

Diffusion of Orange Fleshed Sweet Potatoes by Smallholder Farmer Households in Petauke District; Zambia

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Abstract Since 2010/2011 farming season an innovation crop: Orange Fleshed Sweet Potato (OFSP) has been integrated in the farming system of the smallholder farmers of Eastern Province to help provide vitamin A to children below five years and pregnant women. The diffusion of the innovation was hierarchical and contagious and has improved household food security and livelihoods of the smallholder farmers in Petauke District. The methods used to collect data included simple random sampling, questionnaire, three Focus Group Discussions (FGDs) with smallholder farmers and a data sheet. Key informants were also interviewed. The analysis of qualitative data used the Statistical Pack for social scientists (SPSS) version 20. The sample size was 118 smallholder farmers. A total of 28 smallholder farmers out of the 107 that had received the information on the innovation representing 23.7% had adopted the innovation and remaining 76.3% had not adopted and were still in the decision stage. Between the 2011/2012 and 2013/2014, 91 out of 118: 77.1% had adopted. The other 8 households: 6.8% adopted the innovation in the 2012/2013 farming season while 19 representing 16.1% adopted the OFSP in the 2013/2014 farming season. The barriers and challenges to the diffusion included different types of capitals and generally lack of planting vines. The others included the perceived lack of market, sweet potatoes diseases, pests and livestock destroying the crop. The innovation crop met food security dimensions of availability, access, preference and utilization despite seasonality.

Keywords: *innovation, diffusion, innovation adoption, smallholder farmers*

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1. Introduction

According to Mueller and Chiona [13] in September 2011 the Feed the Future Initiative program of the United States Agency for International Development (USAID) began to integrate the OFSP in the food system of smallholder farmers with a focus on Eastern and Central Provinces of Zambia. This was done in collaboration with the Zambia Agriculture Research Institute (ZARI).

These organizations seek to identify the best performing and taste orange-fleshed sweet potato varieties. Mueller and Chiona [13] further pointed out that by the year 2015 quality planting material of these varieties would have been delivered to 15,000 households, prioritizing women with children less than five years of age. The OFSP project in Eastern Province seeks to strengthen the research capacity regarding performance and taste because preference is an important parameter of assessing food security. Nyborg and Haug, [15] stated that there could be food available but, if the people do not prefer that type of food then there could be no food security. Secondly, in collaboration with public sector extension, the sweet potato project aims at establishing a cadre of trained

Decentralized Vine Multipliers (DVMs) located near the communities they would serve. The farmers were given the vines of the orange sweet potatoes varieties to multiply and plant in their farms/gardens. According to Mueller and Chiona [13], DVMs help in the diffusion of the growing of the OFSP

1.1. Statement of the Problem

Food security for rural communities in Zambia is usually dependent on seasonal maize subsistence agriculture which has been highly affected by negative effects of rainfall unreliability and variability that cause droughts. Zambia experienced six droughts between 1991/1992 and 2004/2005 farming seasons (CSO, 2006). According to the Post Harvest Survey conducted by CSO, production of staple crops which include maize, millet, sorghum and rice dropped by 22 percent from 1,134,319 tons in 2003/2004 to 884,575 tons in 2004/2005 harvest season. This decline was mainly due to drought effects on production of maize which is the main staple food and accounting for more than 90 percent of cereal production [2].

Apart from unfavourable climatic factors, poor maize harvest has been as a result of lack of inputs among the

smallholder farmers because they have no money to purchase inorganic fertilizers or cannot be reached by Farmer Input Support Program (FISP). There is therefore need to find alternative food crops to maize to meet household food security when either maize fails or as a supplement. This research therefore, studied the integration of the drought tolerant Orange Fleshed Sweet Potatoes (OFSP) which is rich in vitamin A as a supplement in the food system and assessed the diffusion patterns among the smallholder farmers in Petauke District.

1.2. Significance of the Study

This study highlighted the important issues related to the contributions of OFSP to the food security and livelihoods of the people of Petauke District in particular those in Chief Nyamphande and Kalindawalo areas. The study also helped to share diffusion information with the stakeholders so that the innovation could be appreciated and informed decisions could be made concerning the adoption of the OFSP, contribution to food security and livelihoods by the people of Zambia. Information from this research would help smallholder farmers to understand the importance of drought tolerant supplement crops in time of environmental stress. The government and other partners dealing in food security enhancement are also informed so that they could better help other smallholder farmers facing similar challenges due to the diffusion process of innovation in the food system. It also adds to the body of existing knowledge.

2. Methodology

To achieve the aim and the objectives of this study, the research used the following methods to acquire the data. These methods included reviewing the documents from CIP website and offices in Petauke (study area) and Chipata (project office). OFSP Decentralized Vine Multipliers (DVMs) were selected purposively because they were key informants and were interviewed because they kept the data and information of the smallholder farmers that adopted the new crop. Thereafter smallholder farmer households (either OFSP adopted or not) were randomly selected by simple random sampling to participate in the study. Government agricultural offices at provincial, district and camp level were also interviewed. The different research instruments used were interview schedule, questionnaire and field assessment sheets.

2.1. Primary Data.

A field survey (reconnaissance survey) was initially conducted to gather information to help the researcher to become familiar with the OFSP growing areas. The primary data included information on Bio data, the adoption of the intervention, types of capital owned to influence adoption and the costs related in production, benefits, challenges and opportunities associated with the cultivation of the root crop. The other primary data encompassed diffusion process. A questionnaire was used to collect data from a sample of 118 respondents representing (49%) out of 241 population households.

Since most households were not educated enough to complete the questionnaires correctly, the researcher and research assistants asked the questions and completed the questionnaires as the respondents gave feedback appropriately.

2.2. Personal Observations

Personal observations together with Field Assessment (FA) sheets were used throughout the growing period to help assess the land under OFSP cultivation in area the innovation was adopted in. Among the observed were the growth of the innovation and the total area used for the OFSP. Personal observations were used in all the four stages of the FA until the researcher finally had an estimation of the harvest for 2013/2014 season. Institutional arrangements and management of common pool resources like water and grazing areas for livestock were observed for they influenced and exerted pressure on vine rising during the dry season because the cattle was free range.

2.3. Field Assessments

These were used to collect data at different growing stages of the OFSP. The data collected included the labour aspects of the households, land preparation, amount of land planted, acquisition of vines by smallholder farmers and the diffusion/adoption of the 2013/2014 farming season, timing at planting, the care of the OFSP during the growing season up to harvest.

2.4. Interviews for Key Informants

The key informants included 9 respondents. These were 2 village headpersons, Provincial Agricultural Coordinating Officer (PACO), the District Agricultural Coordinating Officer (DACO), the Project Manager for CIP, 2 MAL camp officers from Nyamphande II and Kawere camps, an officer from Rural Initiative for Children's Hope (RICH) implementing the project in Nyamphande and Kalindawalo, and 2 Decentralised Vine Multipliers.

2.5. Focus Group Discussions (FGDs)

These were three FGDs to triangulate the data from the questionnaire from the 118 respondents from households and the interviews from the DVMs and other key informants. The FGDs were held in the different areas of South Nyamphande II and Kawere farming camps. The FGD participants were selected by the researcher himself to avoid biases of having farmers of similar characteristics. These first two FGDs were not gender sensitive comprising 5 women and 5 men. Since women and men work together in households and livelihoods. The third FGD was a combination of 5 men and 5 women held at the headperson's residence in Nyamia village in Nyamphande chiefdom.

2.6. Secondary Data

Literature that looked at adoption and diffusion and acceptance of innovations of interventions to bring food security to smallholder farmers was reviewed.

2.7. Sampling Frame

Petauke district has 14 wards and 22 agricultural camps. The sampling frame included two (2) out of twenty two (22) agricultural camps in Nyika ward. These are South Nyamphande II and Kawere agricultural camps. In South Nyamphande II, four villages comprising 121 households and a population of 587 were studied. The villages in Nyamphande included: Nyamiya Village 45 households, Nyamia farms 48 households, Mbabe village 24 and Cheukani village 4 holdholds. In chief Kalindawalo, two villages: Kaulu and Kawere stores in Kawere camp with 120 households were also part of the sampling frame with a village's ratio of Kawere stores 50 and Kaulu 70 smallholder farmers.

2.8. Sampling

Nyika ward out of fourteen (14) was selected purposefully because it has OFSP smallholder farmer households. Thereafter two (2) agricultural camps: South Nyamphande II and Kawere were selected out of twenty two (22) for the study within Nyika ward. The selection criterion of the farmers was first through cluster sampling using the villages as a cluster. A total number of 118 households were randomly selected from the villages which were proportionate ratio of 98% households of the total village household population. In the households, both husband and wife or any other elderly person available in the household was allowed to answer the questionnaire because they belonged to the household and had similar livelihood sustenance.

2.9. Ethical Consideration

The headpersons in respective villages of Cheukani, Mbabe, Nyamiya, Nyamiya farms, Kawere Stores and Kaulu were visited in the course of the research due to ethical value and to facilitate entry into the communities. The names of the households that were not comfortable to be recorded were withheld. However many wanted their names recorded because it was as though the research was bringing a government food relief programme or free intervention to solve their food security problems.

3. Analysis and Presentation of Data

SPSS Version 20 was used to analyse the data. Descriptive statistics of central tendency were used together with tables and graphs. A logistic curve was used to show the rate of adoption of the OFSP innovation in the area under study.

4. Location of the Study Area

The Eastern Province has longitudinal location of between 10° 30' to 15° south latitudes and 30° 25' to 34° east longitudes. Refer to Figure . It covers a total area of 69 000 square kilometres, representing nine percent of the total land area of Zambia [14]. It shares international borders with Malawi to the East and Mozambique to the

South. Within the country, it shares borders with Central Province to the Northwest and Lusaka Province to the Southeast. After the establishment of Muchinga Province which comprises Mpika, Chinsali, Isoka, Mafinga, Nakonde and Chama district, the Northern Province border was replaced by Muchinga Province to the north. Petauke district in eastern province is located along the geographical coordinates of latitude 14°15'S and longitude 31°20'E.

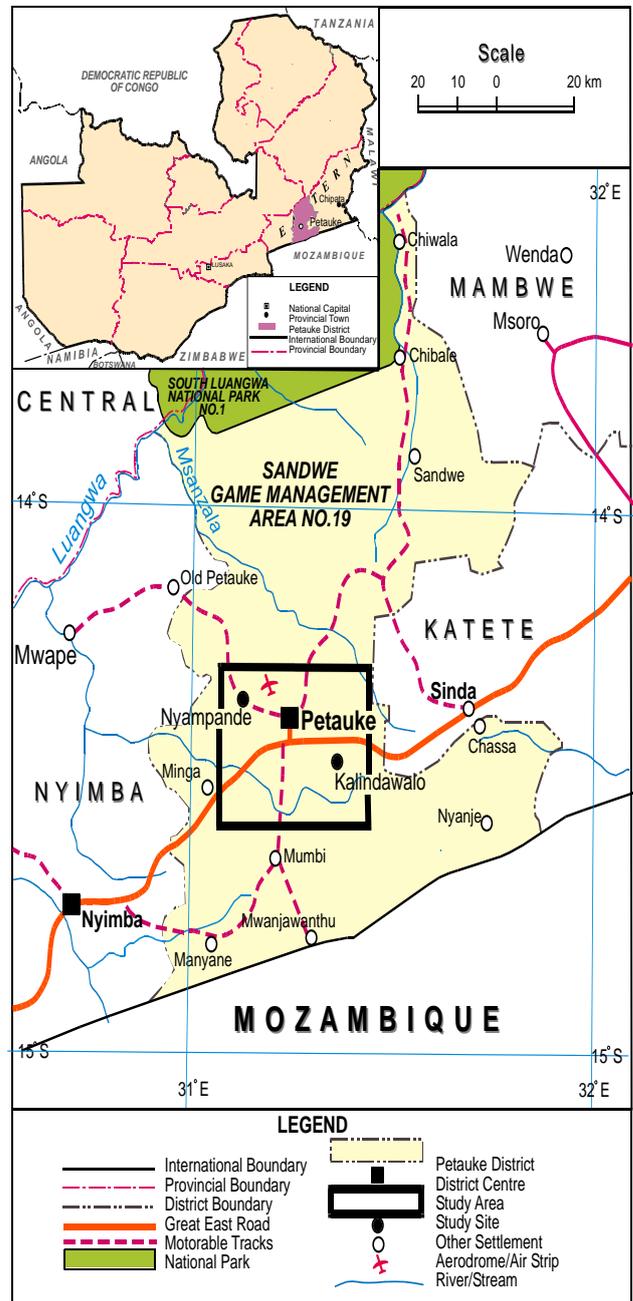


Figure 1. The location of Nyamphande and Kalindawalo study areas (sites) in Petauke District (Source: Topographical map 1431, A1-A4)

5. Results and discussions

5.1. Sample Characteristics

There were 118 respondents drawn from two chiefdoms of Petauke district: Nyamphande and Kalindawalo. Out of

the 118 respondents, 42 representing 35.6% were drawn from Nyamphande while 76 smallholder farmers representing 64.4% were from Kalindawalo chiefdom. The numbers of villages in Table 2 were chosen as proportions of the number of the households in each village except for Kalindawalo and Chinga'mba. These two farmers were selected purposefully because they were decentralized vine multipliers that had adopted from Nyamia and it was important to include them in the sample because they were established in the growing of the crop.

Table 1. Sampled villages from Nyamphande and Kalindawalo Chiefdoms

Chiefdom	Village	freq	%	cum percent
Nyamphande	Nyamia farms	14	11.9	11.9
	Mbabe	19	16.1	28.0
	Chinga'mba	1	.8	46.6
	Chitungwi	21	17.8	70.3
Kalindawalo	Kawere Stores	28	23.7	71.1
	Kalindawalo	1	.8	72.9
	Nyamia	34	28.1	100
Total		118	100	100

Source: Field data, 2014.

5.2. Diffusion and Adoption Patterns of OFSP in Petauke Districts: Nyamphande and Kalindawalo Chiefdoms

Nyamia village was the entry point through which OFSP was introduced into the study area. This was in the farming season 2010/2011. During the year of introduction, the innovation had only spread among the female smallholder farmers comprising 10 women in a club representing (8.5%) of the sample. These women that had adopted were given a few vines to plant and multiply in their gardens. However in the very first year of adoption, some of the farmers could not grow in their fields during the wet rainy season because the vines were eaten by cattle. This was because their gardens were not well secure and the cattle were free range at the time of adoption which was during the dry and hot season.

Initially the OFSP was introduced by the CIP which later entered into partnership with RICH. RICH began to train and monitor the farmers in the raising of the vines and the growing of the OFSP. The first smallholder farmers to grow the OFSP were the DVMs. These were initially the women that belonged to the same club. It was easier to start with these women as DVMs because they were already organized in the club.

5.3. Smallholder Farmers Engaged in Growing OFSP

The number of smallholder farmers that grew the OFSP by 2013/2014 was 28 out of the 107 that had received the information on the innovation. This only represented 23.7% adoption rates of the sample. The remaining 76.3% had not adopted and were still in the decision stage.

5.4. Trend in the Adoption of the OFSP Innovation

There was a positive trend in adoption in two farming seasons 2011/2012 and 2013/2014. From the 118 respondents, 91 households representing 77.1% had adopted on paper but on the ground not all had grown the OFSP. The other 8 households representing 6.8% adopted the innovation in the 2012/2013 farming season while 19 representing 16.1% adopted the OFSP in the 2013/2014 farming season. The above percentages show a positive trend which then dropped to the negative and later back to positive. This was due to either the smallholder farmers could not access the vines during the subsequent planting season or their vines were destroyed by livestock in the gardens. This kind of trend is common among smallholder farmers because they do not usually plan the kind of crop to grow prior to the rain season.

Table 2. Trend in the adoption of the OFSP

Adoption year	Freq.	%	Cumulative Percent
2010/2011	0	0	0
2011/2012	91	77.1	77.1
2012/2013	8	6.8	83.9
2013/2014	19	16.1	100.0
Total	118	100.0	

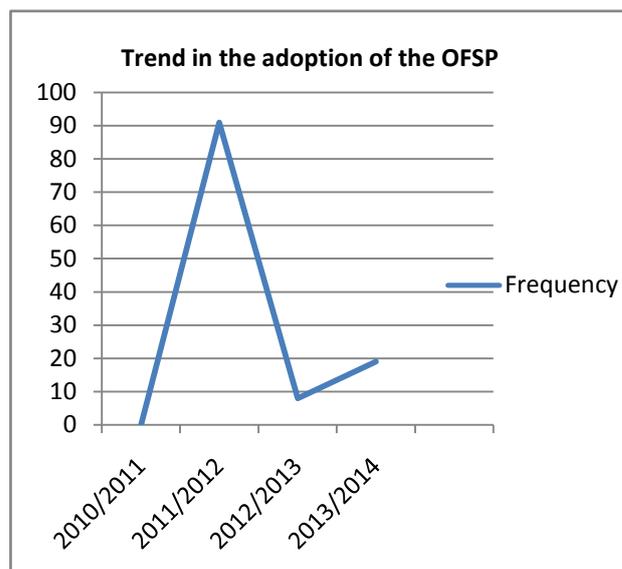


Figure 2. Trend in adoption of OFSP (Source: Field data 2014)

5.5. Barriers to Adoption of OFSP in Nyamphande and Kalindawalo Chiefdoms

The most common barriers identified in the adoption of OFSP in the two chiefdoms are as follows: non-availability of water during the dry season to raise the vines and the problem of difficulties in acquisition of the vines for planting. The non-understanding of the utilization of the OFSP is another barrier. Lack of sufficient land and labour for the preparation of land into ridges was a problem too. Some of the farmers used rented

land and hired labour. The incentives that were given to the farmers that practice other innovations/technologies like conservation farming (CF) were a barrier to adoption because smallholder farmers expect something from the implementers of the OFSP innovation. They viewed the growing of the OFSP as though it was a favour to the NGO/s, government agricultural departments implementing the program. Non-attractive markets for the roots produced have also impacted negatively on the adoption of OFSP by the smallholder farmers.

5.6. Incentives in the Adoption of the OFSP

Some of the respondents argued that incentives like mineral fertilizer and treadle pumps were promised and were not given; they could not adopt or discontinued with the growing of the OFSP because they felt cheated. Other adopters also discontinued growing the new subsidiary crop in the subsequent growing season/s because they viewed growing OFSP as a benefit of the Government and NGO's like CIP and RICH and not their own. The incentives were viewed as more important than the benefit that came about from the produce and the contribution to household food security.

5.7. Level of Acceptance of Adoption of the Innovation

The bigger number of 95 respondents representing 80.5% had not yet accepted the innovation despite having heard and gave no response, 13 respondents: 11.0% said it was very easy to accept because they were already farmers of other traditional varieties of sweet potatoes. The other 6 representing 5.1% said it was easy but were reluctant because they were either not sure about the food security contribution of the crop, its market or did not have the means to acquire the vines of the innovation. The remaining 4 people representing 3.4% said it was difficult for them to adopt the innovation due to other various reasons. The acceptance depended on the smallholder farmer's conviction on the viability of the crop and its contribution in the household food security.

5.8. Production Data of the Sweet Potatoes (2010-2014).

There was a positive increase in production of traditional sweet potatoes (Chingovwa or Solwezi) in the first three seasons (2010-2013) of the study. In the fourth season (2013-2014) there was a drop in comparative production because many of the farmers wanted to concentrate on the growing of the OFSP varieties.

5.9. Type of diffusion of the OFSP: Hierarchical and Contagious Diffusion

OFSP has been adopted in Nyamphande and Kalindawalo chiefdoms through both hierarchical and contagious diffusion. The contagious diffusion has been expansion in nature. The movement of OFSP messages was from CIP to RICH and to the DVMs and lastly to all other smallholder farmers. In some instances CIP worked

through MAL to Agriculture Extension officers to the DVMs and finally to the smallholder farmers. This is hierarchical movement of the innovation because the OFSP vines and idea followed a hierarchical order within the social structural framework from CIP to either RICH or MAL to DVMs and then the small holder farmers in the two chiefdoms. The OFSP vines were initially grown in green houses at Mount Makuru before they are transferred to Msekera greenhouses under the auspices of ZARI/CIP. In the greenhouses, the vines are kept disease free.

5.10. Hierarchical and Contagious Diffusion Patterns of OFSP Adoption.

Hierarchical diffusion describes transmission through a regular sequence of order, class or hierarchies. Contagious diffusion depends on contact within a population and those near the innovation usually adopt first and the innovation then moves outwards in a centrifugal manner. When expansion diffusion occurs the innovation spreads outwards but it remains in the area of origin [8]. The OFSP has continued spreading through expansion diffusion in the study area and had continued to intensify in the in Nyamia village which is the entry point.

To elaborate hierarchical diffusion of the OFSP, Mount Makuru Agriculture Research Station greenhouses in Chilanga are managed by ZARI (national), CIP has its offices in Chipata town and greenhouses at Msekera Agricultural Research Station where they develop and raise disease and virus free OFSP varieties in partnership with ZARI which can be described as an urban area (Provincial centre). From the province, CIP works with RICH and MAL at the district in Petauke who then work with DVMs and smallholder farmers in Nyamphande and Kalindawalo chiefdoms that are located in Petauke district. CIP initially intended to work directly with the focal point farmers that are called DVMs. Each DVM was to multiply the OFSP vines in the dry season in their gardens then recruit smallholder farmers within the catchment areas they lived in. When these DVMs were visited, they each had an average of 20 smallholder farmers in their registers. However, when the people on the registers were followed about 90% had not grown the crop. This was deceiving because those that relied on these official records had data showing that there was massive adoption when many had not grown at all.

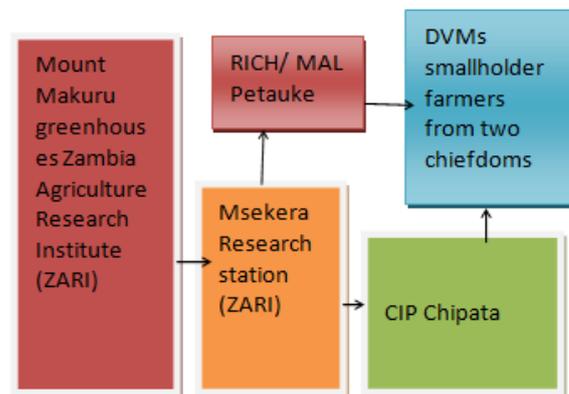


Figure 3. Hierarchical diffusion of the OFSP from Mount Makuru to smallholder farmers

5.11. Contagious Diffusion

On the other hand contagious diffusion started with RICH or Agriculture Extension officers under MAL. The RICH and Agricultural Extension Officers recruited 10 DVMs among smallholder farmers respectively from their surrounding area. The recruited smallholder farmers continued to share the information on the OFSP growing during different social gatherings like funerals, football matches, and traditional dances like Tuwimba or at beer parties. In this way OFSP growing is spreading outwards to far areas. Apart from the smallholder farmers, the RICH officials are involved in contagious diffusion by looking for areas that have water during the dry season. This is how the OFSP varieties were introduced to Kalindawalo chieftdom in villages like Kawere store and Kalindawalo itself from Nyamphande chieftdom. Sources of water that do not dry during the dry season have been a very important factor in the initial adoption process by DVMs. These water sources could either be dams, wells in gardens or dambo areas able to hold water throughout the year. The innovation of growing these orange fleshed sweet potatoes has been growing outwards from the initial point of acceptance: Nyamia. The OFSP diffusion involved direct contact of persons to share an idea/innovation or information. Distance between two persons or points had an influence in the adoption process. This means that the nearer the persons or villages were the higher the probability of contact to share information. When this trend continues with other subsequent nearby villages the pattern of diffusion of OFSP spreads in concentric manner with the early adopters in the centre followed by early majority, late majority and the laggards at the very outer points. The adoption in these two chieftdoms have not reached saturated stage yet because a lot of people in villages in the two chieftdoms have not yet adopted the innovation though a big number of the smallholder farmers indicated willingness to adopt as vines would become available.

5.12. The Extent of Adoption of OFSP in Nyamphande and Kalindawalo Chieftdom

The extent of the adoption of OFSP has grown larger and this success can mainly be attributed to the coordination of the CIP, RICH, MAL and the DVMs. The establishment of DVMs among the smallholder farmers has been a very powerful tool to spread the OFSP innovation even in the absence of the spearheading organizations. Each established DVM had a poster done by the road side that led to where he/she was located. These posters by the road sides were an important tool in the dissemination as to where about people could locate and access the OFSP vines. People from far places could sometimes go to buy the vines by just following the direction and the distance indicated on the posters. Communication on these posters included the contact mobile numbers of the DVMs. In this way proximity to passable roads had influence on the adoption especially from those people that came from outside the study area.

6. Conclusion

The diffusion pattern of the OFSP in the study area was hierarchical contagious in nature. The information and messages on the OFSP has been disseminated through various means like radio, interpersonal, printed materials and television. The innovation has been diffused throughout the study area. The technology was not adopted by many smallholder farmers as evidenced by relatively smaller number of adopters. There were small proportions of the agricultural land allocated to the OFSP. Since OFSP is a subsidiary crop, the people in the study area still had food security from maize which provided food security availability and accessibility to many. There were a lot of factors that influenced the adoption of the root crop which included availability of planting vines, money to purchase the vine, knowledge about the utilization of the bio-fortified OFSP. However to the few that had adopted the OFSP provided them with food security availability, accessibility and utilization with vitamin A when the crop was in season.

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