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EXECUTIVE SUMMARY

Bio-fortified crops have been identified as an effective approach to mitigate micro-nutrient deficiency which currently affects more than half of the global population mostly in low income countries. In Zambia, Vitamin A Deficiency (VAD) is one of the most common micro-nutrient deficiencies and remains a major concern affecting mostly children and women in rural households. These households are primarily small holders who entirely rely on their own farm production for food provisions. Thus, for bio fortification to have significant effect on reducing VAD, these vulnerable households need to adopt the technology. However, in Africa, evidence on the adoption of bio-fortified crops has been mixed. Studies done in project areas using cross sectional data have highlighted relatively high adoption rates of bio-fortified crops, while studies that have used nationally representative cross sectional data have shown high adoption rates for some bio-fortified crops while very low rates for others.

Using a three-wave nationally representative panel dataset (covering the 2010/11, 2013/14, and 2017/18 agricultural seasons), this study sought to shed more light on the adoption of orange-fleshed sweet potatoes (OFSP) in Zambia. OFSP is one of the bio-fortified crops that was developed to mitigate VAD and was promoted in Eastern Province of Zambia. The key question addressed in the study is: what is the adoption, dis-adoption and non-adoption rate of OFSP among sweet potato-producing households in Zambia? Adoption of OFSP in this study is defined as farmers growing orange fleshed sweet potatoes as a percentage of farmers growing any type of sweet potato (i.e., white/yellow/orange fleshed sweet potatoes) in a given survey year. Dis-adoption is defined as the percentage of sweet potato growing farmers who were growing OFSP in the previous survey year but had discontinued growing them in a given survey year, and non-adoption is defined as the percentage of sweet potato growing farmers who had not grown OFSP in the survey year and previously.

The study highlights three major findings. Firstly, at the aggregate level, it shows low adoption and high non-adoption rates of OFSP among sweet potato-growing households in Zambia. The adoption rate ranged from 2.0% in 2010/11 to 4.4% in 2017/18 while the non-adoption rate declined from 98.0% to 94.1% over the same period. Secondly, the study shows that in Project Districts from the four Provinces (Central, Eastern, Luapula and Northern Provinces) and the Zone of Influence districts of Eastern Province where the Integrated Orange-Fleshed Sweet Potato Project was implemented, the rate is considerably higher, but adoption has plateaued at levels referred in Roger's adoption curve as innovators and early adopters. The observed rates of adoption in Project Districts in the three survey years was 4.6%, 6.5% and 7.4% respectively. The rate of adoption of OFSP in the Zone of Influence districts of Eastern Province in the three survey years was 15.3% in 2010/11, 9.9% in 2013/14 and 11.8% in 2017/18. Thirdly, the study finds no sustained adoption of OFSP in Zambia, even in the Project Districts from Central, Eastern, Luapula and Northern Provinces and also in the Zone of Influence Districts of Eastern Province where it was intensively promoted. In other words, farmers who were growing OFSP in a given survey year were reporting not growing this variety anymore in the following survey rounds. This is the most disturbing finding and raises concerns about the sustainability of OFSP promotion efforts.

The evidence of overall low adoption of OFSP over the six years since it was promoted in Zambia also indicates that the farmer-to-farmer dissemination of this new variety is a slow process. Dissemination of OFSP as a public health strategy to increase dietary vitamin A intake will require concerted and continued efforts across wide geographies to reach a critical number of farmers who will adopt these varieties and make them part of their cropping system like the traditional white and yellow fleshed sweet potato varieties. Designing a strategy to achieve this goal requires better understanding of reasons behind low adoption, high non-adoption, and no sustained adoption. We therefore propose a follow-up exercise to conduct in-depth interviews with adopting, dis-adopting, and non-adopting households in some selected districts. In addition, interviews with key informants and focus group discussions could also be conducted to better understand constraints to adoption of bio-fortified orange fleshed sweet potato.

Key words: Orange-Fleshed Sweet Potatoes, Adoption and Diffusion, Zambia.

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LIST OF ACRONYMS

CHW	Child Health Week
CIP	International Potatoes Centre
FAO	Food Agriculture Organization
FGDs	Focus Group Discussions
FTF	Feed the Future
NGOs	Non-Governmental Organization
OFSP	Orange-Fleshed Sweet Potato
RALS	Rural Agricultural Livelihoods Survey
SEAs	Standard Enumeration Areas
SPSS	Statistical Package for the Social Sciences
VAD	Vitamin A Deficiency
WHO	World Health Organization
ZARI	Zambia Agricultural Research Institute

1. INTRODUCTION

Micronutrient deficiencies afflict more than two billion individuals globally (FAO et al., 2013). This public health challenge affects an estimated 190 million preschool-aged children in Africa and South-East Asia (WHO 2009, Hannah and Roser 2019). Women and children are particularly vulnerable to micronutrient deficiencies because of their unique physiological needs and socioeconomic characteristics (MoH 2017). Vitamin A deficiency is one of the most common micronutrient deficiencies across the globe (WHO 2011). In Zambia, the focus of this study, approximately 26% of children 5 years and below are vitamin A deficient (NFNC 2014).

Several approaches have been developed to help tackle the problem of micronutrient deficiency among children and women. These include provision of vitamin A supplements every 4 to 6 months yearly to children under 5 years of age, and selling micronutrient-fortified foods such as sugar (WHO 2009). Though these efforts are helping, there are still challenges related to reaching some rural children and women because of inadequate facilities. Further, the majority of rural households cannot afford to buy fortified foods due to lack of purchasing power (Meenakshi et al. 2010). Production and consumption of bio-fortified crops has been identified as another method that can help fight micronutrient deficiencies in children and women (Mica et al. 2015, De Brauw et al. 2018). For this method to be effective, rural households have to first adopt and use the bio-fortified crops. A key example of a bio-fortified crop rich in vitamin A is orange-fleshed sweet potato (OFSP).

A number of studies have been done to assess the adoption of bio-fortified crops (Vaiknoras et al. 2019, De Brauw et al. 2018, Labarta et al. 2012, Kaguongo et al. 2010, Muzeza 2004). Studies conducted in project areas where OFSP has been actively promoted have generally found high adoption rates after the end of a project. Adoption rates in such project areas have ranged from 38% to as high as 70% for OFSP (Kaguongo et al. 2010, Muzea 2004; De Brauw et al., 2018). For OFSP to play an important role as a public health strategy to increase dietary vitamin A intake, the dissemination of information about this technology beyond the targeted project areas is critical. Thus, for tracking and monitoring the scale of diffusion of bio-fortified crops over time and across countries, a more appropriate method is estimating its adoption using nationally representative surveys. Thus far, few studies have estimated the adoption of bio-fortified crops at the country level based on nationally representative data. One such study was by Labarta et al. (2012) who found the adoption rate of OFSP in Rwanda to be 0.1% in 2007 while the same report found the adoption rate of OFSP in Uganda to be 9% in 2009. Similarly, using data from a representative survey in Rwanda, Vaiknoras et al. (2019) found that the adoption rate of iron rich beans was 6% in the early years of introduction of the technology to as high as 23% in 2015. In both studies, these national level adoption rates were estimated few years after the bio-fortified crops were introduced in the country, and thus represent early adopters/innovators on Roger's (1983) diffusion curve. Both previous studies on the adoption of bio-fortified crops used nationally representative cross-sectional data that gave a snap-shot of

adoption for one time period. They could not identify sustained adopters and dis-adopters, which is of interest in understanding the early diffusion of a new technology.[1]

This study contributes to the literature on adoption of OFSP (and of bio-fortified crops more broadly) by using a three-wave nationally representative panel dataset (covering the 2010/11, 2013/14, and 2017/18 agricultural seasons) to estimate adoption, dis-adoption, non-adoption, and sustained adoption rates of OFSP among sweet potato-growing households in Zambia over a seven year period since it was introduced and actively promoted in 2011.

The paper is organized as follows: Section 2 discusses the development of OFSP and its promotion in Zambia. Section 3 describes the dataset and the methods, section 4 presents the results and section 5 highlights the conclusions and recommendations.

[1] The adoption and non-adoption rates for iron beans were determined based on the retrospective questions in Vaiknoras et al. (2019).

2. DEVELOPMENT AND PROMOTION OF ORANGE-FLESHED SWEET POTATO IN ZAMBIA

To counteract the problem of high Vitamin A Deficiency (VAD) in Zambia, several approaches or methods have been used. The Government of the Republic of Zambia has a programme called Child Health Week (CHW), which is a bi-annual programme through which child health and nutrition interventions such as vitamin A supplementation, de-worming and vaccinations to children 5 years and below are implemented. Other interventions to fight VAD include a law that compels sugar producing companies in Zambia to fortify sugar for human consumption with vitamin A. Other interventions that are promoted in Zambia include the development, production and consumption of bio fortified crops such as pro vitamin A maize and OFSP, among others. Staple crops are targeted by bio-fortification efforts because they often have low micronutrient density and are consumed in large quantities by a large proportion of resource-poor populations (Talsma et al. 2017). In Zambia, maize and sweet potatoes are grown by about 90% and 16% of the rural households, respectively (Chapoto et al. 2015). Given that the focus of this study is to understand the adoption of OFSP, the next paragraph highlights the development of this crop and its promotion in Zambia.

The Zambian Government working with United States Agency for International Development (USAID) through the Feed the Future (FTF) Initiative funded the International Potato Centre (CIP) and the Integrated Orange Fleshed Sweet Potatoes program under the Zambia Agricultural Research Institute (ZARI) of the Ministry of Agriculture to breed and promote the use of OFSP. Multiplication of OFSP disease free vines started around 2010/11 agricultural season. The OFSP vines were supposed to be integrated in the farming systems of farmers in order to improve OFSP production, conservation, and utilization techniques and improve the nutrition status of farmers. To achieve this, the project identified partners[2] (relevant government departments, NGOs and private stakeholders) to work on the promotion of orange fleshed sweet potatoes and distribution of the vines. According to ZARI, OFSP was promoted in 5 districts of Eastern Province[3], Kapiri Mposhi of Central Province, Mansa of Luapula Province and Luwingu and Mbala of Northern Province. By 2014, the project had reached out to 17,800 rural households with improved orange-fleshed sweet potatoes in Eastern Province (Mueller et al. 2012). Beyond this targeted region, the information and even planting materials (vines) might have been passed to farmers in other provinces by some partners that were involved in the promotion and distribution of OFSP as some have operations in other provinces.

[2] Agribusiness in sustainable Natural African Plant Products (ASNAPP), Arulussa Farm Community Markets for Conservation (COMACO), Chipata District Multi-Sector Nutrition Committee (CDNMC), Care International, CARITAS, Catholic Relief Services – Mawa, Conservation Farming Unit (CFU), Covenant College, Development Aid from People to People in Zambia, Every Home for Christ (EHC), Golden Valley Agricultural Trust (GART), HarvestPlus, International Institute of Tropical Agriculture (IITA), Kennedy Kaunda Foundation, Ministry of Agriculture and Livestock (MAL), Ministry of Community Development, Mother and Child Health, National Food and Nutrition Commission, Organic Producers and Processors Association of Zambia, Peace Corps, Rising Fountains Development Program, Rural Initiative for Children's Hope Foundation (RICH), Women in Agri-business in Sub Sahara Africa Alliance (WASAA)

[3] Chadazi, Chipata, Katete, Lundazi, Petauke/Sinda

3. DATA AND METHODS

3.1 Data

The Rural Agricultural Livelihoods Survey (RALS) is a three-wave nationally representative panel survey conducted in 2012, 2015, and 2019. The sampling frame for the RALS 2012 survey was based on the 2010 Census of Housing and Population. A stratified two-stage sample design was used for the RALS 2012 sampling. The first stage involved identifying the Primary Sampling Units (PSUs). The PSU refers to a Standard Enumeration Areas (SEAs) and has a minimum number of 30 agricultural households. The SEA is the smallest area with well-defined boundaries identified on census sketch maps. At the second stage, all households in selected SEAs were listed and agricultural households identified. Listed agricultural households were then stratified into three categories, A, B, and C, on the basis of total area under crops, presence of some specified special crops (not including OFSP), number of cattle, goats and chickens raised, and sources of income. Systematic random sampling was then used to select 20 households distributed across the three strata in each SEA.

The total sample number of households interviewed in 2012 was 8,840 households. Of these, 7254 households were re-interviewed in 2015. Furthermore, an additional 680 households were interviewed in 2015, which brought the total number of households surveyed in 2015 to 7,944. In 2019, there were 7121 households that were re-interviewed and of those, 6,254 households were panel HHs that had been interviewed in all three waves 2012, 2015, and 2019. The balance 592 households were new households that were added in 2015 and re-interviewed in 2019 (i.e., they represent two year panel for the most recent years) (Table 1).

Table 1: Distribution of households interviewed, by province (Unweighted)

	Total households in 2012	New households in 2015	Re-interviewed households in 2015 (excluding new households)	Re-interviewed panel households in 2019
Central	840	0	650	554
Copperbelt	680	0	549	486
Eastern	2000	340	1723	1875
Luapula	840	0	692	606
Lusaka	360	160	286	397
Muchinga	680	180	537	670
Northern	1000	0	791	702
North Western	640	0	516	478
Southern	1040	0	893	804
Western	760	0	617	549
National	**8,840**	**680**	**7,254**	**7,121**

Source: RALS 2012, 2015 and 2019

Statistics presented onwards in this report are weighted to produce representative provincial estimates and district estimates in Eastern Province. Therefore, the data are expected to yield reliable estimates of adoption of OFSP at national, provincial levels, as well as at district level for Eastern Province. Table 2 below shows the number of sweet-potato growing households

during the 2010/11, 2013/14 and 2017/18 agricultural seasons (see Appendix 1 for unweighted statistics). There were 253,940, 234,976, and 276,320 households that grew sweet potatoes in 2010/11, 2013/14 and 2017/18 agricultural seasons respectively. Among those, 4,959, 10,563 and 12,056 households at national level grew orange fleshed sweet potatoes in 2010/11, 2013/14 and 2017/18 agricultural seasons.

Table 2: Number of households growing sweet potatoes[4] (weighted)

	HHs that grew sweet potatoes			HHs that grew OFSP		
	2010/11	2013/14	2017/18	2010/11	2013/14	2017/18
Central	36,326	35,277	41,327	186	1,570	38
Copperbelt	25,565	21,461	23,289	-	623	51
Eastern	10,010	8,251	9,525	1,808	906	1,278
Luapula	33,081	42,193	44,954	1,177	1,043	773
Lusaka	8,735	7,569	5,990	330	320	638
Muchinga	26,401	19,360	21,950	43	1,351	2,679
Northern	39,063	20,356	32,648	280	1,926	3,322
North Western	19,348	24,149	22,069	-	696	40
Southern	43,929	42,068	47,945	1,134	2,085	2,994
Western	6,522	3,729	14,566	-	42	242
National	**248,981**	**224,413**	**264,264**	**4,959**	**10,563**	**12,056**

Source: RALS 2012, 2015 and 2019. Note:

3.2. Methods

Descriptive statistics were generated using SPSS to estimate the rates of adoption, dis-adoption and non-adoption of OFSP in a ZARI project districts[5], in the zone of influence districts[6] from Eastern Province and national at large.

[4] Sweet potato means growing white and/or yellow and/or orange fleshed sweet potatoes

[5] Projects districts where OFSP was intensively promoted by ZARI were Kapiri Mposhi (Central Province), Chadiza, Chipata, Katete, Lundazi, Petauke (Eastern Province), Mansa (Luapula Province), Luwingu, and Mbala (Northern Province)

[6] Project districts where orange-fleshed sweet potato was intensively promoted were Chipata, Katete, Lundazi, Nyimba and Petauke districts.

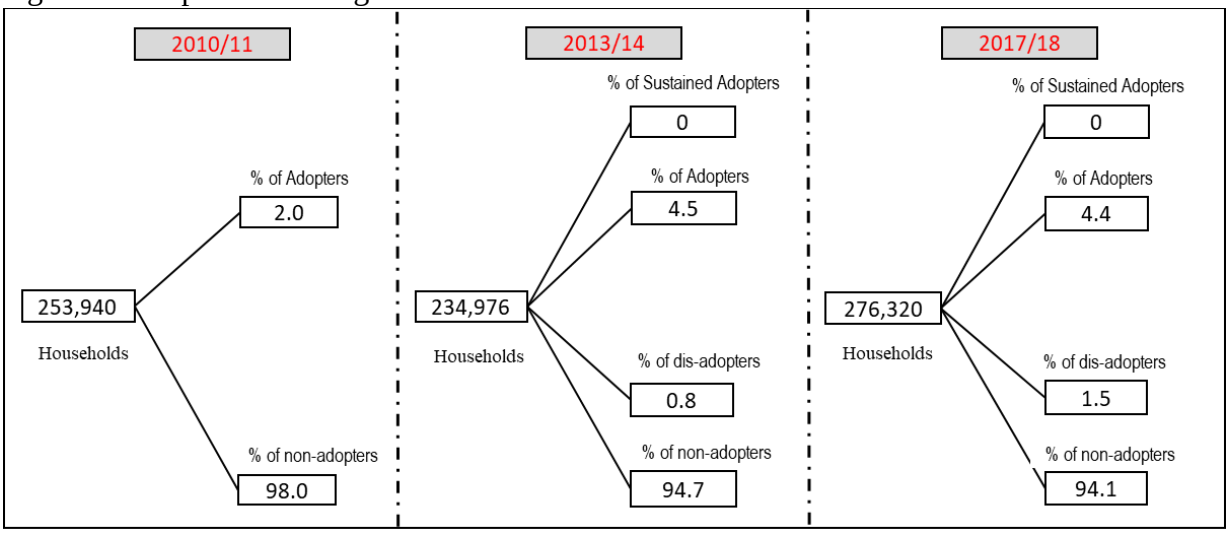
4. RESULTS AND DISCUSSIONS

4.1 Adoption rates of orange-fleshed sweet potatoes

This section presents descriptive results about the adoption, dis-adoption and non-adoption of OFSP in Zambia in general as well as in project districts[7] and non-project districts within Eastern Province, in particular.

There are over 1.5 million rural households in Zambia whose main activity is agriculture and about 11%, 19%, 10% and 12% are found in Central, Eastern, Luapula, and Northern Provinces respectively. Several crops are grown by these rural households in Zambia. According to Chapoto et al. 2015, sweet potato production is among the top five crops grown by rural farmers. It ranks number five after maize, groundnuts, cassava and mixed beans. About 16% of rural households grow sweet potatoes in Zambia. Of the total sweet potatoes rural household growers, 22%, 4%, 29% and 12% are found in Central, Eastern[8], Luapula and Northern Provinces. (Chapoto et al. 2015).

Figure 1: Adoption of Orange fleshed Sweet Potatoes in Zambia



Source: RALS 2012, 2015, 2019

Notes: The number of households refers to the total number of sweet potato-growing households in the sample for each survey wave (be it OFSP and/or other types of sweet potato). Dis-adopters refers to households that planted OFSP as of the previous survey but did not plant it as of the current survey. Non-adopters refers, in 2010/11, to households that did not plant OFSP that year; in 2013/14 and 2017/18, non-adopters refers to households that did not plant OFSP in that year or the previous survey year. There were no households in the sample that planted in OFSP in more than one survey round. Percentages calculated with population weights applied.

Figure 1 presents results on the adoption of OFSP which is computed on a sampling frame of all households growing sweet potatoes. Results show that at an aggregate national level, the level of

[7] Project districts of orange fleshed sweet potato promotion was in 5 of the 7 districts of Eastern Province namely Chipata, Katete, Lundazi, Nyimba and Petauke districts.

[8] This percentage represents about 9,200 sweet potato growing households in Eastern Province while the USAID Feed the Future Sweet Potato project supported about 17,800 rural households by giving them OFSP planting vines during the 5 years project period (2011- 2015). This number is more than double the number of farmers that grow sweet potatoes in Eastern Province.

adoption of OFSP in Zambia was 2.0%, 4.5% and 4.4% in 2010/11, 2013/14 and 2017/18 respectively. For the overall country, this represents early stages of adoption on Roger's diffusion curve (Roger 1983). Interestingly, the results show no households in the sample that planted OFSP in more than one survey round as indicated by the 0% sustained adoption figures with RALS 2015 and RALS 2019 datasets. This implies that, there were many OFSP farmers that dis-adopted growing orange fleshed sweet potatoes after growing at least in one year. Of the farmers that planted OFSP in 2010/11 and 2013/14 agricultural seasons, 0.8% and 1.5% stopped growing OFSP varieties, respectively. Ideally the percentage of dis-adopters for 2013/14 and 2017/18 agricultural years should be the same as the percentage of adopters in the previous survey rounds. But due to attrition (i.e., non-contacts with some of these households) this percentage is smaller than the percentage of adopters in the previous round as shown in Figure 1.

4.2 Adoption of orange-fleshed sweet potatoes by Province

The OFSP varieties were developed by the Ministry of Agriculture, Zambia Agricultural Research Institute (ZARI) working with the International Potato Centre and the University of Zambia. In its promotion of OFSP activities, ZARI worked with a variety of NGOs[9] of which some had operation activities in beyond the Project Districts Kapiri Mposhi of Central Province, Chipata, Katete, Lundazi, Sinda, Petauke of Eastern Province, Mansa of Luapula Province, and Luwingu, Mbala of Northern Province. This approach might have led to the spread of OFSP in other provinces beyond these Project districts where it was more actively promoted. The adoption rate of OFSP by provinces is shown in Table 3.

The results show that the diffusion of OFSP is still at very early stages or not yet taken off in many parts of the country. The adoption of OFSP in 2010/11 agricultural was highest in Eastern Province at 15.3%, followed by Lusaka and Luapula Provinces at 3.6% and 3.4% respectively. This is due to the fact that the Eastern Province had more targeted districts under which orange fleshed sweet potatoes was promoted. The promotional programme started in 2010/11 agricultural season. However, in 2013/14 agricultural season, Eastern Province still remained a province with the highest adoption rate at 9.9% even though the adoption rate declined from the level (15.3%) it was in 2010/11 agricultural season. This was followed by Northern and Muchinga Provinces at 8.6% and 6.5% adoption rates respectively. The provinces with the least adoption rate in 2013/14 agricultural season was Western Province at 1.1%. In 2017/18 agricultural season, the number of orange fleshed sweet potato adopters at the national level declined slightly to 4.4% from 4.5% in 2013/14 agricultural season. However, Eastern Province

[9] Agribusiness in sustainable Natural African Plant Products (ASNAPP), Arulussa Farm Community Markets for Conservation (COMACO), Chipata District Multi-Sector Nutrition Committee (CDNMC), Care International, CARITAS, Catholic Relief Services – Mawa, Conservation Farming Unit (CFU), Covenant College, Development Aid from People to People in Zambia, Every Home for Christ (EHC), Golden Valley Agricultural Trust (GART), HarvestPlus, International Institute of Tropical Agriculture (IITA), Kennedy Kaunda Foundation, Ministry of Agriculture and Livestock (MAL), Ministry of Community Development, Mother and Child Health, National Food and Nutrition Commission, Organic Producers and Processors Association of Zambia, Peace Corps, Rising Fountains Development Program, Rural Initiative for Children's Hope Foundation (RICH), Women in Agri-business in Sub Sahara Africa Alliance (WASAA)

adoption rate rebounded and had the highest adoption rate at 11.8%, followed by Muchinga, Lusaka, Northern and Southern Provinces at 10.9%, 9.6%, 9.2% and 5.9% respectively. The province with the least adoption rate was Copperbelt at 0.2%. There were four provinces that recorded a decline in the rate of farmers adopting OFSP in 2017/18 agricultural season and these were; Central (-4.2%), Copperbelt and North Western (-2.6%), and Luapula Provinces (-0.7%) respectively. The decline in percentage of farmers that planted OFSP was highest in the Central, Copperbelt and North Western Provinces at -4.2% and -2.6% respectively. On the other hand, Lusaka, Muchinga, Northern, Southern and Western Provinces recorded a higher adoption rates in 2013/14 than 2010/11 agricultural seasons and 2017/18 than 2013/14 agricultural seasons respectively (Table 3). The decline in the number of farmers adopting OFSP in 2017/18 agricultural season in Central and Luapula Provinces was low despite having 1 project district in each province. This shows that diffusion of OFSP technology was seldom taking place.

Table 3: Percent of sweet potato-growing households that planted OFSP by Province

	2010/11		2013/14		2017/18	
	Sweet potato growing HHs	% who planted OFSP	Sweet potato growing HHs	% who planted OFSP	Sweet potato growing HHs	% who planted OFSP
Central	36,512	0.5	36,848	4.3	41,366	0.1
Copperbelt	25,565	0.0	22,084	2.8	23,341	0.2
Eastern	11,818	15.3	9,157	9.9	10,803	11.8
Luapula	34,259	3.4	43,236	2.4	45,727	1.7
Lusaka	9,065	3.6	7,888	4.1	6,628	9.6
Muchinga	26,444	0.2	20,711	6.5	24,629	10.9
Northern	39,343	0.7	22,283	8.6	35,970	9.2
North Western	19,348	0.0	24,845	2.8	22,110	0.2
Southern	45,064	2.5	44,153	4.7	50,938	5.9
Western	6,522	0.0	3,770	1.1	14,808	1.6

Source: RALS 2012, 2015 2019

Notes: N refers to the total number of sweet potato-growing households in the sample for each survey wave (be it OFSP and/or other types of sweet potato). Percentages calculated with population weights applied.

4.3 Adoption of OFSP in Project Districts and Non-Project Districts of Zambia

As highlighted in chapter 4.2, Zambia Agricultural Research Institute (ZARI), International Potato Centre and the University of Zambia seriously promoted OFSP in 9 districts of 4 provinces of the Republic of Zambia.

Table 4 below shows the adoption, dis-adoption and non-adoption rates of OFSP in the Project Districts and the Non-Project Districts as a percentage of total sweet potato growers in Project Districts and Non-Project Districts and in a given year respectively. Results show that about 4.6%, 6.5% and 7.4% of the sweet potato farmers planted OFSP in the Project Districts in 2010/11, 2013/14 and 2017/18 agricultural seasons respectively. This shows a growth rate of 61% in farmers planting OFSP from 4.6% in 2010/11 to about 7.4% in 2017/18 agricultural season. The adoption rates of OFSP in non-project districts are 2.1%, 4.3% and 2.8% in 2010/11,

2013/14 and 2017/18 agricultural seasons respectively. The growth rate of 33% in farmers planting OFSP was recorded from 2010/11 to 2017/18 agricultural season. The difference in growth rates between the Project Districts and the Non-Project Districts shows the effect of the project interventions in promoting the production of orange fleshed sweet potatoes.

Table 4: Adoption of OFSP in ZARI Project and Non-Project Districts of Zambia

	Project Districts[10]			Non-Project Districts		
	2012 (N=36,938)	2015 (N=28,829)	2019 (N=36,106)	2012 (N=84,994)	2015 (N=82,695)	2019 (N=97,760)
	----------%----------					
% Sustained Ad		0	0		0	0
% Adopters	4.6	6.5	7.4	2.1	4.3	2.8
% Dis-adopters	0.0	1.2	3.2	0.0	1.3	1.7
% Non-adopters	95.4	92.2	89.4	97.9	94.4	95.5

4.4 Adoption of OFSP in Zone of Influence[11] and Non-Zone of Influence Districts of Eastern Province

Eastern Province was the province with more districts where the production of OFSP was promoted in Zambia. Unlike Central Province with 1 district, Luapula Province with 1 district, and Northern Province with two districts, Eastern province had 5 districts where which OFSP was promoted. However, Chadiza and Mambwe districts are the two districts that did not receive any promotional activities for OFSP.

Table 5 below shows the adoption rates of OFSP in the Zone of Influence Districts and the Non-Zone of Influence Districts of Eastern Province. Results show that about 15.8%, 11.8% and 13.2% of the sweet potato farmers planted OFSP in the Zone of Influence Districts in 2010/11, 2013/14 and 2017/18 agricultural seasons respectively. The adoption rates of OFSP are higher in Zone of Influence Districts than the adoption rates of OFSP in Non-Zone of Influence Districts of Eastern Province. They are higher by 4.1%, 11.8% and 9.1% in 2010/11, 2013/14 and 2017/18 agricultural seasons respectively. These differences show the effect of the promotion of OFSP production in the Zone of Influence districts compared to Non-Zone of Influence Districts.

[10] 9 Project districts include: Kapiri Mposhi (Central Province), Chipata, Katete, Lundazi, Sinda, Petauke (Eastern Province) Mansa (Luapula Province), Luwingu, Mbala (Northern Province).

[11] Zone of Influence districts: These are districts where the USAID Feed the Future Initiatives were promoted. One of those was promotion of orange fleshed sweet potatoes (OFSP).

Table 5: Adoption of OFSP in Zone of Influence and Non-Zone of Influence Districts of Eastern Province

	ZOI Districts			Non-ZOI Districts		
	2010/11 (N=10406)	2013/14 (N=7689)	2017/18 (N=9202)	2010/11 (N=1412)	2013/14 (N=1469)	2017/18 (N=1601)
	----------%----------					
% Sustained Ad		0	0		0	0
% Adopters	15.8	11.8	13.2	11.7	0	4.1
% Dis-adopters	0	4.6	7.2	0	0	0
% Non-adopters	84.2	83.6	79.6	88.3	100	95.9

Source: RALS 2012, 2015, 2019

Notes: N refers to the total number of sweet potato-growing households in the sample for each survey wave (be it OFSP and/or other types of sweet potato). Dis-adopters refers to households that planted OFSP as of the previous survey but did not plant it as of the current survey. Non-adopters refers, in 2010/11, to households that did not plant OFSP that year; in 2013/14 and 2017/18, non-adopters refers to households that did not plant OFSP in that year or the previous survey year. There were no households in the sample that planted in OFSP in more than one survey round. Percentages calculated with population weights applied. The Zone of Influence Districts of orange fleshed sweet potato promotion were in 5 of the 7 districts of Eastern Province namely Chipata, Katete, Lundazi, Nyimba and Petauke districts. The two Non-Project Districts are Chadiza and Mambwe.

4.5 Results Discussion

The nationally representative rural livelihood agricultural surveys, conducted in 2012, 2015 and 2019, provide comprehensive datasets in the best estimates of the adoption of orange fleshed sweet potato varieties in Zambia. The sampling frame allows the estimation of district level adoption rates in Eastern Province while the rest of the provinces estimation of provincial estimates can be done.

The results highlight evidence of differential adoption rate based on where the technology (OFSP) was actively promoted and where it was not as shown by higher adoption rates in Project Districts than in Non-Project districts of the four Provinces. The picture is the same even in the Zone of Influence districts and Non-Zone of Influence districts of Eastern Province. The adoption rates of OFSP was higher in Zone of Influence than Non-Zone of Influence of Eastern Province. This implies that active promotion is needed for a new variety to take-off. These results confirms study results identified in De Brauw et al. 2018, Vaiknoras et al. 2019 studies. For example, De Brauw et al. 2018 found 75% and 79% of farmers adopting OFSP in areas where the technology was intensely and moderately promoted compared to only 6% farmers adopting OSFP in control areas in Mozambique. The study further found 67% and 63% farmers adopting in areas where the technology was intensely and moderately promoted against 5% farmers adopting OFSP in control areas of Rwanda.

This study found 2% adoption rate of OFSP in 2010/11 agricultural season in Zambia. This indicates low rate of adoption of the OFSP by farmers in Zambia. These results are similar with what was found in technology adoption (OFSP) studies in Uganda and Rwanda where the adoption rates of a technology were low in the early stage of technology introduction (Labarta et al. 2012, Asare-Marfo, Caitilin Harrington et al. 2016). For example the adoption rate of 1.3% of

OFSP was observed in Rwanda and less than 1.6% adoption rate of OFSP was estimated in Uganda in 2012 (Labarta et al. 2012), and about 2% adoption rate of iron rich bean varieties in Rwanda (Asare-Marfo, Caitilin Harrington et al. 2016).

Strangely, the rate of adoption of OFSP at national level is constant over the past 6 years, which is not encouraging. According to the Roger's adoption curve, the 4% at which the rate of adoption of OFSP has plateaued is still in the early stage of adoption stage under the adoption curve (Rogers 1983). Other studies have shown an increase in the rate of adoption within 10 years of the introduction of a technology (Vaiknoras et al., 2019). For example, the rate of adoption of iron rich beans increased from 9% after the technology was introduced in 2012 to about 22% in 2015 (Vaiknoras et al. 2019). However, the study shows that in project districts, the rate of adoption of OFSP has marginally grown from 5% to about 7%. Another puzzling result is that there is no sustained adoption of the OFSP among the farmers in Zambia, even in the Project Districts in four Provinces and in the Zone of Influence Districts of Eastern Province where the promotion of OFSP was targeted. The adoption of OFSP by new farmers from year to year is increasing which means that the OFSP varieties are spreading.

5.0 CONCLUSION AND RECOMMENDATIONS

Using a nationally representative panel dataset of three waves (2012, 2015 and 2019), the study estimated the adoption, dis-adoption and non-adoption of OFSP among smallholder farmers growing sweet potatoes in Zambia.

The study highlight a low rate of adoption (and concomitantly a high rate of non-adoption) of OFSP among sweet potatoes growers in Zambia. The adoption rates ranged from 2.0% in 2010/11 to 4.4% in 2013/14 agricultural season while the rate of non-adoption of OFSP among sweet potato farmers declined from 98.0% to as low as 94.1% in 2010/11 and 2017/18 agricultural seasons. The low adoption rate especially in the early stages of technology introduction are common as highlighted by several studies of technology adoption and range from 1.5% to as high as 47%. Though the rate of adoption of OFSP is low in Zambia, there is evidence of differential adoption rate based on where the technology (OFSP) was actively promoted and where it was not as shown by higher adoption rates in Project Districts than in Non-Project Districts in the four Provinces (Central, Eastern, Luapula and Northern Provinces) and also in the Zone of Influence Districts of Eastern Province. For example, the rate of adoption of OFSP in Project Districts in 2017/18 was 7.4% compared to 2.8% in the non-Project Districts. Even in the Zone of Influence Districts of Eastern Province, the rate of adoption was 13.2% compared to 4.1% in Non-Zone of Influence Districts. The high percentage in the Project and Zone of Influence Districts is because the districts were targeted by the Integrated Orange-Fleshed Sweet Potato Project in promoting OFSP in Zambia. Muchinga Lusaka, Southern and Western Provinces have also shown a steady increase in adoption rates of OFSP over time.

The study has highlighted key insights in the adoption of OFSP in Zambia which have raised more questions that need answers; for example with adoption of OFSP by new farmers, how is this happening? Why new farmers are picking up this variety but previous adopters discontinuing? Why adoption is short-term only and not sustained? These are interesting questions that need to be answered, and justifies exploring them through a qualitative study.

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APPENDICES

Appendix 1: Number of sample households growing sweet potatoes

	HHs that grew sweet potatoes			HHs that grew OFSP		
	2010/11	2013/14	2017/18	2010/11	2013/14	2017/18
Central	212	112	112	2	7	1
Copperbelt	231	144	154	0	4	1
Eastern	98	50	59	16	4	11
Luapula	203	201	190	4	6	6
Lusaka	64	74	47	3	3	3
Muchinga	167	106	109	1	6	7
Northern	247	89	120	3	6	10
North Western	148	110	95	0	7	1
Southern	244	190	174	6	9	7
Western	43	16	52	0	1	3
Total	**1657**	**1092**	**1112**	**35**	**53**	**50**

Source: RALS 2012, 2015 and 2019