

**DIFFUSION OF THE ORANGE FLESHED SWEET POTATOES (OFSP) AND ITS
IMPACT ON HOUSEHOLD FOOD SECURITY AND LIVELIHOODS IN PETAUKE
DISTRICT, ZAMBIA**

BY

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Master's dissertation

The University of Zambia
School of Natural Sciences
Department of Geography and Environmental studies

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A dissertation submitted to the University of Zambia in partial fulfilment of the requirements of the degree of Master of Science in Environmental and Natural Resources Management.

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LUSAKA

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DECLARATION

I, **Andrew Chilala**, declare that this dissertation is my own work, and that it has not been previously submitted for a degree, diploma or other qualification to the University of Zambia (UNZA) or any other University in the world. All the other sources of work referred to by other authors have been specifically acknowledged.

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APPROVAL

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ABSTRACT

In Zambia, many smallholder farmers achieve household food security through the production of maize ‘zea mays’. During the years of maize failure due to drought, there is need for other crops to enhance food security like Orange Fleshed Sweet Potato. Since the 2010/2011 farming season, the Orange Fleshed Sweet Potato has been integrated in the farming system of the smallholder farmers of Eastern Province to help the household food security.

The aim of this study was on the diffusion of the Orange Fleshed Sweet Potato and its contribution to the household food security and livelihoods of the smallholder farmers in Petauke District of Eastern Province in Zambia. The specific objectives were: i, To establish the diffusion of the OFSP; ii, To assess the contributions of the OFSP to household food security in; iii, To find out the livelihoods improvement for smallholder farmer households and iv, To identify the challenges smallholder farmers face in the growing of the OFSP. A questionnaire was used to collect data from a purposively selected sample of 118 Orange Fleshed Smallholder farmers. Key informants and two Focus Group Discussions (FGDs) were used to triangulate data from the questionnaire. The analysis of quantitative data was done by the aid of the Statistical Package for Social Sciences (SPSS 20). This helped to come up with percentages presented in statistical tables and graphs.

The innovation was introduced in Petauke in 2010/2011 farming season by the International Potato Centre. In 2011/2012; 76.3% smallholder farmers adopted the crop while in 2012/2013; 6.7% additional smallholder farmers adopted and in the 2013/2014; 16.9% respondents adopted. The diffusion of the Orange Fleshed Sweet Potatoes was through hierarchical diffusion which was expansion in nature. The pillars of food security met were food availability and access.

The crop contributed to the household food security because the adopters had additional food from the OFSP. The livelihoods of the people improved because they were able to raise money to buy household goods and managed to buy family goods and services. The challenges the farmers faced were the acquisition of vines for planting, diseases, pests and difficulties in preservation. The other challenge was lack or insufficient different types of capitals like physical, financial, and social. A lot of opportunities exist for the OFSP because the crop was viable as it contributed to their livelihood that they could buy farming implements and inputs for other crops like maize from the money earned after selling the harvest.

Key words: *innovation, diffusion, food security, orange fleshed sweet potatoes, livelihood, capital*

DEDICATION

To my lovely late wife, Mercy Banda Chilala, who was an academic inspiration and died in the course of my pursuing this Master's degree. She ran our family affairs and took the responsibility of nurturing our children alone in my absence. She gave me moral support throughout, till the time she fell ill and subsequently passed on. I also dedicate this work to my three sons, Ndalumba Chileleko Chilala, Dalitso Chiwego Chilala and Chisomo Andrew Chilala for all the days they spent lonely as I was away on my studies. Thank you.

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ACRONYMS

AC	Agriculture Camp
AEO	Agriculture Extension Officer
CA	Conservation Agriculture
CIP	International Potato Centre
CSO	Central Statistics Office
DACO	District Agriculture Coordinating Officer
DVM	Decentralized Vine Multiplier
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FO	Field Officer
LAF	Livelihood Analysis framework
MAL	Ministry of Agriculture and Livestock
NGO	Non-Governmental Organization
OFSP	Orange Fleshed Sweet Potato
PACO	Provincial Agriculture Coordinating Officer
RICH	Rural Initiative for Children's Hope
RLF	Rural Livelihood Framework
US aid	United States Aid for International Development
WFP	World food Program
WHO	World Health Organization
ZARI	Zambia Agriculture Research Institution

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DEFINITIONS OF TERMS

Head of Household: This is a person who is in charge of making day to day decisions concerning the running of the household and is regarded as such by all household members (CSO, 2000).

Household: A group of persons who normally live and eat together. These people may or may not be biologically related to each other and make common provision for food and other essentials for living (CSO, 2000).

Smallholder Farmer: This is a farmer who cultivates less than 5 hectares of land (CSO, 2000).

Conservation agriculture: A farming system which involves many farming practices which conserves the soil like hoe dug planting basins or Ripper made planting furrows. No ploughing or ridging is done (CFU, 2007). Rippers can either be animal draft or machinery power pulled.

Diffusion: A process by which an innovation is communicated through certain channels over time among the members of a social system (Rodgers, 1962).

Adoption: A process that involves five stages namely; knowledge, persuasion, decision, implementation and confirmation in the use of an innovation (Rodgers, 1962).

Rate of adoption: Is the relative speed with which an innovation is adopted by members of a social system. It is usually measured by the length of time required for a certain percentage of the members of a social system to adopt an innovation (Rodgers, 1962).

Barriers: These are factors that hinder or block the spread of an innovation to other areas (Abler et al., 1971).

International Potato Centre: this is an international organization based in Lima Peru that implements the Orange Fleshed Sweet Potatoes (*Ipomoea batata*) growing in the world and also in Eastern Province of Zambia

Vines: These are the sweet potatoes planting materials.

Decentralised Vine Multiplier (DVMs): These are immediate supervisors to fellow smallholder farmers whose role is to multiply and distribute OFSP vines to other. They give feedback to the International Potato Centre officials on the progress of adoption and growing of sweet potatoes.

Innovators: These are the first individuals to adopt an innovation. These were Decentralised Vine Multipliers. They were given the vines earliest to multiply and give to other smallholder farmers interested and willing to grow the OFSP. They had closest contact to scientific sources and interaction with innovators who introduced the Orange Fleshed Sweet Potato in Petauke. (Rodgers, 1962).

Early Adopter: Second category of individuals who adopt an innovation. They have highest degree of opinion among the other adopter categories. They are more discrete in adoption choices than innovators (Rodgers, 1962).

Early majority: Adopted the innovation after a varying degree of time. They tend to be slower in the adoption process, have above average social status, contact with early adopters, and seldom hold positions of opinion leadership in a system (Rodgers, 1962).

Late majority: Adopt an innovation after the average member of the society. They approach an innovation with a high degree of scepticism and after the majority of the society has adopted the innovation (Rodgers, 1962).

Laggards: The last individuals to adopt an innovation. They have typically an aversion to change-agents and tend to be advanced in age (Rodgers, 1962).

Food security: exists, ‘when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.’ It includes both physical and economic access for people’s dietary needs of their preferences (UN, 1996).

Livelihood: This is what a family or particular group of people is engaged in to secure the necessities of life in relationship to the types of capitals they have, use and how they interact with the environment.

Food availability: presence of food to an individual or group of people at a given time it is needed

Food accessibility: to be able to get (reach) food and eat whenever one needs it or is hungry.

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CHAPTER 1

DIFFUSION OF THE ORANGE FLESHED SWEET POTATOES (OFSP) AND ITS IMPACT ON HOUSEHOLD FOOD SECURITY AND LIVELIHOODS IN PETAUKE DISTRICT, ZAMBIA

1.1 Background

In Eastern Province of Zambia, many smallholder farmers have been contributing to the national food security through the growing of maize ‘(zea mays’). These farmers and the government have generally been using maize as a measure of food security. In times that they had some excess maize to the yearly household consumption, they sold to the Food Reserve Agency (FRA): the parastatal responsible for maize marketing in Zambia, to earn some income to meet some of their socio-economic needs.

Apart from maize, the smallholder farmers in Eastern Province have been growing other crops to ensure that they were food secure during different seasons of the year. These crops include cowpeas, (*Vigna unguiculata*), groundnuts (*Arachis hypogaea*), cassava (*Manihot esculenta*), sweet potatoes (*Ipomoea batatas*), beans (*Phaseolus vulgaris* L.), sorghum (*Sorghum bicolor*), and pumpkins (*Cucurbita* spp) and many more. Among the cash crops they grow are sunflower (*Helianthus annuus*), cotton (*Gossypium* spp), tobacco (*Nicotiana glauca*) and soybeans (*Glycine max*). These crops are usually sold and the money earned help to secure the other household needs. Maize accounts for about 80 percent of the total area for crops in Eastern Province (El-Beltgy and Madkour 2012). Further El-Beltgy and Madkour,(2012),said agriculture in general accounts for 84 percent of the household income in Eastern Province. Due to the higher percentage of people growing and relying on maize as a staple food crop, the government through the Ministry of Agriculture and Livestock (MAL) has been placing a lot of emphasis on the policies that are aimed at increasing its production and attaining food security. Most of the extension work in crop agriculture by government has been on maize and a lot of financial resources are being spent every year on mineral fertilizer to grow maize. However, despite the government and farmers’ efforts on maize, its production is dependent on climatic conditions. This means that any change in climate can affect the production either negatively or positively.

According to Kajoba (2008), Zambia periods of climate stress from time to time. The effects of climate change like droughts have been affecting general crop yields causing vulnerability on the

food system. He continues that the food system has increasingly become vulnerable to environmental shocks resulting from global environment change because maize is more susceptible to droughts unlike sorghum, millet, cassava and even sweet potatoes which are drought tolerant. Kajoba (2008) pointed out that a drought technically exists when rainfall is 70% below average for 21 days or longer. Sichingabula and Sikazwe (1999) contend that in Zambia recorded droughts go back to as early as 1908 and since then, droughts have been more frequent than wet years. For example during 1991/1992 farming season, there was a severe drought in Zambia which caused a negative impact on the food system. Nationally, there was a 60% crop failure. Harvest of staple maize were down by 93%, 85%, 80%, 79% and 57% in Southern, Lusaka, Western, Eastern and Central provinces, respectively compared to the previous year (Kajoba, 1998).

According to FAO, (2002) prolonged dry spells during the 2001/2002 growing season in five of the nine provinces of Zambia, sharply reduced yields and production of cereals. The 2002 output of main staple maize was estimated at about 606 000 tonnes, 24 percent below the 2001 poor harvest and 42 percent lower than the normal crop of 2000. Cereal imports in Zambia were required for the marketing year 2002/2003 and were estimated at 626 000 tonnes. Commercial imports were projected at 351 000 tonnes with a remaining deficit of 275 000 tonnes which was to be covered by Government and external assistance. About 2.329 million smallholder farmers were worst affected and were in dire need of international emergency cereal food aid of about 174 383 tonnes, due to the second consecutive reduced harvest and exhaustion of their coping mechanisms (FAO, 2002). In the past 16 years from 1990 to 2005, Zambia experienced six droughts in 1991/1992, 1994/1995, 1997/1998, 2000/2001, 2001/2002 and 2004/2005. On average, droughts occurred once every 2-3 years (CSO, 2006). Further, FAO/WFP (2006) goes on to say that in Zambia however, agriculture is by far the biggest real sector. It is estimated that 75 percent of Zambia's population's livelihood is directly or indirectly dependent on the agricultural sector (FAO/WFP, 2006)

In drought years, significant damage is done to major crops such as maize, millet and sorghum. 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 tonnes in 2003/2004 to 884,575 tonnes in 2004/2005 harvest season. This decline was mainly due to drought effects on production of maize which is the main staple food and accounted for more than 90 percent of cereal production (CSO, 2006).

Considering the above levels of crop failure and the periodic occurrences of droughts, there is need for adaptation options to the impact of droughts. The government and Non-Governmental Organizations (NGOs) in Zambia have been active in agriculture to respond to the climate change effects either through adaptation or mitigation (Bhadwal, 2006). Adaptation strategies at both national and local levels are encouraged to complement mitigation efforts (IPCC, 2001). Adaptive capacity is defined as the general ability of institutions, systems and individuals to adjust to potential damages, to take advantage of opportunities and to cope with the consequences (Kadamayo, 2007). To cope with droughts that generally cause maize and other cereals to fail, smallholder farmers need to adopt measures of growing drought tolerant crops like sorghum, millet, cassava and sweet potatoes which are more likely to withstand droughts than maize.

Eastern Province of Zambia has seen an emphasis in the adoption of such mitigation measures through the growing of Orange Fleshed Sweet Potato (OFSP) in most of the districts. Sweet potatoes, as acknowledged above are drought tolerant and have the potential of providing food security to rural households during the time it is in season and can be a substitute to cereals (Mueller and Chiona 2012). The smallholder farmers in Eastern province have now adopted new varieties of sweet potatoes and have integrated them in the farming system. Smallholder farmers are generally subsistence producers of staple foods with occasional marketable surplus. In Zambia smallholder farmers comprise about 85% and cultivate about 5 hectares or less (Chomba, 2004).

According to Mueller and Chiona (2012) 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 in Zambia. The OFSP was integrated in the food system of the smallholder farmers because it was bio-fortified with vitamin A which is very vital to pregnant women and children especially below five years of age. Vitamin A improves both immunity of mothers and children and is required for proper eye sight.

Mueller and Chiona, (2012) agreed with Gibson et al (2009), that Orange Sweet Potatoes can provide food security to the smallholder farmers. They noted however, that for many farmers to grow the OFSP there was need to increase planting vines availability. The farmers were given the vines of the Orange fleshed Sweet Potatoes varieties to multiply and plant in their farms/gardens. Mueller and Chiona, (2012) further said that the first recipients of these OFSP vines were called

Decentralised Vine Multipliers (DVMs). The International Potato Centre and Zambia Agricultural Research Institute believes that the more the OFSP was diffused, the more food secure the smallholder farmers would become especially during the times of below normal rainfall. Nyborg and Haug, (1994) stated that not only food availability was important but, the people should also prefer that type of food for food security exist. The marketing of the OFSP would also improve the socio-economic status of the smallholder farmers in Petauke through increased income.

1.2 Statement of the problem

Food security for rural communities in Zambia is usually dependent on seasonal subsistence agriculture which has been highly affected by negative effects of rainfall unreliability and variability that cause droughts leading to the poor yield of traditional food crop maize. There is therefore need to find alternative food crops to maize to meet household food security when maize either fails or as a supplement. The Orange Fleshed Sweet Potatoes (OFSP) rich in vitamin A is one such alternative crop to maize integrated in food system in Petauke. This research therefore studied the contribution of the OFSP to household food security and how it influenced the livelihoods of the smallholder farmers in district.

1.3 Aim of the study

The aim of this study was to establish the diffusion of the OFSP and its contribution to household food security and livelihoods of smallholder farmers in Petauke District.

1.4 Research objectives

To achieve the above aim the following specific objectives were used to guide the research.

1. To establish the diffusion of the OFSP in Petauke District.
2. To assess the contributions of the OFSP to household food security
3. To find out the livelihoods improvement for smallholder farmer households.
4. To identify the challenges smallholder farmers face in the growing of the OFSP.

1.5 Research questions

1. How is the diffusion of the OFSP in Petauke District?
3. What are the contributions of the OFSP to food security?

3. What livelihoods improvements exist in smallholder households in Petauke district?
4. What challenges do the smallholder farmers engaged in the growing of OFSP face?

1.6 Significance of the study

This study highlights 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's areas. The study will also help to share diffusion information with the stakeholders so that the innovation could be appreciated and informed decisions could be made concerning the OFSP contribution to food security and livelihoods by the people of Zambia. Information from this research will help the government and other partners dealing in food security enhancement to be better informed so that they could help the smallholder farmers in case of the challenges faced due to traditional food system failure. It will also add to the body of existing knowledge in relationship to OFSP.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section will cover a review of literature of Orange-fleshed Sweet Potatoes' role and contribution to livelihoods and food security at global, regional and local level. It also provides a critique on the diffusion and livelihood frameworks.

2.2 Background of sweet potatoes

Sweet potatoes are said to be a native crop to Central America and are one of the oldest root crops known to man. They have been consumed since prehistoric times as evidenced by sweet potato relics dating back 10,000 years that have been discovered in Peruvian caves. Christopher Columbus brought sweet potatoes to Europe after his first voyage to the New World in 1492. By the 16th century, the Spanish brought them to the Philippines and the Portuguese brought them to Africa, India, Indonesia and Southern Asia (World Health Foods, 2012).

OFSP was introduced in the United States as “yams” to distinguish it from other varieties of sweet potatoes. Many Asian and Latin American cultures in their food system also use sweet potatoes prominently with China, Indonesia, Vietnam, Japan, India and Uganda in Africa as key producers and exporters of OFSP (World Health Foods, 2012).

2.3 Food security

The Food and Agricultural Organization (FAO) (1996) notes that food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. This research adopts the following pillars of this definition: availability and access. FAO goes further to say concerted action at all levels (individual, household, national, regional and global) is required to acquire food security.

In smallholder farmers, increasingly interlinked institutions, societies and economies, coordinated efforts and shared responsibilities are essential to improving food security availability and access

(FAO, 2002). Improved access to OFSP in Petauke is essential in poverty eradication and equitable access to stable food supplies. Long term investment in research and in cataloguing and conservation of genetic resources of the OFSP at household level is essential for continued production of this crop to insure household food security (WFP, 2006). The United Nations Plan of Action on eradicating hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level before 2015 would be achieved through such efforts like growing and consuming OFSP (FAO, 2002). Underlying causes of food insecurity are multifaceted, the number of hungry and malnourished people will reduce in smallholder rural farming communities and sustainable food security will be achieved through integration of the OFSP (Mba et al, 2012).

2.4 Global food security

The international community agreed at the beginning of the new millennium in year 2000 to eradicate extreme hunger and poverty by 2015 (Desai, 2009). However, climate change is already responsible for forcing some 50 million additional people to go hungry and driving over 10 million additional people into extreme poverty (Desai, 2009). To avert the worst outcomes of climate change leading to food insecurity, Petauke district in Eastern Zambia has found the OFSP growing as an adaptation effort needed to achieve food security when the usual staple food fails in view of the prevailing bad weather situation. The international community, especially developing countries like Zambia were asked to increase funding for adaptation efforts to mitigate food insecurity. The CIP's implementation of the OFSP in Africa and Zambia in particular is one such effort from the international community through USAID in collaboration with the Zambian government (Mudenda, 2012)

According to Bogdanski (2012), agriculture is the main source of food and income for most of the world's poorest people, in both rural and urban areas. Improving food systems is critical to global poverty reduction and achieving food security objectives. He further stated that the world counted one (1) billion hungry people in 2012. He further extrapolated that the population was projected to reach 9 billion by 2050, thereby increasing world food demand. He argued that if the world was to be food secure, food production needed to increase by 70%, mostly through yield increases. Mba et al (2012) acknowledged that poverty is one of the drivers of food insecurity in individual households. Lack of money precludes the purchase of food, however plentiful its availability.

However, barter system exists in many places, where people exchange some commodities like clothes for food. He goes further to point out that shortage of food is not the cause of global hunger because the world has plenty of food except it needs to be transported to needy areas. Poverty can be overcome by engaging in the production of crops that do not need a lot of financial and physical capital to grow like the OFSP. He went further to say that the marketing of these crops like the OFSP can be enhanced through value addition so that they would attract national and international markets. The money raised from the crops would go a long way in helping the rural households to acquire their other needs at household level and get out of the bracket of poverty.

2.5 Food security status in Africa

The status of food security in Africa is generally very poor. Many people do not have proper food security due to many factors. According to Mba et al, (2012), Africa is one of the most vulnerable continents to climate change and climate variability due to many semi-arid regions and would have a projected increase of climate change impact of 5% to 8% on crop production by the 2080s and likely reduction in the length of growing seasons. Large regions are expected to be marginal agricultural land and this is projected to cause reduction in crop yields of up to 50% by 2020. He further claimed that a fall in crop net revenues of up to 90% by 2100 was expected. These statistics signal a serious problem about the predicted status of food security in Africa and there was need to increase the long term adaptive capacity and resilience in the food systems. Resilience is the capacity of the food system to bounce back to its productive capacity after some shock (Kadomayo, 2007). A shock is that impediment to production like drought which disturbs the drought intolerant crops' production and productivity.

Orange-fleshed Sweet Potatoes - a food based approach at world level is promoted as an effective approach for reducing vitamin A deficiency (VAD) in African countries including Zambia for several reasons. Sweet potato is already widely grown in Zambia. Many OFSP varieties have extremely high levels of bio-available beta-carotene (Ewell and Mutuura, 1991). The crop tends to be grown by women who also bear the responsibility for child feeding and children like the taste and its agronomic characteristics. Market value makes it an attractive crop for all types of households including the poor, who may be hard to reach by other interventions. The success of a nutrition focused OFSP program depends on the timely availability of quality vines and effective demand creation through nutritional and extension messaging.

In Africa sweet potato is a food and nutrition security crop in terms of production and consumption and is grown in almost all agro-ecological zones of the world. Sweet potato is grown by smallholders, especially youth and women and is mainly produced for home consumption. The preparation for consumption in most families in parts of the world involves boiling, roasting and deep-frying of the roots and the leaves are eaten as a green vegetable with Nshima, rice or other food items. The vegetables are sometimes dried and packed for consumption during the dry season. In most parts of the Africa sweet potato has gained importance due to its adaptability to marginal conditions such as drought, wet conditions, low soil fertility, and is ranked high as food security crop when local staple crops like maize and rice are scarce or fail. The problems on staple crops aggravate food insecurity, and thus increase the importance of sweet potato in the different countries including Zambia. The national fresh root yield at farm level in the world is only 5.6 metric tons per hectare compared to potential yields of 20-40 t/ha (Ewell and Mutuura, 1991). Below is a table showing sweet potatoes production per area and yield per hectare in Tanzania.

Table 1: Sweet potato Production in Tanzania in 1991

Year	Area Harvested In Hectares	Total Production Metric Tons	Yield Metric Tons Per Hectare
2003	135,470	207,830	1.5
2004	517,530	1,501,620	2.9
2005	469,110	1,414,820	3.0
2006	480,000	1,396,400	2.9
2007	450,000	1,322,000	2.9
2008	460,000	1,379,000	2.9
2009	465,000	1,381,000	2.9
2010	480,000	1,392,000	2.9

Source: FAO, 2010

2.6. Food Security Status in Zambia

The government of Zambia attaches great importance to crop production, especially of Maize and other cereals for food security. The majority of the Zambians depend on production of food crops for food security. The crop production and harvest increases the food availability pillar of food

security. For many smallholder farmers availability of staple food crops and other cereals is considered food security. There is food security stability during and just after the harvest period. It is also felt that the growing and harvest of the OFSP enhanced food security though it is a subsidiary crop. There is, however, need for the government to also consider food security concepts like access and utilization (nutritional) pillars of food security so that the malnutrition, hunger, famine undernourishment (chronic, transient and acute), stunting and other anthropometric indicators can be measured and addressed especially by the organizations that deal with nutritional values of food like Ministry of Health.

2.7. The concept of diffusion of an innovation

Spatial diffusion of innovation theory was used in investigating the spread of the intervention of OFSP in this study. The theory of spatial diffusion has important stages in adoption of an innovation. Apart from the stages, there are different types of diffusion patterns (Haggett, 1983 and Rogers, 1962). The research explored the OFSP diffusion in Petauke District in Zambia using spatial diffusion. Ryan and Gross (1943) seem to be the earliest proponents of the studies of diffusion with their study on diffusion of corn (zeamays) seed in Iowa, United States of America. This work is said to have led to the discovery of diffusion as an autonomous process that multiplies the impact of research and extension (Roling, 2009). However, the concept of diffusion was first popularized by the pioneering work of the Swedish geographer Torsten Hagerstrand and his colleagues in 1952 at the University of Lund (Haggett, 1983).

According to Haggett (1983), Hagerstrand propounded diffusion as the movement of an innovation from one place to another. He introduced the concept of contagious diffusion process which he suggested was a model with four-stages. In his model, Hagerstrand suggested that the innovation moved as innovation waves. The four stages that he identified were: the primary stage which marks the beginning of the diffusion process. Centres of adoption are established and then there was a strong contrast between these centres of innovation and remote areas. Then secondly, is the diffusion stage which signals the start of actual diffusion process. Thirdly, the condensing stage which shows the relative increase in the numbers of areas accepting an item. Here the innovation was present in all locations regardless of their distance from the innovation centre. Finally, the saturation stage which is marked by a slowing and eventual dying of the diffusion process (Haggett 1983). Diffusion sometime is hierarchical. 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 earlier and the innovation then moves outwards in a centrifugal manner (Haggett, 1983).

Chilala and Kajoba (2017) agree with Haggett (1983) on hierarchical diffusion as they described the moved of the Orange fleshed Sweet Potates from Mount Makuru in Chilanga ; Zambia (National research Centre) to Msekera in Chipata (Provincial Reaseach Centre) to Ministry of Agriculture and Livestock and Rural Initiative for Children’s Health in Petauke (District level) and finally to the lowest level for the Small holder farmer in Kalindawalo and Nyamphande Chiefdoms. This is presented in Figure 1.

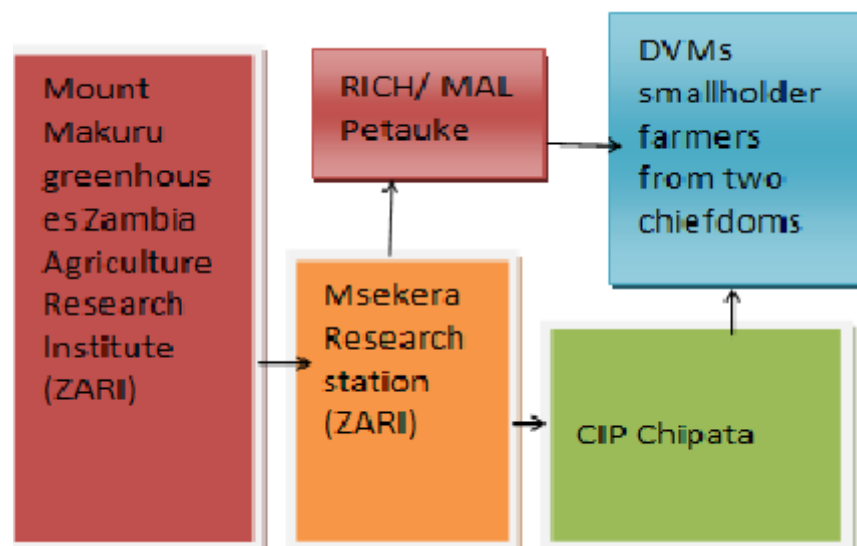


Figure 1: Hierarchical diffusion from Mount Makuru to Smallholder farmers in Petauke

Adapted from Chilala and Kajoba, (2017).

In 1957, Griliches explored the wide differences in the rate of adoption of hybrid corn (Griliches, 1957a, 1957b). Rogers (1962) formalised the theory of diffusion of innovations in his classic book, *Diffusion of Innovations*. According to Rogers (1983), the rate of adoption of a new idea followed an S-shaped curve over time, with only a few individuals initially adopting a new idea and the number increasing as a large number begin to accept the innovation, and that the adoption rate finally slackens

Rogers (2003) noted that the S-curve of adoption began to occur when the opinion leaders in a system used the new idea. He also observed that an innovation is first adopted by an individual who

is socially closest to the source of the new idea, and that it spreads gradually from higher status to lower status individuals.

According to Sahin (2006a), the words “technology” and “innovation” are used as synonyms. In this study, “technology” will mean the OFSP intervention which is designed to bring household food security to smallholder farmers. When the farmer does not adopt the growing of the OFSP then he/she has rejected the innovation which is the intervention of the OFSP.

Rogers (1962, 2003) defined diffusion as the process in which an innovation is communicated through certain channels over time among the members of a social system. According to Sahin (2006b) and Rodgers (2003), there are four elements in the diffusion of an innovation. These are innovation, communication channel, social system and time.

2.8. Innovation “An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption” (Rogers, 2003: 12). The newness characteristic of an adoption is more related to the three steps (knowledge, persuasion, and decision) of the innovation-decision process. These stages were used to assess the adoption in the growing of the OFSP.

2.9. Communication Channels

According to Rogers (2003:5), communication is “a process in which participants create and share information with one another in order to reach a mutual understanding”. This communication occurs through channels between sources. Rogers (2003) states that a source is an individual, an institution or organization that originates the intervention. A channel is the means by which a message gets from the source to the receiver”. As Sahin (2006b) pointed out, this study evaluated the contribution of Mass media and interpersonal communication as communication channels in sharing the information about the OFSP leading to the adoption of the innovation.

2.10. Social System

The social system is the last element in the diffusion process. Rogers (2003:23) defined the social system as “a set of interrelated units engaged in joint problem solving to accomplish a common goal”. Since diffusion of innovations takes place in a social system, it is influenced by the social structure of the social system. For Rogers (2003:24), structure is “the patterned arrangements of the

units in a system. Structure is all about the categories or hierarchy of a given community. This variable helped to determine whether the OFSP adoption is in a way influenced by the status of individuals in a society.

2.11. Time

According to Rogers (2003) the time aspect is ignored in most behavioural research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoptions all include a time dimension. According to Haggett (1983), Hagerstrand considered time aspect as an important factor between two places of different characteristics. The time aspect was used to evaluate whether it influenced rate of adoption of the OFSP. This is presented in Figure 2.

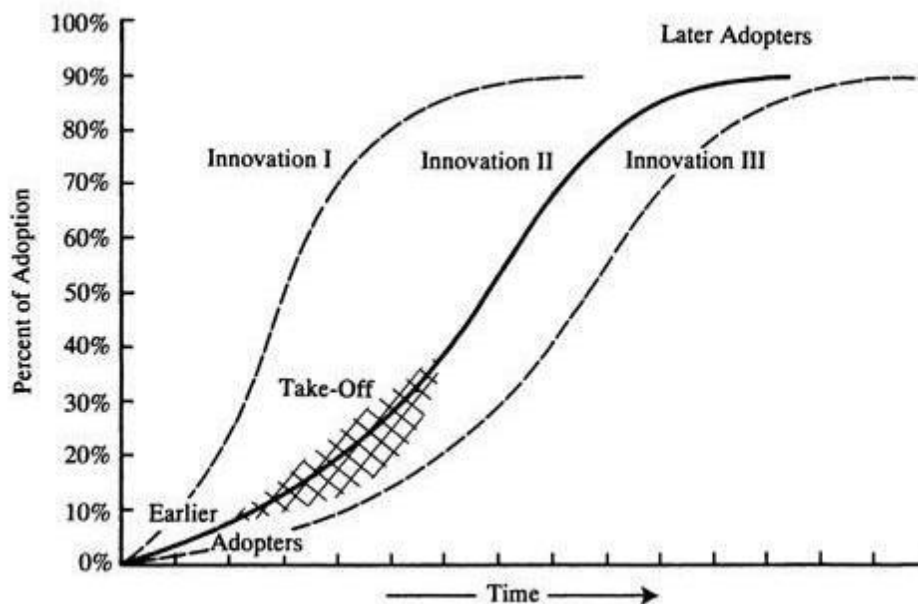


Figure 2: Innovation Diffusion Process

Source: Adapted from Rodgers, (2003)

2.12. The Innovation-Decision Process

Rogers (2003) described the innovation-decision process as an information-seeking and information-processing activity where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation. The process involves five steps which were considered in the study of the spread of OFSP in Petauke District: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. These stages typically follow each other in a

time-ordered manner. Further, he stated that diffusion waves in a profile have both the time and space elements. In this study the innovation-decision process was followed to establish at which stage in the diffusion process of the innovation was at in Petauke. This is presented in Figure 3.

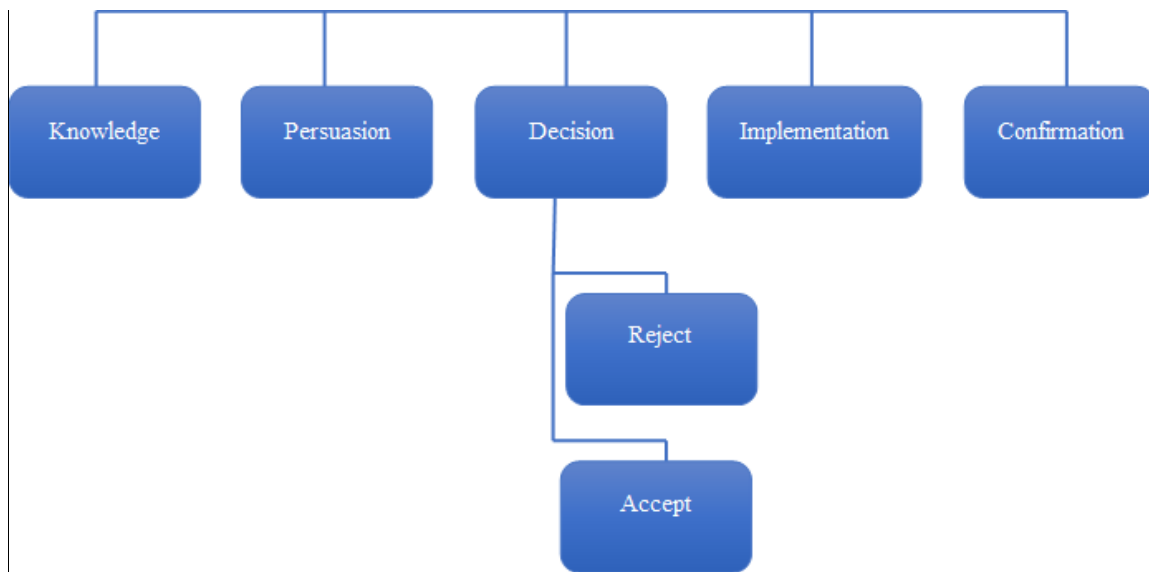


Figure 3: Five Stages in the Decision Innovation Process

Rodgers (1962, 2003) and Abler et al, (1971) identified innovators as follow: Early Adopters, Early Majority, Late Majority, and Laggards. Like Rodgers, Hagerstrand acknowledged the stages in diffusion and called them: primary, diffusion, condensation and saturation stage (Haggett 1983). He further explained that innovations can be shown as a wave in time and space which can change characteristics with distance from time and point of origin. For Rodgers (2003), innovators were willing to experience new ideas.

Rogers (2003) argued further that early adopters are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation. The early majority do not have the leadership role that early adopters have. However, their interpersonal networks are still important in the innovation-diffusion process. The late majority comprises about three quarters in the population and is sceptical about the innovation and its outcomes. However, economic necessity and peer pressure may lead them to the adoption of the innovation. The laggards according to Rogers (2003) held the traditional view and they are more sceptical about innovations and change agents than the late majority. Because of the limited resources and the lack of knowledge of innovations, laggards first want to make sure that an innovation works before they

adopt. This study looked at the adoption rates of the OFSP innovation in the light of the above categories in Petauke District.

2.13. Critique of Rodgers

Though this theory is applicable to the study of the OFSP, Rodgers' model of diffusion only assumes adoption which is usually received by some people (adopters) that have a high standing in society. Rodgers (2003) does not consider that some people would easily lose interest and dis-adopt the innovation they had earlier or recently adopted, or on the other hand that an innovation would first be received by people that are not influential because the assumption is that innovations always breakthrough in a society by way of meeting key informants first. Sometimes to be laggards does not just mean that they see the innovation as not being viable but they do not have the resources to adopt. It seems the theory took into account only innovations that always need financial resources to adopt. In some innovations, laggards could be the key informants unlike the perception that key informants are always be the first to adopt an innovation.

2.14. Types of diffusion

Haggett (1983) on the other hand explained that there are two types of diffusion: expansion and relocation.

2.15. Expansion diffusion

In expansion diffusion, the information and materials spread spatially from one place to another but also remain in the place of origin and intensify. New areas are added between two time periods (time t_1 and time t_2 are both located in a way that alters the spatial pattern as a whole) (Haggett, 1983). He further noted that this type of diffusion was typical to crop diffusion. Expansion diffusion occurs in two ways namely: direct contact or contagious diffusion. The process of contagious diffusion depends on direct contact. This process is strongly influenced by distance because individuals or regions nearer to the innovation have a much higher probability of contact than people or regions that are farther (Haggett, 1983).

2.16. Relocation diffusion

Haggett (1983) also noted that this is also spatial diffusion though the materials being diffused leave the areas they originate from and move to new areas. Relocation diffusion is typical for the

populations of materials that can move from place to place like human beings. This therefore goes to other elements that can be carried by man like a strain of a disease. Sometimes the diffusion process can combine both the expansion and relocation in the same place. This theory was used to study the diffusion of the innovation being studied.

In diffusion of an innovation, the research also considered some elements in the sustainable rural livelihood analysis framework with a specific interest in the assets and different types of capitals. The access to assets and capital has an influence on the adoption of an innovation. A livelihood comprises the capabilities, assets, (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks maintain or enhance capabilities and assets while not undermining the natural resource base (Chambers, 1987).

2.17. Livelihood Strategies and Livelihood Diversification

Ellis (2000) defines Rural Livelihood Diversification as the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living. Scoones (1998) pointed out that livelihood strategies have one thing in common; they represent potential contributions to the survival portfolio of rural households. He further says that diversification develops a wide range of income portfolios to cover all types of shocks or stress jointly or the strategy may involve focusing on the developing of responses to handle a particular type of common shock or stress through well-developed coping mechanisms. In livelihood studies households can also dynamically respond to changing pressures and opportunities and they adapt accordingly (Ellis, 2000).

Ellis (2000) further argues that livelihood diversification is widespread and enduring in many of the poor countries that make up sub-Saharan Africa. An important characteristic of livelihoods that is subsumed under assets is the access that individuals or households have to two different types of capital, opportunities and services.

2.18. Institutions

North (1990: 3) offers the following definition for institutions: “Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human

interaction”. Three important features of institutions are: that they are “humanly devised,” which contrasts with other potential fundamental causes, like geographic factors, which are outside human control, “the rules of the game” setting “constraints” on human behaviour and that their major effect will be through incentives. When incentives are known, there is a high likelihood of the users of the commons to take and use them responsibly.

In dealing with institutions within the household, access to and control over land resources may be differentiated based on institutions. A household with serious labour or capital constraints may be unable to expropriate land resources even when legal, socio-cultural and political institutional frameworks allow it to do so (Scoones, 1998). However, a household may be able to make use of its social capital and get community members to help it meet its labour or financial constraints.

Vedeld and others (2004) reported that household diversifications are the sources of income. Poor households may invariably earn a lot from land resources. The efforts for sustenance are primarily by land cultivation. To supplement land cultivation, off-farm employment, non-farm employment, remittances, rural trade, livestock rearing and gardening are engaged in. At rural community level, access to land and land resources is modified by social relations (gender, class, ethnicity, age): institutions (rules and customs, land tenure, markets), associations, Non-Governmental Organizations (NGOs), local administrations and state agencies.

Davies (1996) pointed out that the interaction between institutions and organizations are very important in the livelihoods framework. He went further to explain that a livelihood pathway can be seen as the result of a series of livelihoods that have emerged over time.

2.19. Rural Livelihood analysis framework (RLF):

The Rural Livelihood Framework was appropriate because it helped to examine the context, conditions and trends, livelihood resources, institutional processes and organizational structures, livelihood strategies and finally sustainable livelihood outcomes in the study area (Scoones, 1998). The contributions of the different types of capitals and diversification of activities to enhance food security of the people in different parts of the study area where the OFSP was grown were assessed to consider their influence on the adoption of the OFSP in the diffusion process. Under

diversification, the research also considered a range of activities the people are engaged in apart from maize growing which usually they considered to be their staple food.

The rural livelihood framework analysis deals with the types of assets and the types of capitals. Scoones (1998) called these available assets as livelihoods resources or basic materials which were either tangible or intangible assets that people had in their possession. The research studied the assets owned by the households as the logical starting point in the livelihood framework (Ellis 2000). This was because assets (whether owned, controlled, claimed or in some other means accessed by the household) were the basic building blocks upon which households were able to undertake production, engage in labour markets, and participate in reciprocal exchanges with other households under social capital. Figure 4 is the Sustainable rural livelihood analysis framework.

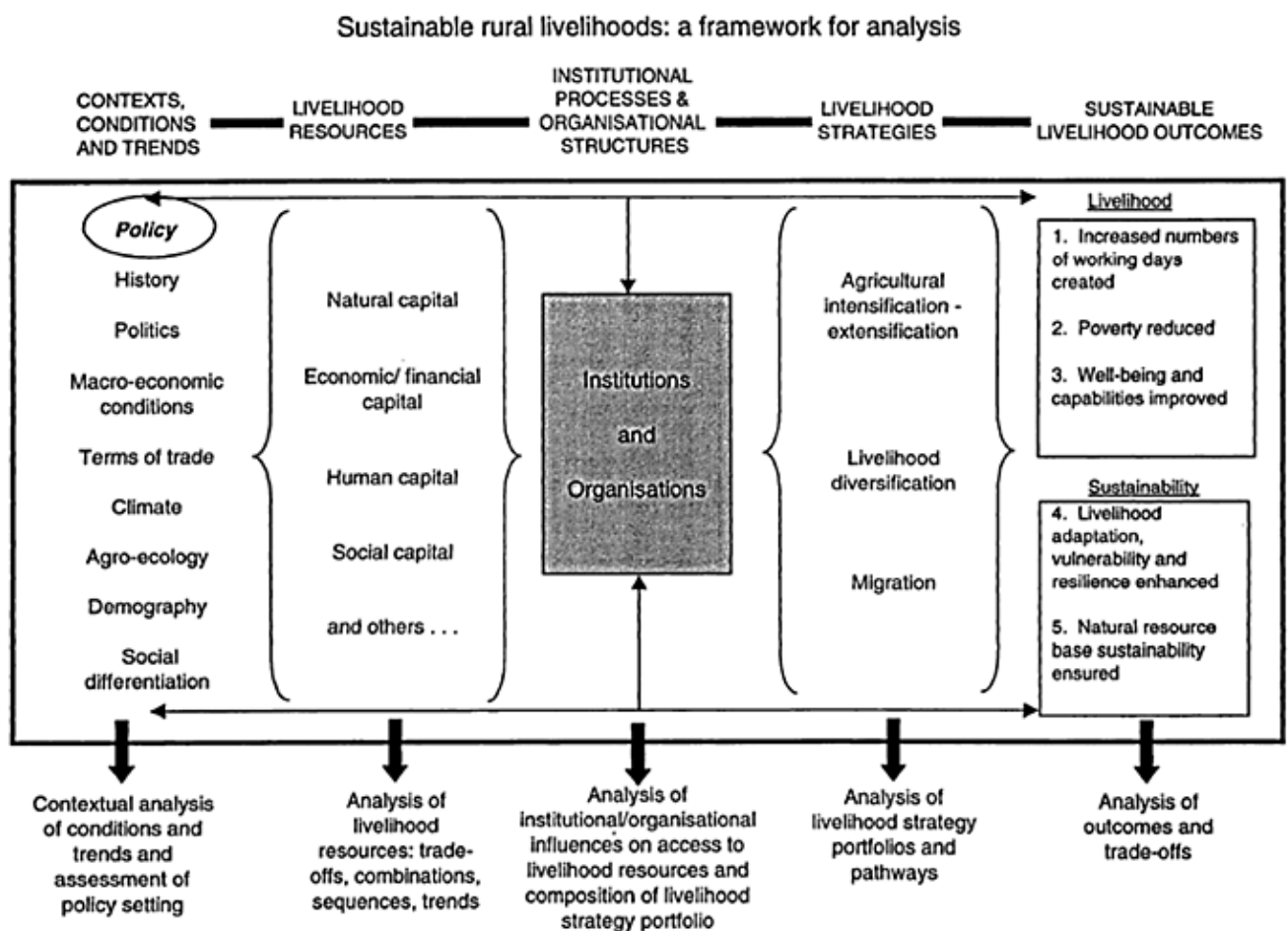


Figure 4: Sustainable rural livelihood analysis framework.

The contexts, conditions and trends pointed to the existing arrangements in the area of study that included the government policy, the social diversification, the population and the land together with the systems put in place for trade policies influenced by macroeconomic conditions in the existing political arrangement. These conditions and trends then led to the type of assets (capitals) that the communities had access to.

The assets in this study were stocks of capital that could be directly or indirectly utilized to generate the means of survival of the household or to sustain its material well-being at differing levels above survival (Scoones, 1998, Ellis, 2000). Both Scoones and Ellis went further and called these types of assets as capitals. Below are the five types of capital according to Ellis (2000). These are natural, physical, human, financial and social capital. Scoones (1998) went further and said that the list of capitals can be longer than five when trade-offs are considered

2.20. The Five Capitals in the livelihood framework approach

These are different types of resources that are necessary in the livelihood framework for production.

2.21. Natural Capital

The natural capital includes the land, water and all biological resources that are utilized by people to generate means of survival. Natural capital is sometimes referred to as ‘environmental’ resources and thought of as comprising the ‘environmental services’ (hydrological cycle and pollution sinks like water bodies and trees) (Scoones 1998). Natural capital is not static, but can be enhanced when brought under human control that increases its productivity (Ellis, 2000).

2.22 Physical Capital

This is capital that was created by economic production processes. It is a producer good, purchased in order to create a flow of outputs into the future. Ellis (2000), however, said that physical capital can be a substitute for natural capital. Physical capital can be man-made items like roads, tools, and machines. In the study area, the people have various implements to enhance cultivation.

2.23 Human Capital

Human capital in the livelihoods framework is the labour needed to do the work. It includes education, skills, knowledge, and health status and physical capabilities of the family members (Ellis, 2000 and Scoones, 1998). It can be increased by investments in education and training, and by the skills acquired through the pursuance of one or more occupations. Labour is often the chief asset possessed by the poor. Toulmin 1992 cited in Ellis (2000:34) is of the view that “Labour as an asset is made more effective when people are free from illness and debilitating health problems.”

2.24. Financial /Economic Capital and substitutes

According to Ellis (2000:34) “Financial Capital refers to stock of money which the household has access to.” It is mostly savings but also loans. Household assets can also be converted into other forms of capital (fungibility). In rural sub-Saharan Africa, money is difficult to come by, livestock keeping plays a cardinal role as a store of wealth. Scoones (1998) adds that the economic base can also include credit/debit savings and other economic assets including infrastructure, productive equipment and technologies which are essential for any livelihood strategy. Rural households may not have the cash but the property they own can sometimes have so much value and influence on their livelihoods

2.25. Social Capital

Sseguya, (2009), Social Capital are the claims on which individuals and households can draw from by virtue of their belonging to social groups of varying degrees of inclusiveness in society at large. He further defined social capital as ‘reciprocity within communities and between households based on trust deriving from social ties. On the other hand, Scoones (1998) defined social capital as social resources (networks, social claims, social relations, affiliations) upon which people draw when pursuing different livelihood strategies requiring coordinated action. Sseguya, (2009) pointed out that there are some central features of social capital that are identified: a) relations of trust, b) reciprocity and exchanges c) common rules, norms, sanctions and connectedness and d) networks and groups.

2.26. Critique of the Livelihood analysis framework (LAF)

This livelihood analysis framework is a workable theory in the agricultural studies which deal with adoption of crops because the aspects of the different types of capitals are vital to the livelihoods that depended on farming activities. This framework offers a wide range of options for production

in a rural setting. The set-up of institutions in the rural areas was critical because if the institutions were not well articulated, there could be a serious cause of depletion of common pool resources like water for irrigation. Institutions are also important for the timings of the livelihood activities in season of different rural areas. The types of capitals that farmers possess help to determine whether the people in the rural areas would easily adopt the innovations or not.

In Zambia for example, Amelia (2014) pointed out the diffusion theory has been used in agricultural studies like in the adoption process of the farmers to conservation farming. Just like in this study the types of capital are critical for the farmers to either decide on taking options either to, or not to adopt the innovation. Increasing food security in Zambia is very important because the population is always increasing thereby placing pressure on the demand of food. Amelia (2014) commented further that the state of food security depends on the ratio of food supply and demand. In Zambia, the constant arable land and the effect of climate change threaten the continuity of food supply while at the same time population growth increases the food demand. Those conditions force farmers to find a way to increase yield productivity. Therefore adoption and livelihood theories are important to increasing food security.

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.1. Introduction

This chapter gives the latitudinal and longitudinal location of the study area and describes some climatic, edaphic factors, population, agricultural and economic activities of the study area.

3.2. Location the study area in Petauke District

The study area in Petauke district is located between 31° 10' East to 31 ° 20' East longitudes and between 14° 15' South to 14°20' South longitudes. This area under study is in the boundary between Chief Nyampande and Chief Kalindawalo. By virtue of its position, it is shared between two agricultural camps: South Nyamphande II and Kawere. This is shown in Figure 5 on page 23.

3.3 Study site in Nyamphande II and Kalindawalo Chiefdoms.

The study sites in this research were Mbabe, Kawere stores, Kaulu, Chinga'mba, Chitungwi and Nyamia farms. This is shown in Figure 6 on page 24.

3.4. Altitude and climate.

Petauke is essentially a plateau which comprises undulating hills at an average altitude of 900 to 1500 meters above sea level. Most of the land is in the middle veld with seasonal rivers that generally flow from December to August. It experiences a tropical to sub-tropical climate with three distinct seasons: a warm wet season from November to March, a cool, dry season from April to mid-August; and a hot dry season from September to October. It has a mean annual rainfall of 950mm per annum, while it's a maximum mean October temperature is 33.1 °C and minimum mean June temperature is 12.3 °C (Chomba, 2004).

3.5. Land ownership

The land tenure systems in the study area is mixed: most small holder farmers hold land under customary tenure while some of the land is under leasehold (FAO 2009). Eighty-two percent of Petauke's farming households are small-holder farmers, cultivating 5 hectares or less of rain fed land. The main land-use system is the maize-livestock system (FAO 2006).

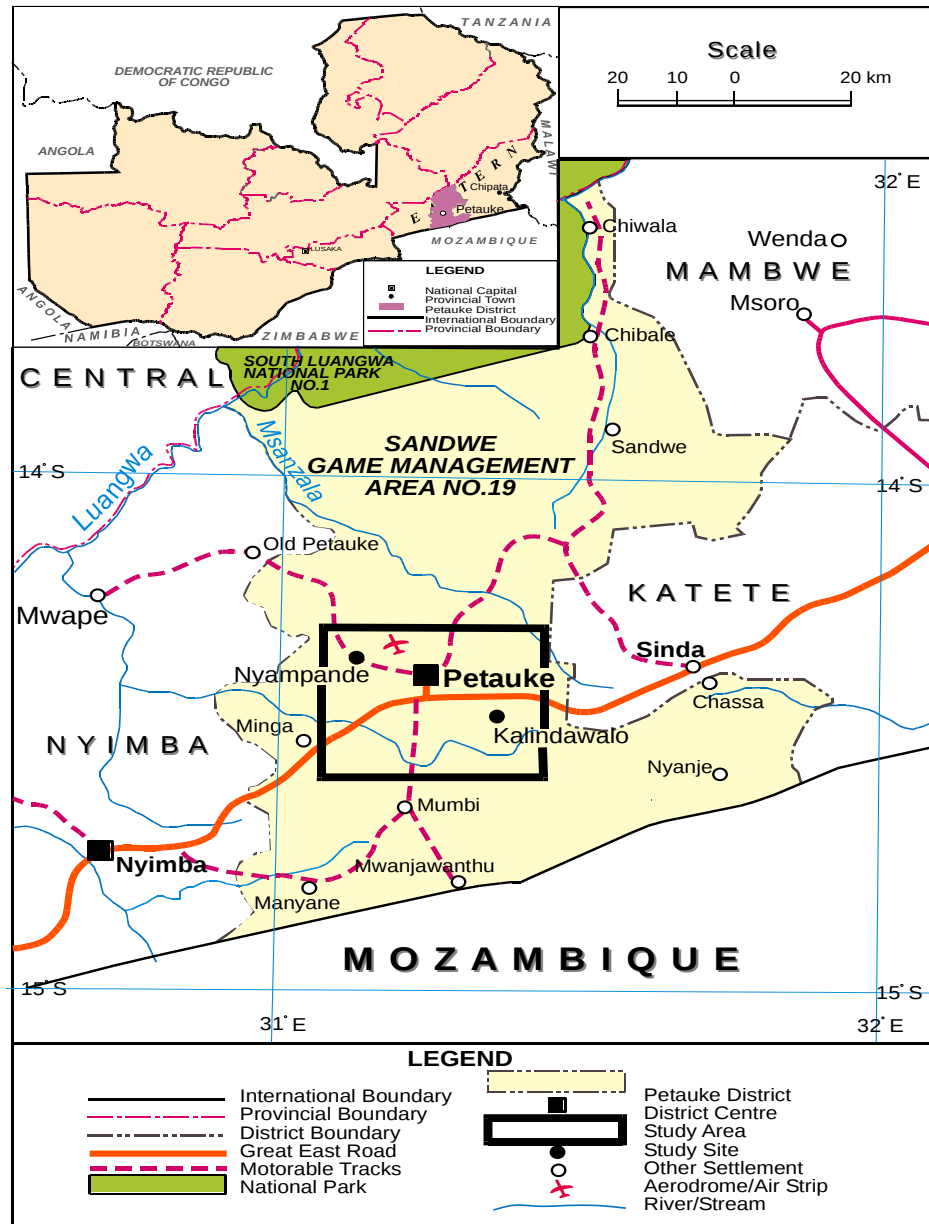


Figure 5: The location of Nyamphande and Kalindawalo chiefdoms in Petauke District

Source: Map, Courtesy of Chalila, (2014). Adapted from topographical map 1431, A1-A4.

3.6. Soils, and agricultural activities in Petauke

The soils are generally Ferrallic Arenosols which are infertile and coarse sands. Cassava, bulrush millet and Bambara nuts (*Vigna subterranea*) are predominate on the upland with some maize and sorghum. In the flood plain rice, maize and sorghum are grown (El wells desciencias socials 2002). Since the soils are infertile, they usually demand a lot of mineral fertilizers to make meaningful harvest of the staple food crop in Petauke: maize. The small holder farmers in Petauke own livestock like cattle, goats, pigs and chickens.

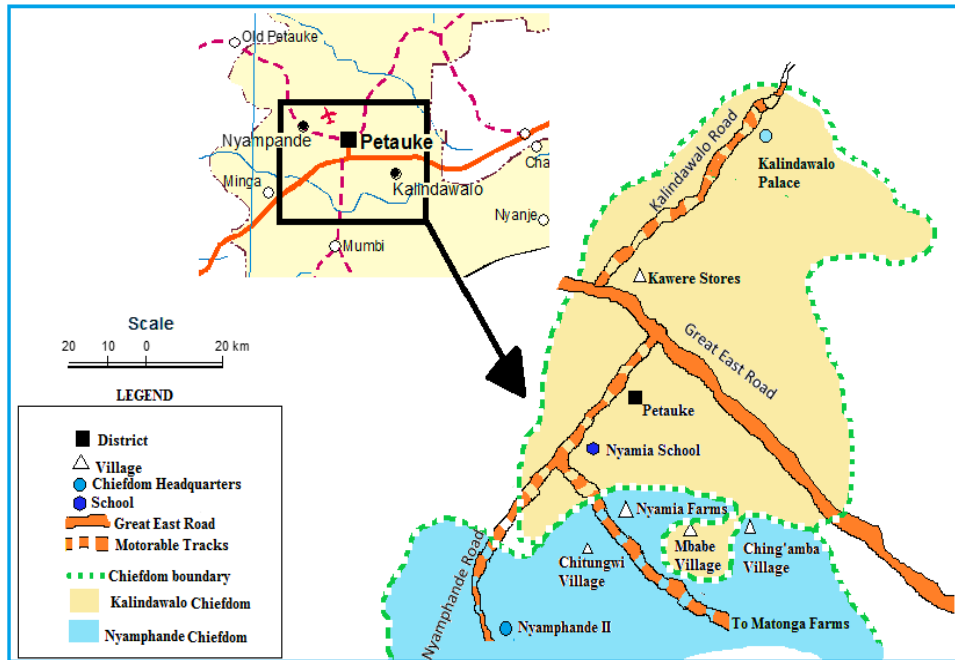


Figure 6: Map of the study sites in Nyamphande and Kalindawalo chiefdoms

Courtesy of Mwanza Gift, (2018).

3.7. Population of Petauke District

Petauke district has a population of about 19 296 people. According to CSO (2011), Petauke's population density stood at 40.72 persons per square kilometre. Farmers in Petauke district live in clustered settlements of up to 100 homesteads referred to as villages (Ngugi 1988). Most of these villages are remote, with little or no access to research and agricultural extension, high-yielding seed varieties, capital and credit facilities, fertilizers and pesticides (Kwesiga et al, 1999, Place and Dewees 1999).

CHAPTER FOUR

METHODOLOGY

4.1. Introduction

This chapter will address the methodology used in this research: the sampling frame, sampling, the sampled villages and the sample size. It will also include the methods of collecting, analysing the data and the theoretical frameworks used. 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 and respondents were purposively selected using the information from Rural Initiative for Children's Hope registers of the farmers they were working with in the OFSP growing. The questionnaires were administered by the help of Rural Initiative for Children's Hope officials since they already knew the area where the farmers that had adopted were located in both Nyamphande and Kalindawalo chiefdoms.

4.2. Sampling frame

The sampling frame included 2 out of 22 agricultural camps in Nyika ward which was purposively selected because this is where the OFSP farmers were located. These agricultural camps were South Nyamphande II and Kawere agricultural camps. In both chiefdoms, three villages were purposively sampled. The villages in Nyamphande chiefdom included: Nyamia Village 24 households, Nyamia farms 14, Chitungwi 22 households. In Kalindawalo the villages included Mbabe 19 households, Kawere strores 28 and Kaulu village 6 household. In South Nyamphande II and in Kawere; 65 and 53 smallholder farmer households were all selected respectively and a questionnaire was incidentally administered to those that were present as the researcher went on with the research.

4.3. Sampling

A total number of 118 households were purposively selected from the 241 households which were proportionate ratio of 49% households. 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.

4.4 Sampled villages

Table 2 shows the villages that were selected from the population for study in the two chiefdoms. These were sampled purposively because they were found in the areas that grew the OFSP.

Table 2: Sampled villages from Nyamphande and Kalinadawalo chiefdoms

Chiefdom	Village	Frequency	Percentage
Nyamphande	Nyamia	29	24.6
	Nyamia farms	14	11.9
	Chitungwi	22	18.6
Kalindawalo	Kawere Stores	28	23.7
	Kaulu	6	5.1
	Mbabe	19	16.1
Total		118	100

Source: Field data, 2014

4.5. Primary data

A field survey was conducted to gather information on the OFSP growing areas. A questionnaire was used to collect primary data from a sample of 118 out of 241 population households in the six villages. Since most households heads or respondents 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.

4.6. Secondary data

This was acquired from the theoretical frameworks used: Diffusion theory, Sustainable Rural Livelihood Analysis framework and other livelihood and food security related literature through desk study.

4.7. Data collection methods and instruments

The research used different data collection methods and instruments as indicated below

4.8. Personal field observation

Apart from the questionnaire, the researcher observed the OFSP growing throughout the growing season. The stages that were observed included: land preparation, planting, actual growing period of the OFSP and harvest time. Types of different capitals were also observed at each village as the researcher went round. The researcher visited the smallholder farmers with the help of RICH officer throughout the growing season.

4.9. Questionnaires

The questionnaire was used as the main data collection instrument for collecting primary data from the 118 respondents.

4.10. Interviews with key informants

The key informants included 2 village headmen, Provincial Agricultural Office, the District Agricultural Office, an officer from Rural Initiative for Children's Hope (RICH), an officer from International Potato Centre in Chipata and 2 Ministry of Agriculture and Livestock camp officers from Nyamphande II and Kawere camps and 2 Decentralised Vine Multipliers.

4.11. Focus group discussions (FGDs)

There was one focus group discussion in either of the agricultural camp: South Nyamphande II and Kawere to triangulate the data from the questionnaire from the 118 respondents. The FGD participants were selected by the researcher himself to avoid biases of having farmers of similar characteristics. These two FGDs comprised 10 members each. The first FGD had 10 women in Mbabe representing Kalindawalo and while the second FGD had 10 men in Nyamia representing Nyamphande. These two villages were close and are found on a common border of the two chiefdoms. These participants were selected purposively.

4.12. Data analysis tool

Both quantitative and qualitative data was derived through the percentages generated by the software SPSS. This helped in the descriptions of qualitative data and presentation of findings

through tables, graphs and pie charts from quantitative data. The theoretical frameworks and data collection instruments used to guide this section are presented in table 3.

Table 3: Theoretical frameworks and data collection instruments

Objective Number.	Objectives	Theoretical Framework	Data Collection Method
1	To establish the diffusion of the OFSP in Petauke District.	Diffusion theory,	Questionnaire, personal interviews with the Decentralised Vine Multipliers, Field observation
2	To assess the contributions of the OFSP to food security.	Rural Livelihood Analysis	Questionnaire, Focus Group Discussion (FGD).
3	To find out the livelihoods improvement for OFSP smallholder farmer households.	Rural Livelihood Analysis, Adoption trends /diffusion theory	Questionnaire
4	To identify the challenges smallholder farmers face in the growing of the OFSP	Rural Livelihood Analysis	personal observations, interviews, FGDs, Questionnaire

4.13. Ethical consideration

The headpersons in respective villages were visited to ask for permission to facilitate entry into their villages to interview their subjects

CHAPTER FIVE:

RESULTS AND DISCUSSION OF THE STUDY

5.1. Introduction

This chapter presents the results of the study from the field and subsequently discusses them. It first describes the characteristics of the sample population and then the OFSP adoption and contributions to the household food security. Finally the problems and solutions that are related to the growing, harvest and marketing of the innovation (OFSP) are presented and discussed.

5.2 The age of the respondents

The age of the respondents ranging from 15 to 60 years represented 83% while the rest were above 60 years of age. This demographic depiction of age shows that the area had enough active people that would be engaged in the agricultural activities which included the OFSP as it needed a lot of labour especially at land preparation, planting and harvesting, especially for those families that did not have animal draft power (ADP). The age of respondents are presented in table 4.

Table 4: Age structure of respondent

Age of respondent	Frequency	Percentage
15-24	22	18.6
25-29	18	15.3
30-34	16	13.6
35-39	16	13.6
40-49	10	8.5
50-54	13	11.0
55-60	3	2.5
above 60	20	16.9
Total	118	100.0

5.3. Marital status and household size of respondents

The marital statuses of the respondents were 16.1% single, 66.1% married, 8.4% divorced and on separation and 9.3% were widowed. Family labour could facilitate adoption and production of OFSP. The household sizes of the 118 respondents ranged from 2 to 13 members. The number of people in the household was very important because it provided labour for the OFSP agricultural activities. If most of the households adopted the innovation, a large number of people would easily access vitamin A since generally food security for rural households is based on household food production from own fields. The mean household size of the two chiefdoms was 7.5 members which were not very far away from the average household size of eastern province of 5.5 persons (Central Statistical Office, 2012). This is just a difference of 2 persons per household. The marital status and household size is presented in table 5 below.

Table 5: Household size of respondents.

Household size(persons)	Frequency	Percentage
2-4	44	37.3
5-6	25	21.2
7-9	29	24.6
10-12	18	15.3
13 and above	2	1.7
Total	118	100.0

5.4. Highest educational attainment of respondent

The level of educational attainment of the people of the two chiefdoms is very low. The first 18.6 % did not have any formal education. The other 53.4% attained only primary school education of which 28 % only had lower primary education. The 28% of the respondents had secondary education and no one had tertiary education. A total of 53.4% of the farmers that had attained junior and senior secondary level were more aware of the importance of vitamin A in their diet. On the other hand 28.8% out of those that had never entered school and those who went up to middle basic educations were not aware of the importance of vitamin A in the diet of either pregnant women or the children below 5 years.

5.5. Land tenure

Most of the land in the study area is held under customary land tenure. This comprised 89% while the remaining 11% that had land above 9 hectares was under leasehold tenure in Nyamia farms. Both the land on customary and leasehold tenure had the same characteristics: did not have meaningful portions of OFSP fields and their grazing land was treated as commons where the cattle were let loose during the dry season to wonder and graze anywhere. Those with leasehold had slightly more land for subsidiary crops while in customary land tenure had to rent portions of land to grow additional crops to maize like OFSP

5.6. Total area under cultivation among the respondents

The following represents land assigned for crop growing between 2010/2011-2013/2014 farming season: Those who farmed less than 1 hectare were represented by 9.8 %. The following 30.5% farmed between 1-2 hectares, 38.1% farmed between 3-4 hectares , 13.6% farmed between 5-6 hectares, 4.2% farmed between 7-8 hectares, 1.7% farmed between 9-10 hectares and 2.1% had used more than 10 hectares.

5.7. Average land size in hectares used for selected crops.

It was clear that a lot of people allocated very small portions of land to OFSP because most of the land was assigned for the conventional cash crops they have been growing like maize, cotton, groundnuts and sunflower according. Apart from these cash crops, other subsidiary crops are usually intercropped in their farming system. These include mbambala nuts, beans, sweet canes, okra, cowpeas, cucumbers, pumpkins, and watermelons. In the two chiefdoms under study the cultivated average land was allocated for included OFSP as shown in Figure 7.

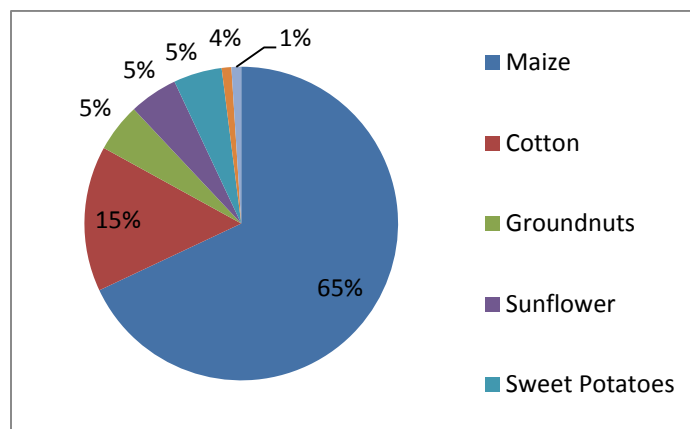


Figure 7: Average land size in hectares used for selected crops.

5.8. Production of OFSP in the study area

There was a positive progression in the production of the OFSP in the first three years in the area under study. The average number of bags produced per farmers that adopted was increasing throughout the three years though they were generally very few. However all 118smallholder farmers still grew Chingovwa (yellow sweet potatoes or Solwezi) because its vines were readily available compared to the OFSP varieties: Twatasha, Zambezi, Olympia and Orange Chingovwa. The production percentages of the traditional and OFSP are presented.

There was a positive increase in production of Orange Fleshed Sweet Potatoes in the first three seasons (2010/2011-2013/2014). This was because the number of the smallholder farmers engaged in growing continued increasing to the already existing of the previous year. In the fourth season: 2013-2014 there was a drop in production because many of the farmers wanted to concentrate on the growing of the OFSP varieties as presented in Table 6. These yields however were lower far below potential yields of 40 t/ha obtainable under ideal production conditions (Mudenda 2012). Partly this is because the sweet potatoes in Zambia are not a staple food crop and is allocated small portions of land.

Table 6: Average production of OFSP by 50kgs bag per hectare of the smallholder farmers.

Season	Non OFSP per 50 Kilograms bag	OFSP per 50 Kilograms bags
2010/2011	47	60
2011/2012	59	80
2012/2013	57	82
2013/2014	51	60

Source: 2014 field data.

5.9. Diffusion and adoption of OFSP in 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 smallholder farmers within Nyamia belonging to a women's club. 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 rain season

because the vines were eaten by cattle. This was because their gardens were not well secured 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 International Potato Centre which later entered into partnership with Rural Initiative for Children's Hope. RICH began to train and monitor the farmers in the raising of the vines and the growing of the OFSP. The first farmers to grow the OFSP were the Decentralise Vine Multipliers. 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 as they belonged to a club.

5.10. Smallholder farmers' adoption of OFSP in the 2010/2011

The number of smallholder farmers that had accepted the OFSP in 2010/2011 was 28 out of the 118 that had received the information on the innovation. This represented 23.7% adoption rates of the sample. The remaining 76.3% had not adopted and were still in the decision stage.

5.11. Trend in the adoption of the OFSP innovation

There was a positive trend of adoption in two farming seasons 2011/2012 and 2013/2014. From the 118 respondents, 91 households representing 77.1% adopted 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 because the smallholder farmers did not access the vines during the subsequent planting season or their vines were destroyed by livestock in the gardens. Figure 8 shows the adoption trend of OFSP.

5.12 Channels of diffusion of OFSP in Nyamphande and Kalindawalo chiefdom

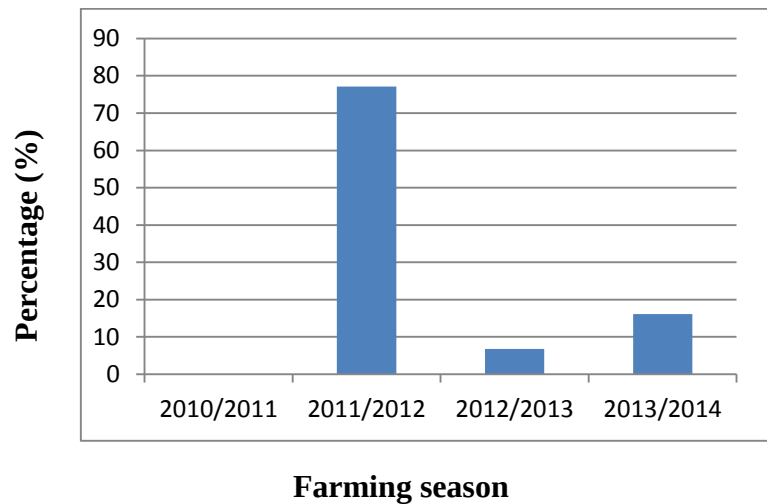
There were several channels through which diffusion of OFSP took place in the study area which include the following.

5.13. Road shows

The OFSP smallholder farmers have been using road shows to market both the OFSP vines and roots. This has been an effective way of sharing information about the innovation. The road shows are sometimes called the market shows where a message of advertisement goes round in that place. On the agreed day, the marketing takes place. The farmers in conjunction with the NGO/s also

display a lot of products made from the OFSP like biscuits, cakes, sweet beer, crisps and vines. As people stop over to view, information is shared and the OFSP continue diffusing.

Figure 8: Trend of adoption between 2010/2011-2013/2014 farming season in percentage



5.14. District show: Ministry of Agriculture and Livestock (MAL) has been organizing district agricultural shows in all the districts including Petauke. The exhibiting of the OFSP was done during the shows of 2011, 2012, 2013 and 2014. During the shows, marketing of OFSP under the auspices of International Potato Centre was done. RICH and the farmers exhibit the food products made from the OFSP. Apart from the vines and roots, they shared recipes of how the OFSP could be prepared and consumed. District shows were an effective channel of sharing information because thereafter the smallholder farmers (show participants) also bought the vines and adopted the innovation. The detail of those that bought vines were recorded and follow ups were later made.

5.15. Conference, Workshops and Field Day Demonstrations

The participants to the conferences, workshops were selected by invitation from the two organisations: International Potato Centre and Rural Initiative for Children's Hope through the Agriculture extension officers from the Ministry of Agriculture and Livestock. CIP organized workshops and conferences where information on the growing of OFSP was disseminated. During these conferences progress on diffusion was shared.

During the field day demonstrations smallholder farmers from the surrounding areas were invited regardless of whether they grow OFSP or not. The owners of the fields and other experts explained their activities in the growing period. The type of information shared started from land preparation, planting, management of the crop and sometimes up to harvest. Finally the sorting out of the roots in preparation for marketing was taught. Figure 9 depicts a farmer explaining stages of OFSP growing in the field



Figure 9: Photo of a farmer in Mbabe village explaining the vine cuttings for planting

Source: field data 2014

5.16. Types of Media in the Dissemination of OFSP messages

The smallholder farmers who had radios and received information through audio represented 21.2%. This was from a number of community radio stations in the area which farmers listened from in the district. However, radio stations one and two of Zambia National Broadcasting Corporation (ZNBC) also gave farmers a wider choice to listen to agricultural messages. For example, ZNBC radio two presented a program called voice of the farmer and rural note book and radio one, Cinyanja, 'Nkhanizaalimi' every week. Radio Breeze aired Agriculture programmes every Sunday at 16:30 hours and on Wednesday at 11:30 hours. This provided greater opportunity to smallholder farmers to learn a lot about farming in general. CIP also ran advertisements on these radio stations.

There were 2.5% of smallholder farmers who owned televisions and had received OFSP messages through visual media. The access of OFSP messages through print media in English only accounted for 15% of the respondents. On the other hand all the 118 respondents said that they had received

brochures in Cinyanja from CIP on the growing and benefits of the OFSP. Therefore, all the respondents in the sample had received messages in Cinyanja.

5.17. Trainings, Meetings and Reporting of OFSP information to the project implementing organizations

International Potato Centre and Rural Initiative for Children's Hope conducted meetings and trainings first with DVMs. The OFSP growing were discussed. Field Officers (FO) and the DVMs taught about 15 to 35 farmers at each arranged meetings. Ministry of Agriculture and Livestocks Extension Officers in Petauke also conduct trainings and meetings among the smallholder farmers within their respective catchment areas and then still reported to CIP who still generated a report together with that one from RICH to USAID office. This information on trainings and meetings was important to track the smallholder farmers that continued growing after adoption of the innovation. From the respondents, all the 118 farmers that had adopted over the years between 2010/2011 to 2013/2014 growing season had received training at various times.

5.18. Barriers to Adoption of OFSP in Nyamphande and Kalindawalo chiefdom

The barriers identified in the adoption of OFSP in the two chiefdoms include: non availability of water during the dry season to raise the vines and difficulties in the acquisition of the vines for planting, non-understanding of the importance of vitamin A (utilization) of the OFSP by the smallholder farmers and insufficient land to spare for growing OFSP. Human capital for the preparation of land into ridges was not enough for those in the category with only 2 family members. The incentives that were given to farmers that practiced other innovations/technologies such as conservation agriculture were also barrier to adoption of OFSP because the smallholder farmers expected similar incentives from the promoters of OFSP. They viewed growing of the OFSP as a favour to the NGOs and government agricultural departments implementing the programme. The incentives were viewed as more important than the household food security. A total of 50% of the respondents felt cheated because the NGOs promised them treadle pumps for watering the OFSP and chemical fertilizer which were never given.

5.19. Factors influencing the adoption of OFSP

These factors are not mutually exclusive. One respondent was allowed to give more one factor. The 118 smallholder farmers had adopted the OFSP to find out the productivity in comparison to the local varieties they were growing. The other 103 % from the 118 respondents respondend that they

wanted to improve their household food security. This was to increase the food options from the other food crops they produced. In addition 75.4% said they wanted to improve their livelihood to earn money for other household needs.

5.20. 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 expansive 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 Ministry of Agriculture and Livestock 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 which is Zambia's national research centre located in Chilanga near Lusaka before they are transferred to Msekera greenhouses under the auspices of ZARI/CIP. Msekera is a local research station located in Eastern province of Zambia.

5.21. Hierarchical and Contagious Diffusion Patterns of OFSP Adoption in Nyamphande and Kalindawalo Chiefdoms

When expansion diffusion occurs the innovation spreads outwards but it remains in the area of origin (Haggett, 1983). 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. International Potato Centre in Zambia 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. Figure 10 illustrates hierarchical and contagious diffusion.

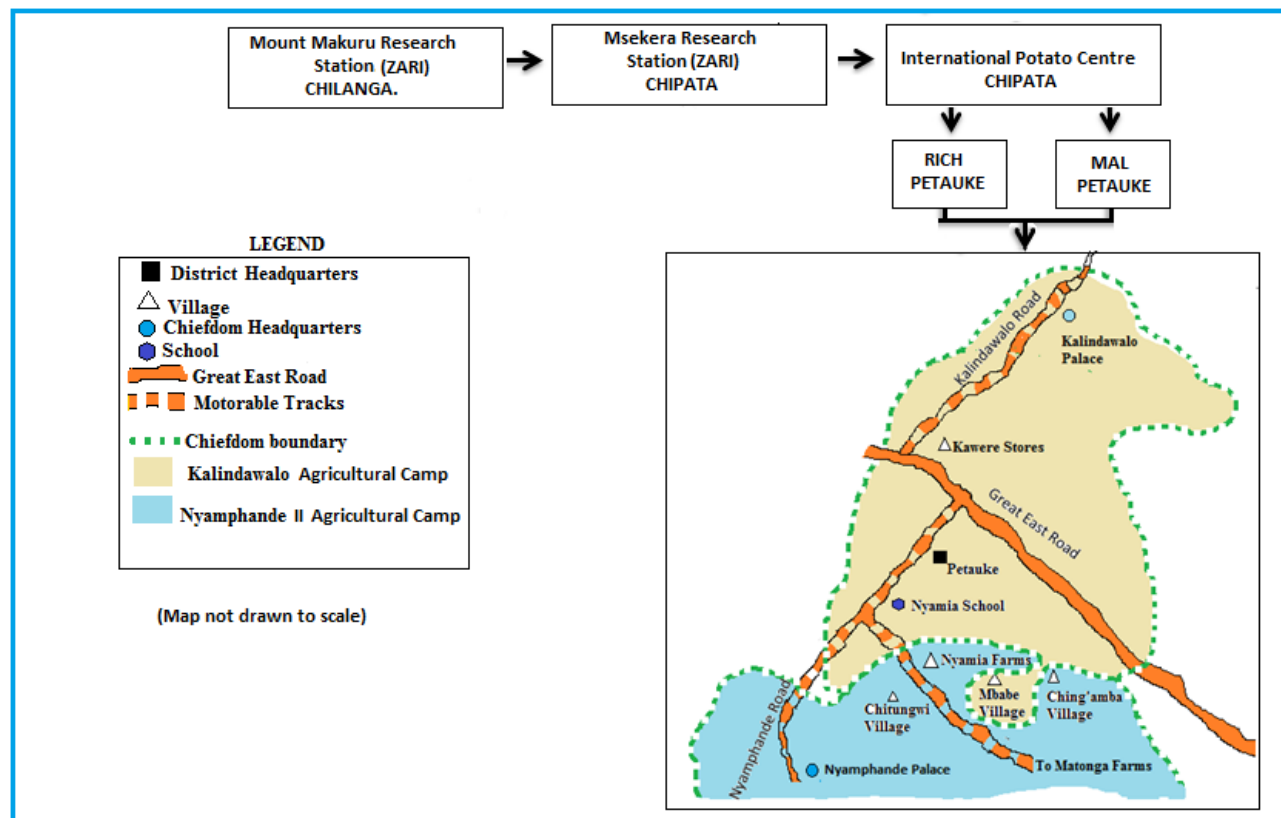


Figure 10: Hierarchical and Contagious diffusion of the OFSP

Courtesy of Mwanza Gift, 2018

5.22. Contagious diffusion.

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 areas. 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 was 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 chiefdom in villages like Kawere stores and Kalindawalo itself from Nyamphande chiefdom. 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 chiefdoms have not reached saturated stage yet because a lot of people in villages in the two chiefdoms had not yet adopted the innovation though large proportions of the smallholder farmers indicated willingness to grow bigger portions as vines would become available.

5.23. The Extent of Adoption of OFSP in Nyamphande and Kalindawalo chiefdom.

The extent of the adoption of OFSP has grown 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 strategy 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 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. Proximity to passable roads had influence on the diffusion and adoption because it influenced the passage of the NGOs implementing OFSP growing.

5.24. The innovation decision making process in the OFSP adoption.

The information on OFSP has spread out in all the 118 households in Nyamphande and Kalindawalo chiefdoms. Decision making stage was done, the smallholder farmers had adopted. From the interviews with the smallholder farmers, took a longer time to adopt due to their attitudes and perceptions. Some believed that starting with the preparation of the OFSP fields wasted time

needed for the growing of the traditional crops like maize. Some argued that they could not be wasting time to multiply vines in the dry season as a result they lacked vines in the growing season. Some of the smallholder farmers did not understand the nutritional value of vitamin A found in the OFSP. Smallholder farmers did not see the economic and food security value of the OFSP in their livelihood. The other attitude of the smallholder farmers in the two chiefdoms was that of incentives. The farmers were expecting to be given incentive for them to grow the OFSP because they felt growing the crop was doing a favour to the organizations implementing the project (CIP/RICH). The other group wanted to be assured of the market of the OFSP before they could grow it. Some expected the crop to grown under out grower scheme so that the NGOs could supply the vines and then buy the roots. These attitudes and expectations to receive something hindered and delay adoption of OFSP by some of the smallholder farmer.

5.25. Contribution to household food security

This section addresses the how the OFSP contribution to the household food security in Petauke thought the OFSP cannot completely replace the staple food in the area but can supplement.

5.26. Food availability

This is one of the pillars of food security. Food availability comes out strong in many societies as synonymous to food security (FAO, 1996) it is when food is available that farmers or governments can discuss the other pillar of food security like access, utilization.

5.27. Food Preparation methods of OFSP

Food prepared is very important in food security. These different ways of preparation give the people the ability to use the new crop throughout the whole day (all the three main meals) in some instances without losing appetite. The following were the responses on preparation: 63.6% it can be eaten raw, 0.8 roasted, 30.5% boiled, 1.7 fried, 2.5% boiled and mixed with ground nuts, cooked mixed with tomato, onion and cooking oil. Apart from the above methods, the OFSP is processed and made into biscuits, drink chips and can be boiled together with others foods like meal sump (Muller and Chiona, 2012).The different preparation methods help to increase on the frequency of the intake of the OFSP that just the traditional boiling which tended to cause constipation. This is shown in Table 7 and Figure 11.

5.28. Access of OFSP in food security

Food access is being able to get the available food to eat (FAO, 1996). The sweet potatoes were easily accessed by the household members during the time they are in season. They are stored in places that can easy to reach by all members of the household to consume. However, there are times when the crop is stored to prevent it from rotting; it was difficult to be accessed by everyone except through elderly household members especially mothers. During preservation children and older members of the families cannot easily reach the sweet potatoes because they are put on top of roofs or high places to prevent dust and livestock from eating it as shown in Figure 12.

Table 7: Food Preparation of the OFSP for consumption.

Preparation	Frequency	Percentage
Raw	75	63.6
Roast	1	.8
Boiled	36	30.5
Fried as chips	2	1.7
Cooked with groundnuts	3	2.5
Cooked with tomatoes/onion	1	.8
Total	118	100.0

5.29. Utilization in food security: Vitamin A intake

Food security utilization is the actual nutritional value provided by the food eaten (FAO, 1996). The different methods of preparation helped the smallholder households to utilize the crop as much as possible to receive the much needed vitamin A. Apart from food availability, the crop provides food utilization (vitamin A). Utilization is about the nutritional value of the food.

5.30. Seasonality in food security of OFSP

Seasonality deals with the aspect of food which is not usually available but has a specific time it is available, in this research is the time when the OFSP mature and harvested for consumption. During the time the OFSP is harvested it provides food security to those households. The OFSP are eaten

by all the 118 respondents in all the main meals: breakfast, lunch and supper. At this time of the year those that have grown this crop make sure they maximize the intake of the crop so that they acquire as much Vitamin A as possible as they could. All the 118 farmers were made aware that the OFSP was able to fight Vitamin A Deficiency (VAD) through the meetings with the NGOs promoting the crop. All the 118 smallholder farmers said the leaves of the OFSP provided relish (kalembula). The favourite variety for plucking leaves for relish is Olympia. This is shown in Table 8.

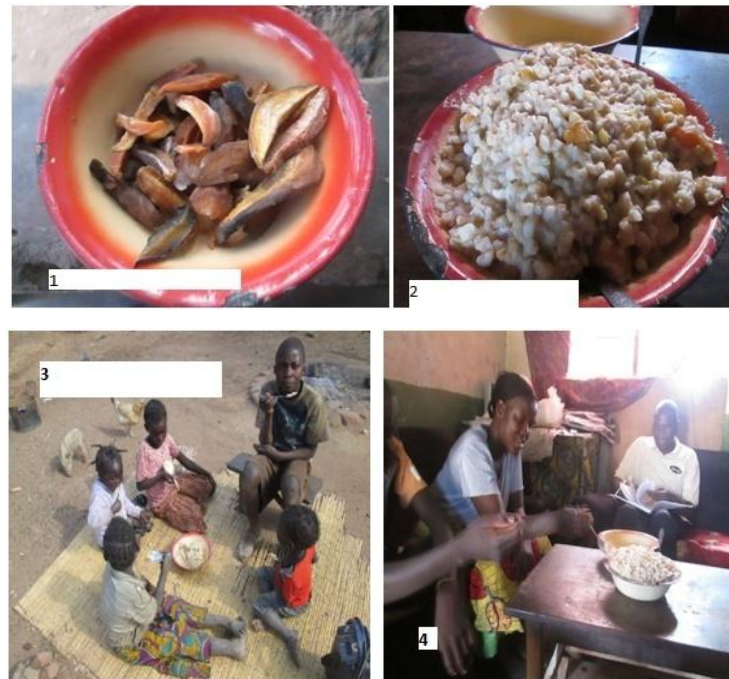


Figure 11: Pictures showing prepared meals and family members eating.



Figure 12: Preservation and storage methods of the OFSP.

The sweet potatoes are a seasonal crop in nature because many smallholder farmers grow it during the rainy season. All the 118 smallholder farmers only grew very little because their major attention was concentrated on staple crop: maize. The respondents that had household food security lasting not more than 3 months were 80.7 %. The remaining 19.3% belonged to the group whose season of consumption was between 4 to 6 months. All the 118 respondents said the OFSP they grew were difficult to preserve or they sold to raise money to buy other foods and meet other household needs.

Table 8: Seasonality food security in the smallholder farmer households

OFSP months of food security	Frequency	Percentage
1 month	85	62.1
2 months	15	12.7
3 months	7	5.9
4months	3	2.5
5 months	6	5.1
6 months and above	2	1.7
Total	118	100

5.31. Contribution to livelihoods of the OFSP smallholder farmers

The contribution to livelihoods deals with the activities that the smallholder farmers are engaged in, in relation to the growing of the OFSP to earn a living or to help them solve some of their family needs. In this research under livelihood are the livelihood resources: natural capital, economic/financial capital, human capital, social capital and other resources at their disposal (Scoones, 1998). The other aspects are livelihood strategies and sustainable livelihood outcomes.

5.32. Livelihood Resources in Petauke

All the 118 smallholder farmers were able to grow the OFSP because they had natural capital: Land. Under natural capital some 50% of the smallholder farmers were able to easily make the mounds for planting using animal draft power from oxen and ploughs while the other 50% used hoes. A total of 75.4%were able to buy the vines for planting from the DVMs using financial

capital. The other 14 respondents representing 11.9% accessed the vines through social capital through relatives and friend that had the vines.

Human capital was available to all the 118 respondents. This is the actual people to work in the fields. Labour for harvest was through the existing households or through social connections. Friends and relatives helped in the planting, weeding and harvesting and in return were given the OFSP roots for consumption as payment in kind. After harvesting, some of the roots are transported to the market for sale. The picture in Figure 13 is a type of transport (Natural capital) used by some of the farmers to transport the OFSP to market places from Nyamia village to earn financial capital for other household needs.



Figure 13: Ox cart for transportation of OFSP to Market.

5.33. Earnings from the sale of OFSP

In the two chiefdoms, the OFSP were sold in the last two growing seasons. So this information represents the earnings in the last two farming season because that is the data that was recalled by the smallholder farmers. These were the 2012/2013 and the 2013/2014 farming season. During the 2012/2013 farming season, one farmer representing 0.8% in Nyamia: Mrs Grace Mwenda was able to grow enough OFSP for sell and earned K5000 kwacha. Apart from Mrs. Grace Mwenda 30 other farmers representing 35.4% sold their OFSP also. In the 2012/2013 farming season the earning were between K150 to K5000. In the following farming season: 2013/2014 farming season, 50 respondents out of 118: (42.4%) smallholder farmers grow enough OFSP for sale. These farmers earned ranging from K1000 to above K20, 000. Among the 50 farmers, a Mr.Ivuta Mwanza had grown 2 hectare of the OFSP and earned about K20, 000. The remaining 68 respondents representing 58 % had just grown enough for their household security (consumption). The

production from these farmers namely: Grace Mwenda and Ivuta Mwanza showed that there was a future in the growing of OFSP in Petauke or among rural households. The money raised from the sales of these OFSP can go a long way in sorting other household needs that need finances. The OFSP are cheaper to grow because they do not need a lot of inputs like maize and cotton. Apart from the vitamin A the households would acquire, the growing of the OFSP would help the smallholder farmers to improve their livelihoods through improved well-being and capabilities (Scoones, 1998). Furthermore, the continued growing of OFSP will help in the livelihood strategy of livelihood diversification.

5.34. Benefits of the financial capital earned from the OFSP

One of the livelihood resources is the economic/financial capital (Scoones, 1998). The financial capital helped 101 of the respondents to acquire livelihood assets while the other 17 respondents used the finances on other household needs and food. The assets acquired included ploughs, cattle, digging well, buying leapers, buying sprayers, fertilizers and other household needs. The following are responses on the other given uses of the financial capital earned: 2.5% on school fees, 6.8% on groceries, and 2.5% bought maize or mealie meal, 1.6% on relish, 1.8% used for grinding mealie meal. Table 9 are responses on how the smallholder farmers spent the financial capital the earned.

Table 9: Expenditure of the income from the OFSP

Financial capital expenditure	Frequency	Percentage
Bought natural capital (Assets)	101	85.6
Other household needs	17	14.4
Total	118	100

5.35. Area under and OFSP production:

All the 118 respondents had a portion of OFSP sweet potatoes in the study area between 2010/2011 and 2013/2014 farming season. The area used by these farmers that grew sweet potatoes ranged between 0.25-5 hectares. The first category of 83.9% grew OFSP on land between 0.25 to 0.9 hectares. The other 11.9% used between 1.0-5.0 hectares and 4.2% used more than 5.1 hectares.

5.36. Size of smallholder farmers' land used for OFSP and other crops

During the four years of this research, of the OFSP, the same areas the farmers had been using for farming the previous years were used for the growing of the OFSP. The farmers owning smaller portions of land did not adopt easily because they needed to get land on rent to grow the OFSP. The renting of land could be a limiting factor to growing a lot of the OFSP in the area.

5.37. Productivity between traditional and OFSP

The farmers that grew both the traditional and the OFSP noted that the varieties of OFSP had higher productivity compared to the traditional ones when their harvest was compared from a similar portion of land. For example a line of 10 meters of OFSP would yield one 50 kg bag while the traditional varieties would take between 20 to 30 meters to fill the same 50kg bag. However the Chingovwa (Solwezi) variety which is not orange but yellow also had higher productivity just like the OFSP. When grown under same grown conditions. The OFSP had a productivity of 40 tons per hectare (Mudenda, 2012). This means the smallholder farmers can solve most of their household food security needs from the growing of the OFSP because they would sell for cash, exchange with other needed foods and indeed eat at different times of the day by different members of the families.

5.38. Challenge in the adoption and production cycle of OFSP

The challenges in the diffusion and adoption of the OFSP and in the growing cycle included lack of financial capital to buy vines reported by 29.7% of the respondents, difficult to preserve the roots after harvesting (49%), diseases and pests on both the leaves and roots (0.8%), the other 0.8% did not have enough land for them to be able to grow the OFSP. The other challenge represented by 0.8% was that households gave first priority to ploughing the fields for traditional crops like maize. This causes the planting of the OFSP to delay leading to low yields and sometimes the late maturing varieties like Zambezi did not even reach maturity. The others 12.0 % responded that the water for watering the vines during the dry season was another challenge. The 3.4% respondents said the test of the OFSP was also another challenge because it was not as sweet as the local varieties. The other challenge reported by 4.2 % was lack of extension services to the smallholder farmers on knowledge on how to deal with the problems of disease and pests.

The challenges faced by the respondents above were twofold: adoption and production. According to (Scoones, 1998 and Ellis, 2000) there is need to boost both physical like implements, access to enough land and financial capital to make it easy for the smallholder farmers to easily adopt the

OFSP. For those that production challenge, physical capital for preparing land early enough to plant, human capital for extension was needed in the area. The challenges are represented in Table 10.

5.39. Interventions to increase adoption and production

5.40. Training of the OFSP farmers

There were 93% respondents that had received training in the growing of the OFSP. The 7% respondents only used the minimum knowledge in the growing of sweet potatoes they had acquired through the growing of the other traditional varieties. Training was higher because the DVMs were equipped with training from the NGOs implementing the project and Agricultural Extension workers from Ministry of Agriculture and Livestock (MAL) first and in turn they trained the others. This could explain the low percentage respondents that gave a response of non-availability of extension workers.

Table 10: Challenges faced in the adoption and production cycle of OFSP

Challenges in the diffusion and adoption of OFSP	Frequency	Percentage
Lack of financial capital to buy vines	35	29.7
Difficult to preserve	58	49.1
Disease of pests, lack of land, test, land preparation	8	7.4
Water for dry season watering	12	10.2
No extension work	5	4.2
Total	118	100.0

5.41. Provision of vines

i. Triple S

This is a system of raising the OFSP vines through burying the sweet potato roots in the soil. These buried roots are then watered until they sprout and these sprouted vines are acquired for planting. This is a good way of raising vines but the challenge is keeping the roots till the planting season. This was said to be a sure solution in times when the small holder farmers have failed to raise vines through preservation in the garden (Mudenda, 2012).

ii. Vines from the greenhouses and the DVMs

This solution was given by the key informants from CIP, RICH and MAL. The continuous supply of vines from the greenhouses has been one sure way of providing planting materials of very high quality which were neither diseased nor already attacked by pests. The vines from the greenhouses yielded more than those from the previous crop: recycled vines. On the other hand however, more than 50% of the vines were supplied from the DVMs' gardens either by the cooperating partners that helped in the distribution to the new areas or by the farmers that bought from the DVM nearer to them.

5.42. Access to capital

According to Scoones, (1998), and Ellis, 2000) there were different types of capital in the livelihood framework analysis that can influence the adoption or lack of adoption of OFSP. These include: financial, physical and social capital. A total of 90% needed financial capital to buy the vines, hire labour and animal draft power for making ridges while 100% had physical capital like hoes, ploughs and the social relations in the production process. Social relations helped to acquire vines from those relatives that had the vines. Most important among the different types of capitals was natural capital (land). Individual smallholder farmers needed land to adopt the OFSP because most of the land was used for either staple food, cash crop or other subsidiary crops. If they needed to produce more for sell, they rented portions of land from those who had more land to spare.

5.43. Market linkages of traditional sweet potatoes and Marketing of the OFSP

Among the sample, 92.4% responded that they had no problems in the marketing of the OFSP because they sold within the village and sometimes in Petauke town and to traders from Chipata and Lusaka. The remaining 7.6% responded had some problems in the marketing of the crop because some of the roots got rotten because they could not sell them in good time after harvest. However barter system with maize was an alternative in the marketing process. The maize earned was either sold to FRA to earn an income or stored to boost food security through food availability.

5.44. Suggestions to improve the market of the OFSP

There were 94.9% respondents who said that the International Potato Centre should help find big market and the other 1.7% said the government needed to set up a market for sweet potatoes just like FRA is buying the maize. The other 2.5% suggested that the OFSP should be grown under the

out growers scheme so that whoever provides the vines and other inputs should be able to buy the crop. The last 0.8% respondents suggested that there should be more publicity through the radio on the advantages of integrating the OFSP in the diet of a household. Increased knowledge of vitamin A utilization would increase the market because people would want to access more of it. The is represented in Table 11.

5.45. Labour and timing for harvest

All the 118 respondents said the timing of the harvest of the OFSP is from May to June. This provides ample labour because many of the farmers would already have finished the harvest of the other traditional and cash crops. The household members are all engaged in the harvest. Sometimes when the smallholder farmers want to harvest a lot in a short time, they would hire people from the neighbourhood to help in harvesting. After they have helped in the harvest, they are usually paid either some OFSP or some money.

Table 11: Solutions to improve the OFSP marketing.

Solutions to improve the market OFSP	Frequency	Percentage
CIP to find market	112	94.9
Government to set market like FRA	2	1.7
Organization to buy trough out grower scheme	3	2.5
More publicity on radio on the importance of OFSP	1	.8
Total	118	100

At the time of harvest, there are plenty of vines that just go to waste. The owners of the fields do not restrict but those people helping during harvest do not take advantage to carry some of the vines to their gardens to start their own nurseries. The OFSP can be harvested the whole year grown in the garden during the dry season and the fields in the wet season, like 0.8% did. Most of these challenges in Petauke are similar to those in Tanzania (Keler, 2012). Below are Pictures showing some of the challenges the OFSP farmers face.

The pictures in Figure 14 are highlighting some of the challenges associated with the growing of the OFSP at different stages from planting to harvest. These challenges include among others poor quality planting vines, rotting of the roots, roots being eaten by the rodents, storage of the roots for future use either for food or Triple S. The other challenge is the cattle that seem to be free range

during the harvest period. These challenges lower production and quality of both roots and vines for the next planting season.

There was need to improve on the OFSP varieties to be disease resistant. The other improvement is on the care of the livestock like cattle so that it does not destroy the vines on the crop during growing and just before harvest. Storage of the OFSP is difficult because it rots easily so advanced preservation and processing would help the small holder farmers not to incur losses after harvesting.

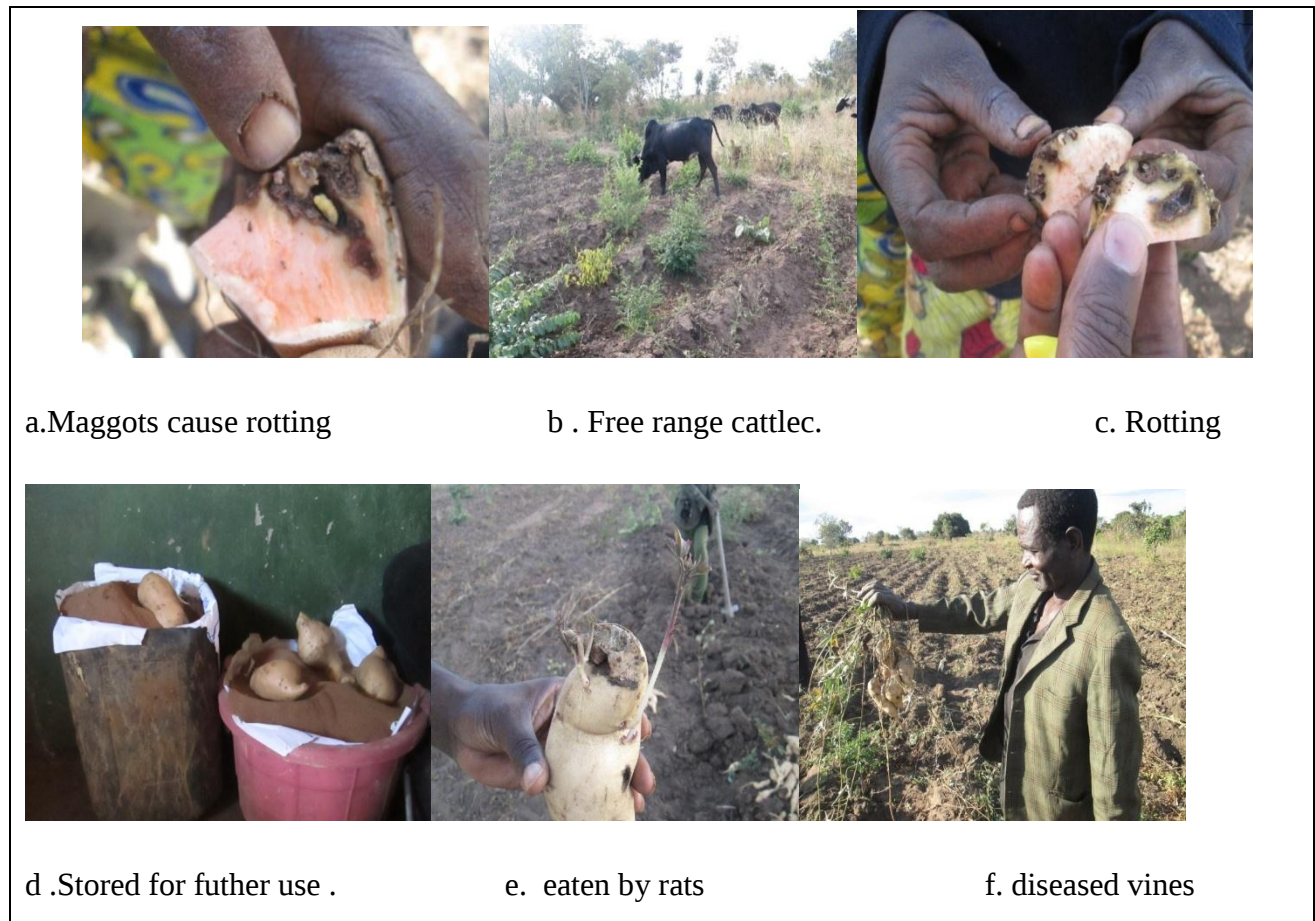


Figure14: Some challenges of the OFSP captured during harvest period.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

This chapter presents both conclusion of the results and the recommendations of the study to the different stakeholders based on the research objectives in the study.

6.2. Conclusion

The research had four objectives as follows: to establish the diffusion of the OFSP in Petauke District, to assess the contributions of the OFSP to household food security, to find out the livelihoods improvement for smallholder farmer households and to identify the challenges smallholder farmers faced in the growing of the OFSP. In this research all the four objectives were achieved.

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. There were small proportions of the agricultural land allocated to the OFSP. There were a lot of factors that influenced the adoption of the root crop which included availability of planting vines, financial capital to purchase the vine, knowledge about the utilization of the bio-fortified OFSP. The farmers that had adopted the OFSP had more options as they had diversification of crops under production for food security availability, accessibility and utilization when the crop was in season. The different livelihood capitals: physical, financial and social influenced in the adoptions of the OFSP and the livelihoods improved because they were able to earn some extra income from the sale of the OFSP to help them purchase other household requirements and pay their children's school fees.

There were, however, some challenges faced by smallholder farmers implementing the OFSP growing in the study area. In some cases the domesticated animals like cattle which were free range damaged the gardens and grazed the vines during the dry season. This led to shortage of planting vines leading to late planting and low yields. The other challenges were pests and diseases that negatively affected productivity of the OFSP. Short life span of storage time, (shelf-life) of the roots

reduced the food security availability because they rot easily. Marketing of the OFSP was also a problem for some of the farmer due to the same shelf life. Considering that OFSP was a subsidiary crop in the livelihoods in Petauke, with time bigger portions of land could be allocated to the crop by many farmers to improve food security and livelihoods as they enjoy the benefits that accrue.

6.3. Recommendations

1. The International Potato Centre should cooperate and collaborate more with the government established institutions at the province, district and camp level to reach out to as many farmers as possible to further the diffusion/adoption.
2. The International Potato Centre to continue advertisements on the radios for the message of utilization of vitamin A so that the farmers would get the essence for growing OFSP for both health and wealth.
3. The Decentralised Vine Multipliers should be given attractive incentives to encourage them to multiply more vines to supply to as many smallholder farmers as possible as are registered to adopt.
4. The International Potato Centre to continue supplying disease free vines to the new adopters in conjunction with Zambia Agriculture Research Institute from the greenhouses that yield more than the recycled diseased ones.
5. Health departments of the Zambian government to be engaged at different levels to advance utilization of vitamin A from the OFSP since it is a cheaper source because it is bio fortified.
6. There is need to heavily secure their gardens against the cattle during the dry season and effectively use Triple-S so that they can always have vines during the planting season.
7. Communal boreholes should be sank in the areas whose water tables go very low during dry season to enable the smallholder farmers (individually or co- operatives) to water the vines till rain season sets.

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APPENDICES

Appendix 1: Questionnaire on the Diffusion of the Orange Fleshed Sweet Potatoes (OFSP) and its Impact on Household Food Security and Livelihoods in Petauke District, Zambia

Dear respondent,

This interview is an academic one towards partial fulfilment of the Master of Science in Environmental and Natural Resources Management. The results of the research will be used for the purpose of the academics. The report results will create awareness or sensitize the province and the nation about the growing of the Orange Fleshed Sweet Potatoes and the benefits that accrue from this farming activity towards the socio-economics of the rural livelihood to enhance food security. The results of this study will also be shared/published with The International Potato Centre (CIP) the project implementing NGO. The results of this research will also be summarized for the people in the research area to know the findings. Therefore I ask you to be free and provide the responses required appropriately

Instructions to respondents: - Tick where there is a box and in case of a space, filling in appropriately). So please feel free to give your responses as accurate as possible.



Section A:

Household demographic information and basic farming history (bio data)

1a. Name of respondent..... 1.b Date of interview

2. Chief.....Village.....

3. Sex of household head; Male/Female 4. Age of house hold head.....years

5. Marital status Single/ married / divorced / separated /widowed **Tick one**

6.a. Household size _____

	Males	Females	Children
Working on the farm			
Total number			

7. Highest Educational attainment of head of the household.....

Lower basic, middle basic, upper basic, High School or Tertiary (tick) and indicate grade

8. How much land do you have in hectares?...

9. Total area for cultivation (all crops).....

10. Do you or any member of your household belong to any farmer association or club? Yes /No

If yes, specify the following		If no, explain why?
Number of household members involved		
Institutions involved		

11. Other occupation/livelihood activities apart from farming.....

Adoption and diffusion patterns of the Orange Fleshed Sweet Potato (OFSP) growing.

12a. Have you heard about OFSP? Yes/ No

b. If yes, through which media hear about the OFSP?.....

c. If no, explain reason.....

13. i. Do you grow OFSP? No/Yes.

ii. If yes, when did you adopt.....iii. If No, explain reason.....

14a. How easy/hard was it for you to start growing OFSP? Very easy / Easy / Difficult /Very difficult, **TICK ONE**

14. b Explain your answer in

15. How big is the portion of your land used for Orange Sweet Potatoes? (in meter squares use 100 metre tape).....

16. How much area was under sweet potatoes growing in the following growing seasons?

Year	2011/2012	2012/2013	2013/2014
Sweet potato grown area			

17. Please name the varieties of sweet potatoes that you have been growing?

18. For how long have you been growing the variety varieties in 17 above ?.....

19. Of the OFSP varieties you have, which one/s is/are your favourite?

20. List the characteristics you consider in ranking these OFSP varieties in the above question.....

21. a. Are you a Decentralized Vine Multiplier (DVM)? Yes ☐ No ☐

b. if yes then administer the DVM instrument. If NO continue normally with the questionnaire

22. Who is the source of your vines?.....

23. Which village did the vines come from before OFSP was introduced to your village?.....

24. After harvest do you preserve the vines for the following planting season after harvesting? Yes/ No. Explain

25a. Are you likely to continue growing the OFSP in the subsequent years? Yes ☐ No ☐

b. Explain your response_____

26. Complete the table below.

Variety	No. of month to maturity	preference of leaves for relish(indicate 1-5 with 1 as highest	Yield in 50 kg bags	Roots preference indicate on a scale of 1-5. 1 for the most preferred
Traditional				
Orange Chingovwa				
Zambezi				
Twatasha				
Olympia				
Kokota				
Kenya				
Chingovwa				

Disease and pests

27. What disease(s) usually attack your sweet potatoes? (Virus or bacterial) (Note: let the farmer describe the symptoms if they do not know the disease)_____

28. What chemical(s) do you use for either of the disease type you have mentioned above?

29. What type of pests do you encounter in your sweet potatoes fields? (Describe them)

30 a. Do you apply any chemicals to control the pests you mentioned above? Yes. / No

b.If yes what chemicals _____

c. If no give reasons. _____

31. Training received. Tick the one that trained you below.

MAL	CIP	RICH	Lead Farmer	Club

What training did you receive? _____

Socio-economic contribution of the orange sweet potatoes to the smallholder households in Nyampande and Kalindawalo area of Petauke district.

32. What has been your production of sweet potatoes during the time you have grown the crop?

Indicate the yields in kilograms, medas 50kg bags in the years below.

Variety	2010/2011	2011-2012	2012-2013	2013-2014
Traditional				
Orange Chigovwa				
Zambezi				
Twatasha				
Olympia				

Harvest time, marketing, transport and period sweet potatoes

Variety	time of harvest	marketing period	where is your market	Market(name and distance)	Mode of transport to market
Traditional					
OFSP					

32. Indicate the income from sweet potatoes in the years below.

	2010/2011	2011/2012	2012/2013	2013/2014
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Traditional				
OFSP				

33. What do you spend the income from the traditional Sweet potatoes/OFSP on?

34. i. Do you have any problems in the marketing of the OFSP? Yes ☐ No ☐

ii. Yes explain_____

35. What do you think should be done to improve OFSP marketing?

Seasonality/Preference

36. In what form do you eat your sweet potatoes?_____

37. How long are you able to use the traditional sweet potatoes/OFSP to maintain food security in your household?

38. If they do not suffice for the whole year what do you think is the problem?

39. Apart from sweet potatoes/ OFSP what other crops do you grow to enhance income and food security?

Cash crops						
Food crops						

Contribution of the OFSP to food security (availability, access and preference in Petauke.

40. Considering the time the OFSP are in season, how often do you eat sweet potatoes/ OFSP?

i. Every day _____

ii. Throughout the week _____

iii. Throughout the month _____

41. Which meal/s are OFSP generally served and/or preferred by your family members? Rate on a scale of 1 to 4. 1. Very strong 2. Strong 3.Weak 4. Very weak

	Breakfast	Lunch	Super	In Between Meals
All members of the family				
Pregnant women				

Children <5 yrs				
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42. Give reasons for the preference of the time of serving OFSP for the selected meal/s above to the different family members

- i. children below 5 years_____
- ii. Pregnant women_____
- iii. All family members_____

43. What could be the reasons for the times it is not served to

- i. children_____
- ii. Women_____
- iii. Men_____

To find out the challenges the farmer experience in the OFSP growing.

44. What challenges do you face in the growing cycle of OFSP?

45. What do you think should be done to overcome these challenges in the question above

Thank you very much for your patience. I appreciate your listening to me and answering all my questions. God bless you.

Appendix 2: Focus group discussion for selected OFSP Smallholder farmers in the village

1. Group/village

2. What type of sweet potatoes do you grow?

3. When did you start growing the OFSP?

4. Who introduced you to the growing of OFSP? How was it?

5. How did you get convinced/ not convinced to grow Orange Fleshed Sweet Potatoes?

6. Have you received any training on the growing of OFSP? If yes explain from which organization?

7. Complete the table.

Variety of sweet potatoes	total land used	period grown	source of vines	vines (adequate or inadequate)
traditional				
Orange fleshed				

8. Are you satisfied with the total area of sweet potatoes you grew. Yes/No, Comment.

9. Labour. Supply the information for the table below.

Agronomic activity	Land preparation	Weeding	Harvesting
Duration days/month			
Male			
Female			
Children			

10. After harvest, how long are you able to use the OFSP to meet your household food needs?

11. Complete the following table.

Growing season/year	2009/2010	2010/2011	2011/2012	2012/2013
Total harvest in 50 bag kilograms				
Amount earned from sales				

12. What benefit do you have in growing OFSP? (food security, financial income)
13. What are the major problems you have faced since you adopted the growing of OFSP?
14. When you consider the benefits and the problems what is your comment on the future of growing OFSP in your household?
15. What is your message to CIP concerning the OFSP growing?

Thank you for your time and the information that you have shared with me. God bless you all.

Appendix 3: Interview Guide for the District Agricultural Office.

- i. Origin of OFSP in Petauke district
- ii. What is the extent of diffusion of OFSP in Petauke district/Nyamphande area?
- iii. What Impact has OFSP on production of other crops in the area?
- iv. What is the impact of OFSP on households in Petauke/ Nyamphande?
- v. How much extension work do you do with the farmers of sweet potatoes/ OFSP?
- vi. How much do you Collaborate with the International Potato Centre (ICP) and its agents like Rural Initiative for children's Hope (RICH)
- vii. What Challenges (barriers) are there in the diffusion/adoption and implementation by your office
- viii. What challenges do the farmers face in the implementation of the intervention?
- ix. How can the challenges be overcome?
- x. What is your comment on the OFSP and contribution to food security?

Appendix 4: Interview Guide for Rural Initiative for Children's Hope Coordinator

- i. How long have you worked with the OFSP farmers of Nyamphande or Kalindawalo?
- ii. How many Smallholder farmers of OFSP are you working with?
- iii. What methods are there for the OFSP growing?
- iv. What barriers are there in the diffusion/adoption of OFSP?
- v. What do you think could be done to overcome the barriers?
- vi. What are you doing Promote OFSP in Petauke?
- vii. What incentives are there for the DVMs?
- viii. How do you collaborate with the MAL and CIP?
- ix. How long does the OFSP give food security to the farmers in Petauke?

Appendix 5: Interview Guide for Ministry of Agricultural and Livestock Extension Officer (Camp Officer)

1. Where is the origin of OFSP in your area
2. How many Smallholder farmers have adopted OFSP in Petauke: Chief Nyamphande and kalindawalo in South Nyamphande 11 and Kawere agricultural camps?
3. How often do you visit the OFSP farmers?
4. How much knowledge do you have on the OFSP?
5. What is the extent of diffusion/Adoption of OFSP in the Farming block?
6. What barriers are there in the diffusion of OFSP?
7. What are the diffusion patterns of OFSP in your Farming block
8. What are some of the difficulties/barriers do you have in the diffusion of the OFSP?
9. What measures are there to overcome barriers to diffusion/adoption of OFSP?
10. How can you rate OFSP and the traditional varieties people have been growing in your area?
11. What incentives are given to the OFSP farmers in your area?
12. How much collaboration do you have with the CIP in your farming block

Appendix 6: Interview guide for Decentralised Vine Multipliers of Orange Fleshed Sweet Potato

- i. How many farmers are under you?.....
- ii. What type of sweet potatoes do you grow in your area?(estimate both the traditional and OFSP)?.....
- iii. What are the average areas under sweet potato growing for the farmers you are working with?.....
- iv. How long have you practiced sweet potato/OFSP growing?.....
- v. Have you received any training on the OFSP growing? If yes explain.....
.....
- vi. Any extension work received in the area concerning the growing of the sweet potato/OFSP.....
- vii. Mention the organization/s you have been working with in the diffusion/diffusion of OFSP.....
- viii. How is the OFSP growing organized in this area?.....
- ix. How do you preserve the vines for the next farming season?.....
- x. How readily available are the OFSP vines for the farmers under you?.....
- xi. How many farmers did you manage to supply vines in your area?.....
- xii. What have been the timings for your farmers receiving the vines?.....
- xiii. What challenge do you have as a DVM?.....
- xiv. What is the best planting time for the sweet potatoes?.....
- xv. Which varieties yield more: traditional or the OFSP?.....
- xvi. What barriers exist in your area to the adoption and diffusion of OFSP.....
- xvii. What Problems are encountered by OFSP farmers?.....
- xviii. What are the benefits of being a DVM?.....
- xix. What in your view should be done to enhance the integration of the OFSP in your area?.....
- xx. What is the role of DVM in the growing of the OFSP?.....
- xxi. Did all the people that had indicated to adopt receive the vines? YES/NO
Comment: