0.651				
Farmers use of the support/credit in				
None	43	105	1	149
Terraces	3	12	1	16
Crops	1	11	0	12
Livestock	2	7	0	9
Others	0	6	0	6
Total	49	141	2	192
χ2=9.868,df=8, p=0.274				

Types of agencies that provided support: At (P>0.05), no marked relationship was observed between the types of agencies providing support and farmers' food production ($\chi 2$=9.535, df=12, p=0.657). That is, there was no difference in food production among farmers in terms of the agencies they received their credit from.

Amount of credit received by the farmers: The amount of financial support/credit did not significantly influence food production ($\chi2=0.969$, df=6, p=0.987). This implied that farmers who received more financial support did not produce more food than those who got less.

Farmers' use of the support was cross-tabulated with their food production, ($\chi2=9.384$, df=8, p=0.311). That is, the way the farmers used the credit did not influence their level of food production.

The H1 hypothesis is rejected while the HO hypothesis was accepted in regards to the farmers who had been supported by outside agencies for a longer period, types of agencies, amount of credit received by the farmers and their use of support did not significantly influence their food production.

4.3.3 Relationship between Farmers' Food Security and Outside Support

H1: There is a marked association between outside support received by the farmers and their food security situation; HO: Outside support received by the farmers did not influence their food security situation. Table 7 shows the cross-tabulations.

Period of support: The Pearson Chi-square test ($\chi2=10.039$, df=8, p=0.262) indicated that the food security situation of respondents who received external support in the form of credit did not significantly differ among those who had received it earlier and among those who got it later.

Amount of financial/credit support: Amount of support provided to the farmers in the form of credit was not significantly associated with food security ($\chi2=0.596$, df=2, p=0.742). This implied that the food security of farmers who received credit did not differ significantly from that of those who did not receive it.

Types of agencies: A Chi-square test ($\chi2=9.601$, df=12, p=0.651) showed that types of agencies providing support did not significantly influence food security. That is, the food security of farmers who were assisted by different agencies did not differ in terms of those supported by one agency versus those supported by another.

Farmers' use of the support/credit: This factor was not significantly associated with farmer's food security ($\chi2=9.868$, df=8, p=0.274) which in effect meant that food security of households did not differ in regards to the way farmers used the support.

The H1 hypothesis is rejected and the null hypothesis accepted in that none of the indicators of outside support was significantly associated with farmers' food security situation.

4.3.4 Regression Analysis of Predictor on Response Variables

A multivariate test was done among the predictor and response variables (p-value<0.1). Pearson's correlation coefficient was used to measure the strength of the association between the variables. Further, a regression analysis was performed to determine the strength of relationships between outside support and response variables, with a 95% confidence level. Response variables were food production, adoption and food security and were regressed on predictor variable of outside support. Below are the findings of the regression analysis.

Table 8. Relationships between Farmers' Food Security, Adoption, Production and Outside Support

	Food security	Adoption of radical terraces	Food production	Year of receiving support	Amount of financial support	Types of agencies providing support	Farmers use of the support
Food security	1						
Adoption of radical terraces	.618**	1					
Food production	.252**	.592**	1				
Year of receiving support	0.027	0.068	0	1			
Amount of financial support /credit	0.061	0.089	0.008	.939**	1		
Types of agencies providing support	0.034	0.105	0.056	.915**	.894**	1	
Farmers use of the support/credit in radical terraces	.199**	0.126	-0.017	.180*	.221**	.183*	1
** Correlation is significant at the 0.01 level (2-tailed).							
* Correlation is significant at the 0.05 level (2-tailed).							

Table 9. Regression of Farmers' Food Security, Adoption, Production and Outside Support

	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	-3.577	2.373		-1.508	.133	-8.258	1.104
Adoption	.313	.032	.700	9.884	.000	.250	.375
Food production	-.261	.119	-.154	-2.186	.030	-.496	-.025
Year of receiving support	-.149	.429	-.066	-.349	.728	-.995	.696
Amount of financial support /credit	.264	.308	.146	.858	.392	-.343	.872
Types of agencies providing support	-.275	.327	-.122	-.841	.401	-.920	.370
Farmers use of the support/credit in	.174	.092	.111	1.895	.060	-.007	.354

Note: Dependent Variable: Food security; R^2 =.418; F (6, 185) =22.179; Number of observations (N) = 191, p<0.001.

Relationships between farmers' food security, adoption, production, and outside support: Farmers' food security was regressed on adoption, food production and outside support. The study hypothesized that predictor variables would influence farmers' food

security. To test this hypothesis, multiple regression analysis was conducted between farmers' food security, adoption, food production and outside support (Table 8). Results of the analysis indicated that adoption of radical terraces (r=.618, p<.001), food production (r=309, p<.001) and farmers use of the support/credit in radical terraces (r=.199, p<.001) were significantly correlated with food security. The other predictor variables were not significantly associated with farmers' food security in the regression model (Table 8).

The regression model explained 41.8% of the overall relationship between farmers' food security, adoption, food production and outside support as significant (R^2 =.418, F (6, 185) =22.179, p< .001). The predictor variables of adoption of radical terraces (β =.313, p=.001), food production (β =.261, p<.030) significantly influenced farmers' food security (Table 9).

4.4 Discussions

The main objective of this study was to assess the contribution of outside support to farmers' adoption of radical terraces. Outside support significantly influenced farmers' adoption about the amount of financial support/credit the farmers had received. That is farmers who received larger amounts adopted terraces better than those who got fewer amounts. Moreover, the regression model explained 41.8% of overall relationships between farmers' food security, adoption, food production and the support received by the farmers from agencies as significant (R^2=.418, F (6, 185) =22.179, p< .001). The predictor variables of adoption of radical terraces, food production and types of agencies providing support significantly influenced farmers' food security. This finding concurred with what Bandeth, R. (2010) found in Cambodia that farmer water user communities had obtained a lot of funding from the government, non-governmental organizations and local authorities.

However, the outside support received by the farmers from outside agencies was not necessarily used in adopting radical terraces. Consequently, most of the outside support indicators did not significantly influence the adoption of radical terraces. Similarly, contrary to the common view (ActionAid International Secretariat, 2015), that there was a shortage of resources for the government to invest in the agricultural sector, the highest proportion of agricultural budget was spent on recurrent costs including salaries and other administrative costs. For instance, Kenya, Uganda, and Zambia spend 23-27% of their agricultural sector budgets on salaries and administration. This left fewer resources for investment in farmer support services such as credit and education.

Farmer's outside support positively and significantly influenced their adoption. This finding confirms that of Garnevska et al. (2011) who found that in the adoption of radical terraces, the government intervened in funded policies like free registration, free training, and easy access to capital and financial resources. This implied that the government would be the main sponsor in the radical terracing programme. Moreover, the finding was in accordance with the findings of Anandajayasekeram et al. (2008) on the Training and Visit (T&V) program which was one of the best known agricultural programs that were implemented in East African countries for supporting the development of state extension services to farmers. In so doing, the role of government in small-scale farming development was not limited to training and visits but also a provision of inputs and subsidies. Musabanganji et al. (2016) found that inputs use by smallholder farmers had increased markedly and their subsidies had been introduced ranging between 15% and 35% for fertilizers and between 50% and 80% for better-quality seeds.

The influence of outsiders' support was likely to promote the autonomy of local farmers in adopting the radical terraces. To encourage them in radical terracing, many financial agencies contributed to the external support in form of a credit to 48.4% of the respondents but 51.6% of the respondents did not get credits from financial institutions. The results concurred with what Musabanganji et al. (2015) found that access by farmers to formal financial services was

still limited and this prevented resource-poor smallholders from having enough financial resources to invest in agricultural sector activities for producing enough food. This was also supported by Karplus, L. (2014) who found that at least some of Swaziland's food insecurity was caused by ineffective and archaic agricultural practices and customs. There was also a lack of farmers' access to agricultural loans. This could explain why many farmers did not take credit from financial institutions for improving radical terraces. This may have been partly to many agencies that provided support and whose efforts may not have been well coordinated. This finding confirms that of Muthoka, R.M.S. (2010) who found that the status of food security was the result of the interactions between the activities of various individuals and institutions in a system and can be interpreted as a social community.

These findings on outside agency support are in agreement with Rogers' (2003) definition of a social system as a set of interconnected elements like individuals, groups and organization that are involved in problem-solving to achieve a common goal. Hence, different interveners in agricultural development include government institutions, financial institutions, NGOs, PSF, farmer cooperatives, and farmers are interdependent in adopting radical terraces for food security.

5. Conclusions and recommendations

5.1 Conclusions

In this study, we set out to assess farmers' outside support and its effect in adopting radical terraces and ensuring food production and security in Nyamagabe district. We also sought to answer the following questions: What is the level of farmers' adoption of radical terraces, food production and food security situation? What is the contribution of outside support to the adoption of radical terraces, food production and security? What is the relationship between the farmers' outside support, adoption of radical terraces and food production and security? We found that 69.3% of the respondents confirmed that they had been loaned while the remainder had not. It was revealed that farmers' adoption of radical terraces is positively influenced by the support they had received from outside agencies to the amount of financial support/credit the farmers had received. That is farmers who received larger amounts adopted terraces better than those who got fewer amounts. Moreover, it was clear that the level of adoption of radical terraces was assessed for most farmers as high (81.8%), the farmer's level of food production was medium (76.6%) and the farmer's food security situation was also at the medium level (73.4%). Besides, outside support to the farmers from the development agencies such as the government, NGOs and private sector significantly influenced their adoption of radical terraces which in turn influenced their food security. Also, results of the analysis indicated that adoption of radical terraces (r=.618, p<.001), food production (r=309, p<.001) and farmers use of the support/credit in radical terraces (r=.199, p<.001) were significantly correlated with food security. These findings confirmed with Rogers' (2003) definition of a social system as a set of interconnected elements like individuals, groups and organizations that are involved in problem-solving to achieve a common goal. Thus, different interveners in agriculture and development are involved and include government institutions, financial institutions, banks, NGOs, PSF, farmer cooperatives, and farmers are interdependent in adopting radical terraces. Thus, the research objectives were achieved owing to the positive effect of farmers' outside support on their adoption of radical terraces for food security in Nyamagabe district.

5.2 Recommendations

Smallholder farmers should make compost for organic manure to help revitalize the unfertile soils especially on terraces that were badly constructed. The agricultural development agencies could enable farmers to collaborate with banks and microfinance institutions for easy access to farm credit. Both local and national government and development partners such as NGOs should support the farmers with low-interest credit to enable them to invest in their farms and increase their production at affordable costs. There is a need for the government of Rwanda to support the farmers with improved seeds for Irish potatoes and wheat and distribute them to farmers in time. Finally, there was a need for agricultural development partners to support the farmers with farming inputs for lime, fertilizers, farm yield manure and wheat and distribute them to farmers in time.

References

ActionAid International Secretariat. (2015). *Delivering Women Farmers' Rights* (February 2015). Policy Brief, Johannesburg, South Africa.

Alinda, p., & Abbott, p. (2012). *Agricultural Policy and Institutional framework for Transformation of Agriculture, Economic Development and Poverty Reduction in Rwanda* (April 2012). Institute of Policy Analysis and Research – Rwanda.

Anandajayasekeram, P., Puskur, R., Sindu, W., & Hoekstra, D. (2008). *Concepts and practices in agricultural extension in developing countries: A sourcebook. Improving productivity and market success (IPMS) of Ethiopian farmers' project*. ILRI (aka ILCA and ILRAD), IFPRI (International Food Policy Research Institute), Washington, DC, USA, and ILRI (International Livestock Research Institute), Nairobi, Kenya. 275 pp.

Bandeth, R. (2010). *Participatory irrigation management and the factors that influence the success of farmer water user communities: A case study in Cambodia* [Unpublished master's thesis]. Massey University, New Zealand.

Bonye, S.Z., Aasoglenang, A. T., & Owusu-Sekyere, E. (2013). Community development in Ghana: theory and practice. *European Scientific Journal*, *9*(17), 79–101.

Chimoita, E. L. (2017). *Factors influencing uptake of improved sorghum (sorghum bicolar) Technologies in Embu County, Kenya* [Unpublished doctoral dissertation]. University of Nairobi, Kenya.

Garnevska, E., Guozhong, L., & Shadbolt, N. M. (2011). Factors for Successful Development of Farmer cooperatives in Northwest China. *International Food and Agribusiness Management Review*, *14*(4), 69-84.

Karplus, L. (2014). *Post-Development Theory and Food Security: A Case Study in Swaziland. Capstone Projects - Politics and Government* [Doctoral dissertation]. https://ir.library.illinoisstate.edu/cppg/20

Mupenzi, J.P., Li, L., Jiwen, G., Habumugisha, J. D., Habiyaremye, G., Ngamije, J., & Baragahoranye, I. (2014). Radical Terraces in Rwanda. *East Africa Journal of Science and Technology*, *1*(1), 53- 58.

Murwanashyaka, E. (2013). *Understanding Community Service as a Tool for Sustainable Development in Rwanda: A Case Study of Nyamagabe District, Rwanda* [Unpublished master's thesis]. University of Rwanda, Rwanda.

Musabanganji, E., Karangwa, A., & Lebailly, P. (2015, November 15). *Determinants of access to agricultural credits for small scale farmers in the southern province of Rwanda. AgroSym2015 Symposium, October 15-18, Jahorina, Bosnia-Herzegovina*. Handle Proxy. https://hdl.handle.net/2268/190058

Musabanganji, E., Karangwa, A, & Lebailly, P. (2016). Intensification of smallholder agriculture in Rwanda: scenarios and challenges towards a sustainable transformation.

2016 Fifth International Conference, September 23-26, 2016, Addis Ababa, Ethiopia 246384, African Association of Agricultural Economists (AAAE). https://doi.org/10.22004/ag.econ.246384

Muthoka, R.M.S. (2010). *Factors influencing food security projects in Kuria district: a case of Njaa Marufuku Kenya (NMK)-KURIA* [Unpublished master's thesis]. University of Nairobi, Kenya.

Ndagi, J.M. (2017). *Monitoring and Evaluation Practices, Ethics and Sustainability of Agricultural food crop project in Nyeri County, Kenya* [Unpublished doctoral dissertation]. University of Nairobi, Kenya.

NISR. (2016). *Rwanda 2015 Comprehensive Food Security and Vulnerability Analysis and Nutritional Survey* (March 2016). NISR, Kigali, Rwanda. http://www.wfp.org/food-security

NISR. (2016). *Seasonal Agricultural Survey 2016 (SAS2016) report* (December 2016). NISR, Kigali, Rwanda. https://www.statistics.gov.rw/datasource/seasonal-agricultural-survey-2016

NISR. (2017). *Comprehensive Food Security and Vulnerability Analysis and Nutritional Survey*. NISR, Kigali, Rwanda. http://www.statistics.gov.rw/datasource/comprehensive-food-security-and-vulnerability-and-nutrition-analysis-survey-cfsva

Nyamagabe District. (2013). *Nyamagabe District Development Plan 2013-2018* (April 2013). Nyamagabe District, Rwanda.

Nyamagabe District. (2018). *Nyamagabe development strategy 2018-2024* (November 2018). Nyamagabe District, Rwanda.

Peshin, R., Vasanthakumar, J., & Kalra, R. (2014). Diffusion of Innovation Theory and Integrated Pest Management. *Integrated Pest Management Reviews*. DOI: 10.1007/978-1-4020-8990-9_1

Republic of Rwanda. (2004). *National Agricultural Policy* (March 2004). MINAGRI, Kigali, Rwanda.

Republic of Rwanda. (2010). *Practical Tools for Sectoral Environmental Planning*. REMA, Kigali, Rwanda.

Republic of Rwanda. (2012). *The evolution of poverty in Rwanda from 2000 to 2011: Results from the household surveys (EICV)*. NISR, Kigali, Rwanda.

Republic of Rwanda. (2014). *National Food and Nutritional policy 2013-2018* (January 2014). MINISANTE, Kigali, Rwanda.

Republic of Rwanda. (2015). *Intended nationally determined contribution (INDC) for the Republic of Rwanda* (29 September 2015). INCD Rwanda, Kigali, Rwanda.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Simon & Schuster, New York, USA.

Tomas-Simin, M., & Jankovic, D. (2014). Applicability of diffusion of innovation theory in organic agriculture. *Ekonomika poljoprivrede /Economics of agriculture*, *61*(2), 517-529. https://doi.org/10.5937/ekopolj1402517t

Turner, J. A., Klerkx, L., White, T., Nelson, T., Everett-Hincks, J., Mackay, A., & Botha, N. (2017). Unpacking systemic innovation capacity as strategic ambidexterity: How projects dynamically configure capabilities for agricultural innovation. *Land Use Policy*, *68*, 503-523. https://doi.org/10.1016/j.landusepol.2017.07.054

World Bank. (2014). *International development association program appraisal document: transformation of agriculture sector program phase 3 program-for-results* (89984-RW). Agriculture Global Practice, Country Department AFCE2, Africa Region, October 9, 2014.

Yuliatia, Y., & Iskaskara, R. (2016). The Strategy to Increase Women Farmer's Participation in The Program of Village Food Barn in East Java. *International Journal of Environmental and Science Education, Brawijaya University, Malang, Indonesia*, *11*(12), 5728-5735.