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Assessing the Effects of Agricultural Technology Adoption on Maize Productivity in small scale Farming: A Case Study of Chongwe

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Abstract
The study focused on assessing the effects of agricultural technology adoption on maize productivity in small scale farming. The specific objectives of the study were to assess the training conducted on the new agricultural technology for small scale farmers in Chongwe district, to find out the type of agricultural technologies adopted for Maize, to evaluate how the adopted technologies have helped to improve productivity and to investigate the affordability of the agricultural technologies available to small scale farmers. The study considered a sample size of 100 small scale farmers in Chongwe by using a random sampling methods. The findings of the study revealed that very little training have provided to small scale farmers, the study further reveals that agricultural input innovations using bio-fortification as a program mechanism do hold promise for improving the food security of smallholder households and in the long run improving the country's much needed maize yields. Introducing higher-yielding, more drought-resistant crop varieties might further increase household income. Further, training program do not seem to improve farmers' incomes, particularly when they are delivered using top-down methods such as traditional agricultural extension. Of the reviewed interventions, extension services and new mechanized agricultural systems presented the largest potential improvements in outcomes. It is therefore the recommendation of this study, that extension services be modernized and that the frequency at which farmers a visited be increase to avoid losing touch of farmer trucking and further a bottom up approach be adopted.

Keywords: Food Security, New Agricultural Technology, Smallholder Farmers

1. Introduction

1.1 Background

Food insecurity and undernourishment are on the rise worldwide, from an estimated 777 million people in 2015 to 815 million people in 2016 (Food and Agriculture Organisation (FAO), 2017) [4]. This increase is a global concern in achieving the second sustainable development goal, which calls for a commitment to end hunger, reduce food insecurity, and improve nutrition by 2030.

Small scale farms account for on average 43% of the agricultural labour force in developing countries—are particularly disadvantaged in accessing productive resources, such as land, livestock, agricultural inputs, technology, markets, and extension and financial services (FAO 2011b) [3].

Agriculture and food production offer stable livelihood options to rural communities throughout the globe. Farm production at the smallholder level continues to be a family enterprise. A fair share of farmers in the Sub-Saharan Africa (SSA) engages in subsistence farming and poverty is a common occurrence among them. Farm enterprises are mostly managed by family members and family labour is a critical asset and often the only reliable investment (Food and Agriculture Organization of the United Nations, 2005) [5].

In 2016 the number of chronically undernourished people in the world is estimated to have increased to 815 million, up from 777 million in 2015 although still down from about 900 million in 2000. After a prolonged decline, this recent increase could signal a reversal of trends. The food security situation has worsened in particular in parts of sub-Saharan Africa, South-Eastern Asia and Western Asia, and deteriorations have been observed most notably in situations of conflict and conflict combined with droughts or floods.

1.2 Statement of the Problem

In this study, the researcher aims at assessing the effects of agricultural technology adoption on agricultural productivity in Chongwe among small scale farmers and this study will have a specific attention set on the maize crop. The area has for many years seen low agricultural yields on maize as a result of poor agricultural technology adoption. Food security is a global challenge and threatens mainly smallholder farmers in developing countries (Nkomoki *et al*., 2019) [6]. In the twenty-first century the pursuit of food security remains a critical challenge for many developing countries like Zambia. In spite of considerable economic growth and improvements in human development across the country during recent decades, the lack of availability and stability of food supplies and access to them in the rural communities continue to be of key concern. Indeed, increased population pressures, environmental degradation and emerging trends beg the question: "Can the small scale farmers in Zambia contribute in the production of enough food at reasonable prices, provide access to food by the poor and not destroy the environment in the process through improved agricultural technology?" The challenge is particularly applicable to the rural communities of Zambia that still have half of the country's 17.4 million hungry people. Zambia achieved lower middle-income status in 2011 following years of impressive economic performance (World Food Program, 2023). Yet, more than half of its population still live below the poverty line. Nutritional deficiency among female and children in Zambia is seen as a major crisis in the making. The 2019 FAO report sends a clear warning signal that the ambition of a world without hunger and malnutrition by 2030 will be challenging and achieving it will require renewed efforts through new ways of working (UNICEF, WFP and WHO. 2017., 2019) [8]. To the best of the researchers' knowledge, there is scarcity in the literature on this topic; yet, it is a critical subject in Zambia. Therefore, this study aims to consolidate past studies to add an incremental contribution with focus assessing the effects of agricultural technology adoption on maize productivity in small scale farming. The significance of the study is to provide information to policy-makers, so that they can gain an understanding of a range of factors that potentially promote food security.

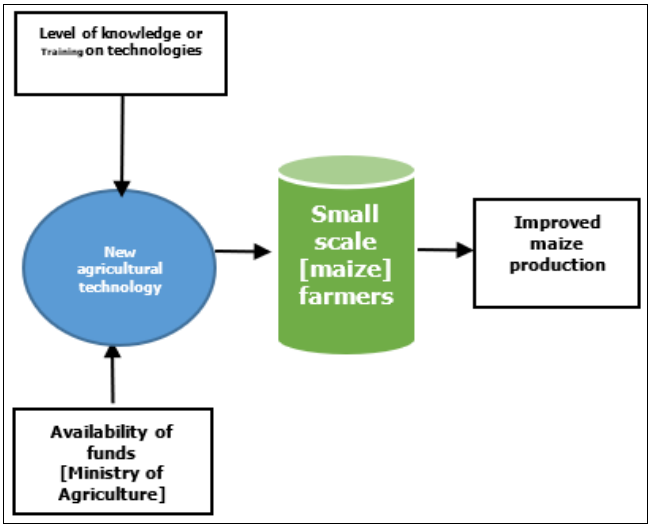
1.3 Objectives

The study's objectives were to assess the training conducted on the new agricultural technology for small scale farmers in Chongwe district, to find out the type of agricultural technologies adopted for Maize, to evaluate how the adopted technologies have helped to improve productivity and to investigate the affordability of the agricultural technologies available to small scale farmers.

1.4 Research questions

1. Have you received any training on use of new agricultural technologies?
2. What agricultural technologies have you adopted as a small scale farmer?
3. Have you noted improvements in production and crop quality after adopting the new agricultural technology?
4. Would you say that the Agricultural Technologies available in your area are affordable to you?

1.5 Conceptual framework



Source: Authors' own construction

In this study level of knowledge or training on agricultural technologies, New agricultural technologies and affordability or financial muscle will be used be used as independent variable whereas improved maize productivity will be used as depended variable. The researcher will try to variations of each in depended variable and its effects on maize productivity. Figure 1.0 below illustrates the conceptual framework.

Closer vertical co-ordination of supply chains is becoming a prevalent feature in the agri-food sectors of many countries. Presents a framework within which to analyse these changes. Creswell, J. W., 2014 [2] The framework links drivers for change to product characteristics, which in turn affect transaction characteristics and transaction costs, thereby leading to a change in vertical co-ordination. A case study of the US grains industry provides an illustration of the framework. Implications for agricultural producers, producer groups and policy makers are discussed.

2. Literature Review

2.1 Training Received on the new Agricultural Technology

The majority of the rural poor in Africa engage in smallholder farming as a livelihood strategy. At the same time, supporting the practice of smallholder agriculture holds the potential to improve farming households' level of food security as well as local economies in rural areas. Agricultural productivity in Africa stands at one-third to half of global productivity and, although the Green Revolution has rapidly improved social and economic livelihoods in other former developing regions, it is by and large absent from the continent.

FAO report of February 2020 also buttress this finding that The project embarked on training a number of extension officers. These extension officer further conducted trainings to raise awareness among the small-scale farmers. Furthermore, the findings indicate that a good number of smallholder farmers about 187 000 did receive awareness.

These training were done in the ten provinces of Zambia including many districts under the provincial and district specialists. However, since funds were insufficient to reach

all the farmers, most of the small-scale farmers were accessed through other integrated activities, such as information dissemination during the Farmer Input Support Program (FISP), as well as during the distribution of other chemicals (Food Agriculture Organization 2020) [11].

The training aimed at increasing productivity of maize, one of the most objective of the agricultural policy is to empower farmers and value chain actors (youth, women and venerable to effectively participate and benefit equitably from an agricultural extension services and demand for services. Maize is an important food and income security crop that supports livelihoods of millions of small scale in Uganda. however, average yields of maize have remained low, ranging between 2.2 – 2.5 MT/ha.

Compared to the potential of 8MT/ha. The standards of maize produced is generally low and loses during harvesting, transportation, storage and processing are relatively high. In order to achieve the provided policy goals and strategic objectives. The ministry of Agricultural Animal Industry and fisheries with support from USIAD feed the future program, Uganda enabling environmental activity and Sasakawa global developed a harmonized maize training manual.

Rural households depend heavily on small-scale farming for their livelihoods. Most of the households despite current trends in climate change issues like drought, flooding, still rely on traditional methods of farming (Kuwornu *et al*., 2011) [9] Some of the traditional methods include use of cutlasses and hoes for weeding and preparing the land, 2 fetching of water manually from wells for irrigation.

2.2 Type of agricultural technologies adopted for Maize

According to (Mubanga, K.H *et al* 2020) [31], usage of mobile technology and cameras are playing a big role for farmers and ranchers are using all the social media sites, for all types of reason some are using apps like foursquare to keep tabs on employees putting up cameras around the farms is a trend that's catching on. Livestock managers are wiring up there burns feed locks and pastures with cameras that send images to a central place for monitoring.

Technology has been seen to contribute an important impact on agricultural development and improvement in developed countries, as well as in the developing world. New technologies provide significant impact on agriculture thereby providing sustainable and productive way of farming. Considering an increasing growth rate of the World population with a figure above 7-million people, more needs to be done in meeting the food needs of people more especially in developing countries.

Utilization of agricultural technologies and new systems of farming have generated an increased yield in developing countries and led to enlarging the size of farmlands for crop cultivation. Turyahabwe, N., Willy, K., Mnason, T. & David, M. T., 2013. Contribution of wetland resources This enhances and improves livelihoods of farming communities which further strengthens economic growth and development of the developing economies.

An assessment of accessibility to agricultural extension services by smallholder farmers in Siaya County in Kenya. The study employed two methods of sampling, the purposive sampling procedure and snowball sampling including simple random. Questionnaires were proportionately randomly sampled. The results of the study show that 66.7% of the smallholder farmers had access to extension services.

Another study conducted by Kabwe *et al*., (2018) [16] in Zambia investigated among other things, the challenges that the extension and field officers faced during an outbreak of FAW in 2016/17 farming season. The study randomly sampled a number of agriculture field workers and used questionnaires. The findings of the study indicate that agriculture extension officers face challenges of funding. Furthermore, the study shows the extension officers faced logistic challenges such as transportation of equipment and chemicals to be used by smallholder farmers during FAW outbreak. This study has an implication on smallholder farmers because it indicates that most smallholder farmers may not have received extension services owing to logistic challenges that the extension officers faced during the outbreak of FAW.

2.3 How Adopted Technologies have Helped to Improve Productivity

The adoption of the new technologies may result in increasing productivity for early adopters, however, with many other farmers embracing the technologies total productivity by the farmers continuously rise which could in turn lead to fall in prices of the produce (Suppan 2020). According to Cochrane for farmers to match with the situation, they have to continuously employ the technologies which eventually leads to the notion of technological treadmill. Several studies have shown some factors that influence adoption of new technologies by farmers in developing countries. Most of the studies have in most cases looked at factors that influence, why and how certain groups of farmers may decide to employ particular farming technologies.

Today's farming operations rely on sophisticated innovative tools such as sensors, robotics and aerial images and satellites to drive long-term productivity and increase profitability. The evolution of stress factors and plant diseases has given importance to the use of sensors to monitor crop growth and performance at every stage of development process.

2.4 Affordability of Technologies Available to Small Scale Farmers

The adoption of the new technologies may result in increasing productivity for early adopters, however, with many other farmers embracing the technologies total productivity by the farmers continuously rise which could in turn lead to fall in prices of the produce (Mbewe J., 2020) [33]. According to Cochrane for farmers to match with the situation, they have to continuously employ the technologies which eventually leads to the notion of technological treadmill (Ferguson, W *et al* 2017) [32].

Food security is a global challenge & threatens mainly smallholder farmers in developing countries (Nkomoki, *et al*., 2019) [6]. The majority of food-insecure populations reside in Africa, which is home to the largest number of the poorest & most poverty-stricken countries in the world (Nkegbe, *et al*., 2017) [15]. Zambia is not spared, as the global hunger index report (GHI) ranks Zambia under the category of alarming levels of hunger in Zambia, the predominant livelihood activity is smallholder farming, mainly cultivating maize & livestock raring. Lcms 2015. The country's main labour force is agriculture, which employs 72% of the national population. Furthermore, the

smallholder farmers are adversely affected by food insecurity. Studies in Mozambique on agricultural technology have revealed that, there are much positive impacts on the level of education of 25 farming household heads and the rate of technology adoption in farming activities have noted in their research in the Bawku West District in Ghana that, educational levels of farming households are important determinant for adoption of technologies for enhancing farm productivity. Agyeman, L. O. (2021) [19].

Also, higher education amongst farmers are relevant for technology innovations and their introduction within the process of adoption. Am J Cardio 1990; 66:1348-54.

3. Research Methodology

This chapter elaborated the methodology the researcher undertook to gather and analyze data and draw conclusions of the research in accordance with the objectives. Furthermore, the chapter discussed the target population and the sampling technique.

The methodology of this study was anchored on Social Constructivism propounded by Berger and Luckman which is typically an approach to qualitative research (Mertens, 1998) [25]. Equally described it as a naturalistic inquiry where knowledge is constructed through meaningful social interactions.

3.1 Research Design

The study will use the quantitative research method this to ensure sure that the results are empirical and easy to alive at conclusions. The quantitative research is regarded as the organized enquiry about a phenomenon, through a collection of numerical data excursion statistical, mathematical, computational techniques. The source of quantitative is positivism paradigm that advocates for approaches embedded statistical breakdown that involve other strategies like inferential statistics testing of hypothesis mathematical expositions, experimental and quasi - experimental designs randomization, blinding structured protocols questionnaires with restricted variety of prearranged answers. (Moser A, Korstjens 2017) [22].

The quantitative research objectives are measurable and can be separated from the variables and hypothesis. concepts that have variations that can take numerous values while hypothesis are untested propositions of relationships between variables. according to (Håkansson, A. (2013) [27].

3.2 Target Population

The target population is this research will be the small scale farmers of Kanakantapa ward of Chongwe district in Lusaka province. It is certain that small scale farmers are the ones that are looking for new innovations that will improve their yield.

3.3 Sample Design

The sample design for this research shall be probability sampling. Probability sampling is a technique in which the researcher chooses a sample from a larger population using a method based on probability. The selection of the sample is done randomly. The most critical requirement of probability sampling is that everyone in the population has a known and equal chance of being selected. For example, if there is a population of 100 persons. Every person will have odds of 1 in 100 for being or getting selected. This approach will ensure a more unbiased and representative sample.

3.4 Sample Size

Trotter (2012) [26] stipulated that researchers offer different recommendations for determining a suitable sample size to reach saturation. Marshall *et al*. (2013) [23] argued that case study researchers should use a minimum sample of four participants. Dworkin (2012) maintained that a sample size of at least five participants is necessary to achieve saturation. The study will be carried out in Kanakantapa ward of Chongwe district. Kanakantapa ward has 28 EAs (enumeration areas) with households amounting to 3149 and an estimated population of 14017. Zamstats 2010 [28] Census of Population and Housing.. Majority of the households in Kanakantapa are agricultural dependent, hence 12 households from the 28 EAs will be picked. A total of 100 questionnaires will administered in Kanakantapa ward and the head of the households will be purposefully picked as respondents. The target farmer in this survey is the small scale one farmers.

3.5 Data Collection Method and Procedures

The researcher used both primary and secondary data. The Primary data will be captured from the small-scale farmers themselves in the field during the research. Furthermore, the study will use secondary study from literature reviews. The researcher will use survey data to complement existing data from secondary sources such as journals, books and other publications for literature review and clarification of the existing critical gaps of the study. Data collection instruments are tools that the researchers use in collecting the needed data or information. The most common used research instruments are questionnaires, interviews schedules, observations, checklist and focus group discussions guide (Zamstats 2001). In this study, questionnaires were used to collect data on the topic under investigation.

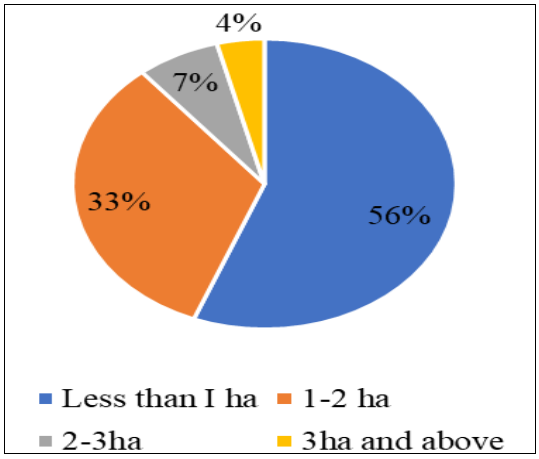
3.6 Data analysis

Analysis of data is a process of inspecting, cleaning, transforming, and modelling data with the goal of highlighting useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, in different business, science, and social science domains. (Saunders *et al*: 2000). Data Analysis involves a systematic application of statistical techniques in a logical manner for the purpose of describing and evaluating data in a study. This process furthermore involves cleaning and modelling the data to decipher information that can be useful for scientific or business decision making (Savenye & Robinson, 2014) [24].

3.7 Triangulation

In addition, the study will carry out triangulation which is a process of checking the data collected whether it is correct. Basically, triangulation is a technique that is common in non-quantitative studies. The researcher normally bases their research on a variety of origins of the data (Creswell, 2014) [2].

4. Results/Findings

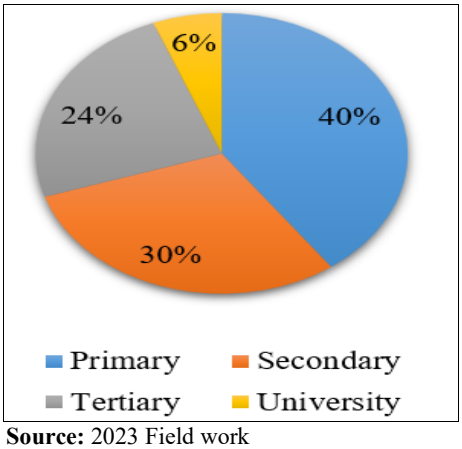


Source: 2023 Field work

Fig 2: distribution of size of farm land

Fig 2 above shows the distribution of female farmers by size of farm l&. The results show that56% (25) of the respondents had 1ha & less, 33% (15) had 1-2 ha, 7% (3) had 2-3ha & 4% (2) had 3 ha & above.

The researcher interviewed the farmers as to ascertain their age ranges. Fig 3 indicates that 40% of the respondents were between 41-50 years, 26% were aged 36-40 years, 25% were 51 & above & 9% represented age group below 35 years.



Source: 2023 Field work

Fig 3: distribution of level of education of respondents

Fig 3 above indicates that 40% of the respondents had primary school education, 30% had secondary level of education, 24 % had tertiary education & 6% were university graduates.

Fig 5 above shows the distribution of farmers by size of farm l&. The results show that 56% (25) of the respondents had 1ha & less, 33% (15) had 1-2 ha, 7% (3) had 2-3ha & 4% (2) had 3 ha & above.

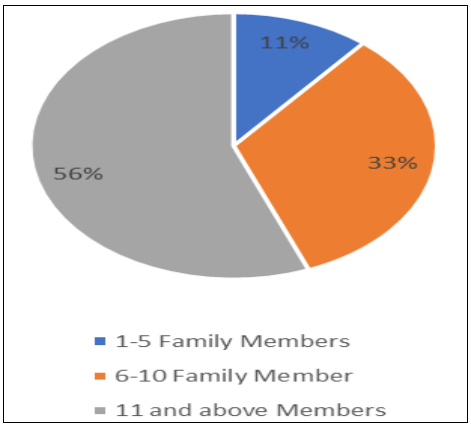
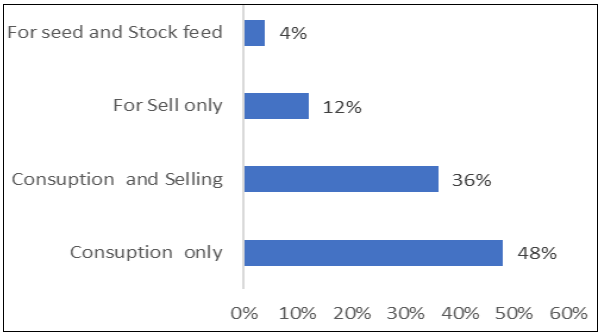


Fig 4: Distribution by size of household

Fig 4 shows distribution by size of household members. 56% were between 1-5 family members, 33% were between 6-10 family members & 11% were 11 & above family members per household.



Source: 2023 Field work

Fig 6: Purpose of farming

Fig 6 shows the respondents by purpose of farming. 47.9% (46) indicated that the purpose of farming was home consumption, 37.5% (36) indicated that it was both consumption & sell, 10.4% (10) indicated that it was for sell & 4.2% (4) indicated that it was for seed & stock feed.

4.2 Training Received on the new Agricultural Technology

Fig 7: Were you provided with training on how to handle and use chemicals for controlling Fall armyworms?

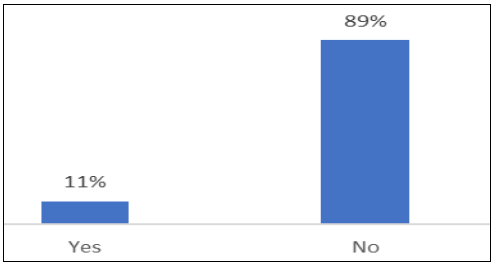


Fig 7:

The researcher interviewed the farmers to find out whether they received any training in the last few years regarding use of chemical for pesticides such as armyworms. It was observed that most of the farmers in Chongwe had not received any training on new technology on farming as only 11% responded that YES they did receive some trainings as indicated in the figure above.

Describe the type of training you participated in the last two (2) years

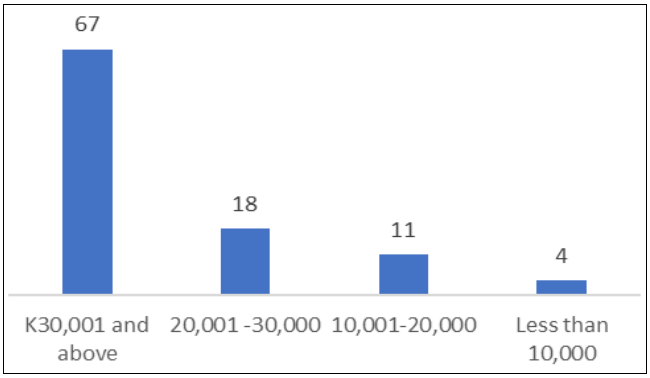
This review assessed the training in which farmers participated in the last two years. The researcher conducted a narrative analysis to come up with some responses which were recorded as follows:

Table 1: Training intervention for this review

Training Component	No Participated
Farmer field schools	The findings show that 30% participated in this training
Extension programmes	None indicated
Innovation and new technology interventions	None indicated
New farming method	Only about 10% indicated having participated
Agricultural practice innovations	No response
Conservation agriculture	10%
Agricultural input innovations	No response
New biological or chemical inputs	No response
Bio-fortified vegetable varieties	No response
Technical input innovation	No response
Machinery applied such as tractors.	No response
Agricultural input innovations	No response
New biological or chemical inputs	No response
Bio-fortified vegetable varieties	No response
Agricultural input innovations	No response
New biological or chemical inputs	No response
Technical input innovation	No response
Machinery applied such as tractors.	20% participated

Table 2 illustrates training intervention categories for this review. We simplified a framework to formulate distinctive exclusive technology and innovation intervention categories. Agricultural practice innovations.

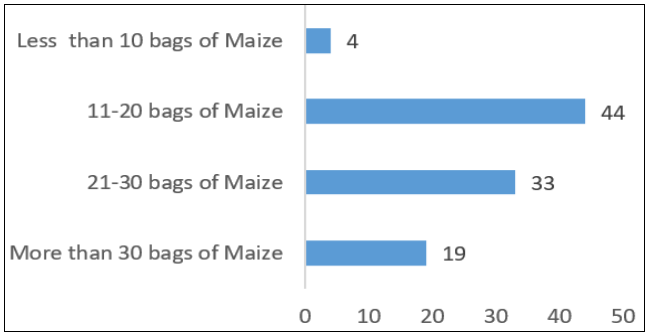
4.3 How Adopted Technologies have Helped to Improve Productivity



Source: Research data

Fig 8: Income from farming

Fig 8 shows respondents by income earned from farming. 67% (30) of the farmers interviewed said earned K 30,000 & more, 18% (8) earned K 20,001-L 30,000, 11% (5) earned K 10,001-K 20,000 & 4% (2) earned less than K 10,000.



Source: Research data

Fig 9: How much yield did you make in 2022/2023 farming seasons

Fig 9 shows respondents by farm yield in 2022/2023 farming season. 44 percent indicated that they had between 11 to 20 bags of maize, 33 percent had 21 to 30 bags of maize, 19 percent had more than 30 bags maize, with the lowest being 4 percent had less than 10 bags.

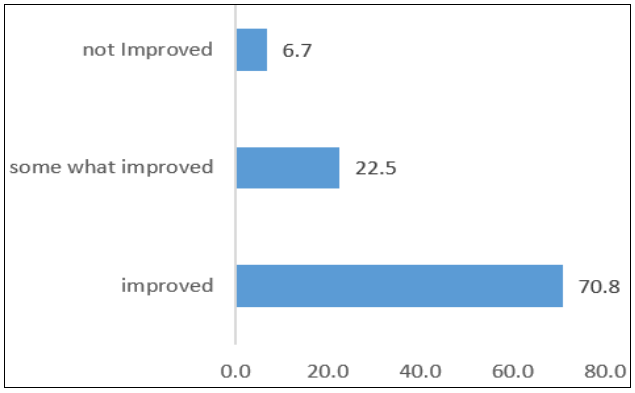


Fig 10: Show percentage distribution of farmer response on whether the adopted innovations helped improve Yields

The figure above shows famer response to whether adopted technologies helped improve the outputs at their farms. Majority of famers responded yes to improvement accounting for 70.8 percent followed by those that said Somewhat improved at 22.5 and the least being Not improved which accounted for 6.7 percent.

4.4 Type of Agricultural Technologies Adopted for Maize

The study developed a theoretical understanding of the system of decision-making with regards to agricultural technology adoption through a review of literature and field observations. The results from the findings indicated the following verbatim responses:

SSC1

Training not only improves agricultural income of trained paddy farmers, but spill over effects also improve the income of relative and neighbouring farmers So, Agriculture extension serve as the means of providing this knowledge to the farmers. Agricultural extension has been traditionally used to overcome the constraints in technological adoption in agriculture at farm level through public sector programs. Though there are many studies on the determinants of technology adoption in agriculture, training either formal or informal has been also identified as one of the important

determinants Though there have been many studies on the impact of training throughout the literature, the impact they have had on agricultural production varies. This could be attributed to the issues of high costs, problems of scale, and lower accountability.

> "We underwent agriculture extension orientation training as the means of providing this knowledge to the farmers. We were educated in agricultural to overcome the constraints in technological adoption in agriculture at farm level through public sector programs"

SSC 2

"Last year in August I attended a workshop in Chongwe dubbed 'Farmer field schools'. The training was specifically to enable women farmers benefit. It was target for farmer with lower literacy levels and farmers with medium sized farmlands"

Affordability of Technologies Available to Small Scale Farmers

The figure below shows percentage distribution of affordability by type of technology.

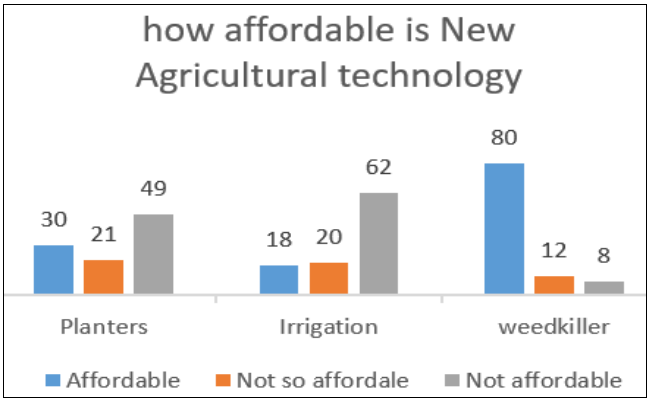


Fig 11: Affordability of Agricultural Technology by type

The affordability of new technology was probed among farmers, it was established that there 3 main types agricultural technological interventions that farmers might need namely planter, irrigation and weed control. it was established that farmers 30.0 percent of farmers think that planter were affordable, 21.0 percent thought they were not so affordable and 49 percent thought they were not affordable.

Irrigation-the affordability of irrigation systems as viewed by farmer was as follows, 18.0 percent of the farmers said the technology was affordable, 20.0 percent said it was not so affordable and 62.0 percent thought the irrigation system not affordable at all.

Weed killer – the majority of farmers thought weed killer was affordable account for 80.0 percent, 12 percent said it was not affordable and only 8.0 percent thought it was not affordable.

The researchers asked farmer suggestion on means they thought would best work for them and four possible answers were provided in the answer category, of all the farmers asked 33.0 percent thought Buy on loan as a cooperative was best of them and this accounted a highest proportion, 30.0 percent thought buying on loan as an individual was the okay for them, buying on hire purchase accounted for 27.0 and the least preferred was to Hire for use within the farming community.

Figure shows percentage distribution of farmers by suggested means of affordability

Source: 2023 Field work

4.5 Discussion of Findings

Training received on the new agricultural technology

It was established from the study that most of the farmers in Chongwe received Agricultural practice innovations. On the micro level, this approach introduced farming processes, such as legume intercropping to prevent soil nutrient loss. On the macro level, it leads to wider changes, such as a fundamental shift from subsistence cultivation to producing crops for export markets.

Secondly, the findings of the study revealed that the emphasis of the training that the farmers received was on processes and practices rather than inputs and products. On Agricultural input innovations, the findings show that the approach introduced new biological or chemical inputs to support smallholders. It emphasized the production input itself rather than how it is cultivated or marketed. Common forms of input innovations included Bio-fortified crop varieties that have, for example, greater nutritional value or higher yields. These findings are in tandem with earlier studies by (Mubanga, K. H, 2027).

How Adopted Technologies have Helped to Improve Productivity

The study found that having adopted the interventions, farmers experienced a change in agricultural inputs, outputs or practice. The introduction of a bio-fortified crop variety on its own presented a change in inputs and resulted, for example, in an improved output (more nutritious staple foods). Interventions, particularly training program, might not have the primary aim to change agricultural inputs or outputs but rather to changed farming practices - for example, through integrated pest management techniques.

The study found that most farmers in Chongwe were able to raise an income of more than K 30,000 from the farming activities. These results are consistent with the average income that most small-scale farmers earn from their yields. Only 2% of the respondents were able to rise less than K 10,000 from their farming activities. The also established that the most farmers were able to sustain their families as 89% of them indicated that they could easily sustain their

families from the farming activities they engaged in such as growing maize & other cash crops like vegetables which they sold on the markets around Lusaka.

The average maize yields from these farmers was around 1-20 bags of maize. This is not a bad harvest considering the price of maize on the market. The results found that 44% of the farmers were able to have a yield of between 11 to 20, 90kg bags of maize & that 19% were able to yield more than 30 bags of maize in 2019/2020 farming season. This yield does not include other cash crops such as cassava & millet.

Type of Agricultural Technologies Adopted for Maize

This finding agrees with an earlier study that found that tension services encompass the wide range of services provided by experts in the areas of agriculture, agribusiness, health & others and are designed to improve productivity and the overall wellbeing of rural populations. The provision of agricultural extension can lead to significant yield increases. Yet, extension provision in developing economies remains low for both women & men, & women tend to make less use than men of extension services (Meinzen-Dick *et al*., 2010) [12].

According to a 1988–89 FAO survey of extension organizations covering 97 countries with sex disaggregated data (the most comprehensive study available) only 5 percent of all extension resources were directed at women. Moreover, only 15 percent of the extension personnel were female (FAO, 1993). In social contexts where meetings between women & men from outside the family nucleus are restricted, a lack of female extension agents effectively bar women from participating. The preference for female extension agents varies by country & marital status.

Affordability of Technologies Available to Small Scale Farmers

It was established from the study that the majority of farmers in Chongwe faced a number of challenges in accessing agricultural inputs owing to technological constraints. These results are in tandem with a number of studies which show that Women in agriculture & rural areas have one thing in common across regions: they have less access than men to productive resources & opportunities.

This results agrees with a study conducted by (CSO 1991) [34] who found that poor access to financing was major setback faced by women in agriculture. Credit is an extremely useful resource to farmers due to the fact that their production activities are most often seasonal in nature & a considerable lag occurs between the time they incur costs & the time that they are able to generate income from their produce.

The study found that most of the farmers have challenges of illiteracy. Illiteracy levels for female farmers in Chongwe were found to be on a higher side as 44% of the female farmers encountered the challenges of less education. The study also found that the other major challenge that contributed to difficulties for female farmer's access l&, credit & inputs was the gender gap as 33% of the farmers indicated that they felt the gender gap was one of the factors.

A number of constraints, including the gender gaps described above, lead to gender inequalities in access to & adoption of new technologies, as well as in the use of purchased inputs & existing technologies. Furthermore, lack of access to transportation technology often limits the mobility of women & their capacity to transport crops to market centers it is important to note that not all types of female-headed households are equally constrained in their access to technology. On small farms in Kenya, households headed by single, divorced or widowed women are the least likely to use animal traction. In contrast, female-headed households in which the husband's lives elsewhere are more likely to use animal traction & hired labour, because they still benefit from their husband's.

The study established that most female farmers in Chongwe faced cultural challenges as 67% indicated that they had cultural challenges in farming. This result is consistent with earlier studies that found that most rural female famers faced challenges of Legal barrier/cultural norms.

Evidence shows that credit markets are not gender-neutral. Legal barriers & cultural norms sometimes bar women from holding bank accounts or entering into financial contracts in their own right. Women generally have less control over the types of fixed assets that are usually necessary as collateral for loans. Institutional discrimination by private & public lending institutions often either ration women out of the market or grant women loans that are smaller than those granted to men for similar activities (Fletschner, 2009; World Bank, FAO & IFAD, 2009) [10].

Saito *et al* (2014) [30] also found that in the RIGA dataset, rural female-headed households are less likely than male-headed households to use credit. In Madagascar, for example, the share of female-headed households that use credit is 9 percentage points smaller than the share of male-headed households who do so. The cases of Ghana & Panama are noteworthy in that no gender gap is apparent in the use of credit. The gender gap in access to credit is also confirmed by other evidence.

5. Conclusion

Food security is a global challenge & threatens mainly smallholder farmers in developing countries). The majority of food-insecure populations reside in Africa, which is home to the largest number of the poorest & most poverty-stricken countries in the world That said, it appears that agricultural input innovations using bio-fortification as a program mechanism do hold promise for improving the food security of smallholder households. Introducing higher-yielding, more drought-resistant crop varieties might further increase household income.

Training program do not seem to improve farmers' incomes, particularly when they are delivered using top-down methods such as traditional agricultural extension. Of the reviewed interventions, extension services and new mechanized agricultural systems presented the largest potential improvements in outcomes. But we also believe that, despite the thin evidence base, overall, bottom-up training, innovation and new technology interventions hold potential to support smallholder farmers in Chongwe.

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