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Interventions on Vegetable Value Chains: An Analysis of the Impacts on the Livelihoods of Smallholder Farmers in Malawi

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International Environmental Studies

Declaration

I, Madison Stadler-Rose, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

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Date: 01.11.2022

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Abstract

Agriculture is a foundational component in Malawi's society, contributing to income, food security, and livelihoods. With climatic stresses, unpredictable crop productions, and poor market access, vegetable value chains for smallholder farmers in Malawi are susceptible to increased risks for an already vulnerable population. An analysis of the pitfalls within the agricultural sector and value chains and determining the impacts on smallholder farmers is critical for identifying areas of improvement. This research analyses the vegetable value chains of smallholder farmers in Malawi. With support and guidance from the TRANSFORM programme, a micro-investment initiative to contribute to sustainable agricultural transformation, this study determines rural farmer's main challenges and opportunities. Through cross-sectional, close-ended surveying in Mchinji and Mzimba districts in Malawi, with the help of Norwegian Church Aid (NCA) Malawi, data was collected from 300 smallholder micro-investment farmers. This study analyses contributing aspects along the vegetable value chain that create challenges for smallholder farmers to thrive. Including, the effects that gender inequalities have on agricultural and household decisions. The vegetable analysis proved that tomatoes are the most prevalent for production, grown by 42.6% of farmers' and most profitable, earning 17,741 MWK per unit. While leafy green vegetables followed in quantity but varied in yield and revenue. The results from the collected data determined that market access varied based on gender, as women had a 16% higher average distance to the market than men, vegetable type, where cucumbers were sold at least 4 km further on average, and district, where Mzimba had more market access. However, intercropping is undoubtedly triumphant over monocropping, as average yield in units increased between 12%-58% for each vegetable. Enhanced farming methods and economic empowerment through income diversity are avenues to sustainable livelihoods. Therefore, interventions throughout vegetable value chains to strengthen smallholder farming in Malawi is an approach to improve food and nutrition and reduce poverty rates.

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Acronyms

BEP	Break Even Price
BEY	Break Even Yield
GDP	Gross Domestic Product
GM	Gross Margin
HH	Head of Household
MWK	Malawian Kwacha
MI	Micro-Investment
NCA	Norwegian Church Aid
TAV	Traditional African Vegetable
TVC	Total Variable Cost
VVC	Vegetable Value Chain

Chapter 1

1. Introduction

The agricultural sector is the foundation for many low-income countries. For Malawi specifically, agriculture is arguably the most fundamental component of society. Malawi is a landlocked southeastern African country with a population of around 18 million, mostly living in rural areas on smallholder farms. Seventy per cent of the population lives below the poverty line, of which 37% are considered food insecure, and 23% are malnourished (CIAT, 2018). Agriculture is the driving force behind Mawali's socio-economic development (Chadha et al., 2008). At the national level, Malawi's economy relies heavily on crop production and exports for economic gain.

In contrast, agriculture contributes significantly to income, food security, and nutrition at the household level. However, many contributing factors throughout the agricultural sector create vulnerabilities. For example, agriculture in Malawi is almost entirely reliant on rain-fed production, which is unstable and leads to high levels of exposure for the economy as a whole but especially for the smallholder farmers (Giertz et al., 2015).

The instability of rain-fed agriculture is just one example of an obstacle in vegetable farming. There are also impediments because of low technological inputs, non-adaptive farming practices, low production, and weak market access and infrastructure (Chagomoka et al., 2014; Giertz et al., 2105). These are all elements in the vegetable value chains that are hindering optimal production for smallholder farmers (Giertz et al., 2015). A value chain is "the full range of activities required to bring a product or service from conception through the different phases of production" (Chagomoka et al., 2014, p.61). And a vegetable value chain (VVC) is a value chain specific to a vegetable crop. The obstacles to achieving strong vegetable value chains are an ongoing concern for smallholder farmers in Malawi. However, at their best, vegetable value chains have the potential to improve livelihoods, nutrition, and food security. Smallholder farmers contribute 80% of the country's total horticulture – mostly low-value and high-volume vegetables including tomatoes, onions, and leafy vegetables (Chadha et al., 2008).

The livelihoods of smallholder farmers are as vulnerable as the agriculture sector. Livelihoods can be defined as the assets, capabilities (including material and social resources), and activities

necessary for a means of living (Hertz, 2010). As 90% of Malawi's population relies on agriculture for livelihood and there are limited alternative sources of income, the vulnerability in this country is considered high (CIAT, 2018). Cultivating vegetable crops in Malawi provides improved nutrition and income for smallholder farmers. However, research gaps surrounding interventions to vegetable value chains, climate-adapted technologies and market access in Malawi, and the implications on livelihoods, challenges and uncertainties surrounding food security and poverty will remain.

Increasing productivity, profitability, and diversification on smallholder farms due to improved value chains to strengthen livelihoods are key objectives of the Sustainable Food Systems for Rural Agriculture Transformation and Resilience, known as the TRANSFORM programme. This programme contributes to sustainable agricultural transformation to grow Malawi's agricultural sector while improving smallholder farmer's food and nutrition security. Using a micro-investment approach while focusing on economic empowerment and capacity building, smallholder farmers will access affordable farming techniques to enhance their practices and move beyond subsistence farming.

This study aims to identify the challenges within agriculture and vegetable value chains and analyse the interventions and opportunities for smallholder farmers in Malawi. Particularly, determining the impacts on vegetable production, livelihoods, and poverty reduction.

1.1. Research Questions

The main research question is:

To what extent do interventions on vegetable value chains influence the income and livelihoods of smallholder farmers in Malawi?

The sub-research questions are:

1. Which interventions on the existing vegetable value chains impact the income and livelihoods of smallholder farmers in Malawi?
2. What role does gender play in the vegetable value chain?
3. How do monocropping and intercropping methods compare in vegetable production?
4. What opportunities do micro-investment interventions create for smallholder farmers in Malawi?

5. What are the key challenges and opportunities along the vegetable value chain?

1.2. Thesis Outline

In addition to this introductory chapter, the thesis consists of four additional chapters. Chapter 2 provides background and contextual information on Malawi. This chapter than analyses the concept of the vegetable value chain and identifies hindrances and opportunities using interventions. Chapter 3 explains the methodological approach, study population and area, and data collection and analysis. Chapter 4 focuses on the results obtained and discusses the findings regarding the research questions. Finally, Chapter 5 summarizes the main findings of the study and conclusions drawn and suggestions for further work.

Chapter 2

2. Literature Review

In this chapter, the purpose is to give background and context to this study, while reviewing past research and explaining relevant concepts. The aim for this chapter is to unpack what is encompassed in vegetable value chains, what the current challenges are within that and agriculture, and explore interventions. In addition, understanding the objectives of economic empowerment and micro-investment as a means of an improved approach to the livelihoods of smallholder farmers.

2.1. Socio-economic and Agricultural Background of Malawi

Agriculture is foundational to Malawi's economy as it accounts for 30% of Malawi's Gross Domestic Product (GDP) and 90% of its export revenue (FANRPRAN, 2017). Smallholder farmers are fundamental to success in this sector, as they contribute 70% of the agricultural GDP (CIAT, 2018). Although relatively small in size, Malawi is densely populated and has a high population growth rate, which puts pressure on the land available for smallholder farming and the environment and natural resources (Giertz et al., 2015). Studies by Knoema (2021) and CIAT (2018) show that in 2018, 59.9% of the land area in Malawi was used for agriculture, however, as mentioned, most of that land is used for rain-fed agriculture, as only 4% of cultivated land is irrigated. The predominant food crops grown include maize, rice, cassava, potatoes, legumes, and cash crops, such as coffee, tea, tobacco, and sugarcane (FANPRAN, 2017). The process for all food crops, including vegetables, is known as the value chain of said crop or product (Figure 2).

Food insecurity is a serious concern in agricultural households in Sub-Saharan Africa as the majority of production is below the expected potential (Tamene et al., 2016). Although agriculture is thoroughly integrated into the country, Malawi is one of the most food insecure countries in the world, as 36.7% of households in Malawi reported being calorie deficient each year (CIAT, 2018). And more than 2.7 million deaths occur worldwide annually because of diseases related to imbalanced diets from insufficient vegetable and fruit consumption (Chagomoka et al., 2014). As a result, Malawi ranked 105 out of 133 on the global food security index in 2017 (CIAT, 2018). These rates of food insecurity in smallholder households, will, directly and indirectly, contribute to higher rates of poverty (FANPRAN, 2016).

Through results from this study, Figure 1 was developed to illustrate the months where participating farmers reported being food deficient. The dry season in Malawi generally runs from April to November (WeatherSpark, 2022). Figure 1 displays that the months with prevalent food deficiencies were November to April, which align with the rainy season. Typically, crops are grown throughout the rainy season and harvested at the start of the dry season. This provides sufficient food for households throughout the dry season. However, as food supplies dwindle near the end of the dry season and climates in the dry season do not support crop production, farmers would then struggle to meet food requirements throughout the rainy season until the next harvest.

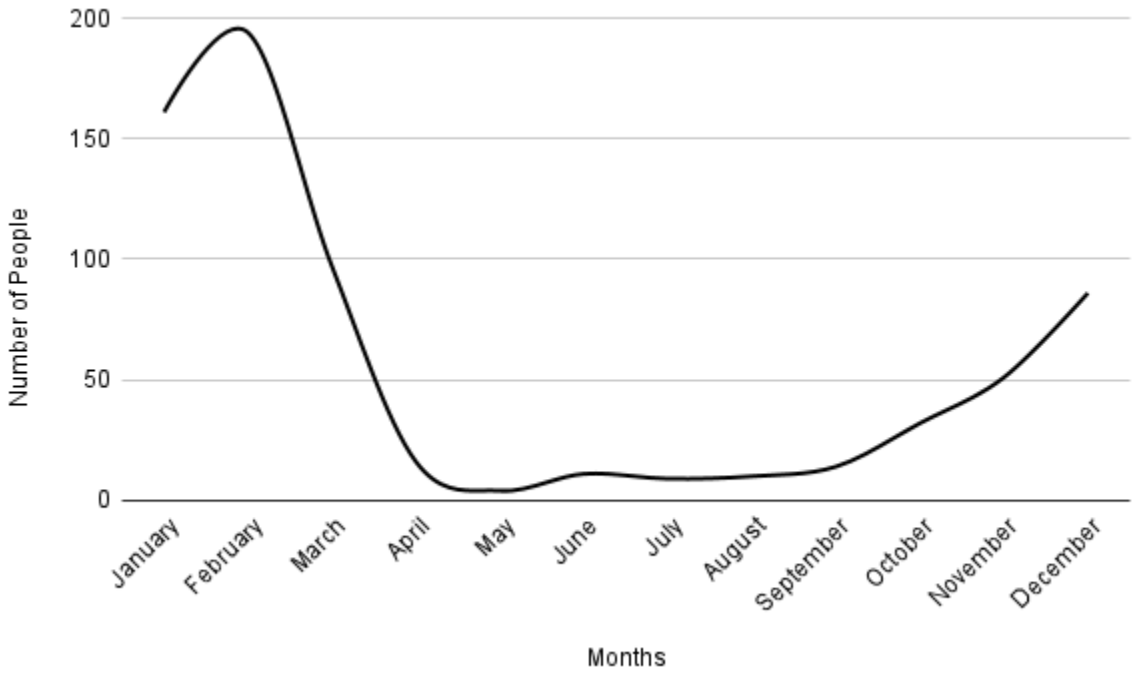


Figure 1. *Number of farmers who were food deficient in selected months*

Through changing climates the rainy season is likely to become shorter, further increasing vulnerabilities of food supply (Bie et al., 2008). Figure 1 demonstrates the need for climate adapted technologies such as drip irriagation systems to allow for crop production throughout the year, thereby increasing household food security. With research and interventions on horticulture crops there is the potential to generate increased income in rural households (Chadha et al.,

2008). Therefore, a focus on agriculture and vegetable value chains in rural Malawi, its effects on the households, and opportunities for improvements, must be a priority for research.

2.2. Vegetable Value Chains

Several components comprise a vegetable value chain (VVC), and many elements contribute to the stages throughout the process. This process is inclusive of all stages between seed to consumer consumption. This study will focus on only the four phases of the vegetable value chain of smallholder farmers that are inclusive of the relevant components within the TRANSFORM programme. As displayed in Figure 2, an original figure for this study, these phases consist of input supply, production, marketing/processing, and sale/output supply.

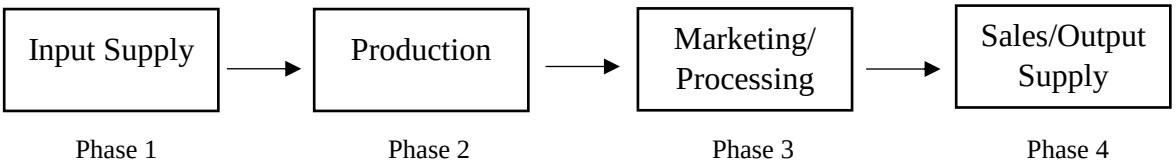


Figure 2. *Vegetable Value Chain*

At the beginning of the VVC, the input supply includes all elements contributing to establishing and launching agricultural practices. The input supply encompasses the material supplies such as farmland, seeds, planting materials, and other agricultural resources as well as the farmer's participation and knowledge. The initial input supply establishes the potential for the outcome of the rest of the phases in the value chain. Smallholder vegetable farmers in Malawi are based on low input – low output production, because of poor input supplies (Wondim, 2021). However, access to an improved input supply creates a higher output potential.

The second phase of the vegetable value chain is the production phase. At this point, farming methods and tools, potentially adaptive technologies, are established. This phase also includes essential farm and production maintenance such as weeding, pruning, and integrating input supplies as needed. The activities in the production phase will vary based on the household and those leading the farm, which can cultivate constraints in the farming methods. However, there is also an opportunity to see significant productivity through intensive and efficient methods. The

connection between phases 1 and 2 must be highlighted, as the planning and resources put into input supply will directly affect production.

Production is followed by marketing/processing. The key aspect of this phase is connecting the farmer to the consumer. This phase encompasses market access, transportation, and vegetable storage, if necessary. Although few and specific, these elements can make or break production becoming profitable, which is critical for the farmers.

Lastly, displayed in Figure 2, is sales/output supply. At this phase, the most important aspect is sales and profitability of the product, whether it is at a market or from the farmer's home, which can include a middleman for sales. This will, in turn, create revenue for the farmers. At the end of the vegetable value chain, this study also evaluates increasing profitability for smallholder farmers in other ways. The idea of income diversity is analysed to increase income, as well as build capacities to allow for continuous profitability in the future.

2.3. Challenges in the Vegetable Value Chain

The integration of agriculture into Malawi's society and smallholder farmers dependency on it, indicates the importance of analysing its processes. Agriculture generates income, provides livelihoods for smallholder farmers, contributes to the household rate of food security, and improves health and nutrition. These aspects are fundamental to reducing poverty rates and enhancing the well-being of smallholder farmers. Therefore, it is important to recognise the challenges and mitigate risks within agriculture and the vegetable value chains that prevent them from reaching their fullest potential.

Challenges can be identified at every stage of the vegetable value chain, even those not highlighted in this study. In the early stages of the VVC, the greatest drawback would be a lack of improved resources such as improved seed varieties, fertilizers, herbicides, and other enhanced planting materials. Inadequate training and adaptive agricultural knowledge and skills, particularly around crop productivity and climate-adapting farming methods, can severely hinder a smallholder farmer's ability to have a productive yield (Giertz, et al., 2015). And lack of diverse participation, meaning one without women or youths, can limit potential income-generating activities (Kamoto & Singini-Nyirenda, 2021).

A lack of improved input supply will also directly affect the production of the VVC. The production phase is becoming increasingly susceptible to vulnerabilities and unexpected changes in the environment and its surroundings. In African countries, changes such as rainfall intensity, desertification, extreme weather events (droughts and floods), the transmission of diseases, and an increase in temperatures are just some of the negative impacts that can occur (Connolly-Boutin & Smit, 2016). These environmental variabilities will result in reduced crop yields (Bie et al., 2008). In a study by Kamanga et al. (2020), it is explained that there is medium to high multi-hazard vulnerability in Malawi as a result of both floods and droughts throughout the country. Water availability will likely be affected as climates continue to change and this will in turn affect crop productivity, particularly in vegetables (Bie et al., 2008). The environmental impacts are at the forefront of agricultural matters as they can reduce areas suitable for farming, shorten or disrupt growing seasons, and cause a decline in agricultural yields (Connolly-Boutin & Smit, 2016). As demonstrated in Figure 1, seasonal change significantly affects household food security levels. Smallholder farm will continue to struggle with production without interventions to adapt to the vulnerabilities. As crop production is considered one of the most important livelihood sources for most smallholder farmers, improved interventions can reduce poverty rates (Bhatti et al., 2021).

The linkages between farmers and consumers do not come without their challenges. Poor market function and access are significant challenges in achieving a successful VVC. For rural smallholder farmers in Malawi, there is a weak or a lack of infrastructure, both for supporting and accessing markets. Which includes poor road access and inadequate transportation, while also having a poor distribution of markets and inconsistencies among market availabilities (CIAT, 2018). These deficiencies create poor coordination methods and ineffective exchange of agricultural commodities (Madsen, 2022). These infrastructural shortcomings can be attributed to institutions and politics in Malawi, which is not in the domain of this study. Still, it can be determined that improvements in market functions and infrastructure would be a tremendous improvement to smallholder livelihoods.

All of these contributing difficulties throughout the VVCs in Malawi determines the potential outcome or output supply that a smallholder farmer can achieve. The opportunity for sales will be directly affected by market functions and access or one’s ability to sell the products from

home. Otherwise, the output supply will be unsuccessful. Poor output will lower the household income, negatively affect their livelihoods, and as a result, influence the food security rate in the household.

2.4. Vegetable Value Chains with Interventions

By analysing the vegetable value chain (VVC) and identifying challenges, it is possible to identify and improve the interventions for better livelihoods of smallholder farmers. It is important throughout districts in Malawi that interventions are adopted to face both present and future vulnerabilities (Bie et al., 2008). Figure 3 shows the VVC with the interventions. These interventions are based on the interventions from the TRANSFORM programme, with the objectives of (1) increased productivity, production, and diversification, (2) increased consumption of safe, nutritious, and diverse foods, (3) and improved profitable market access and entrepreneurship.

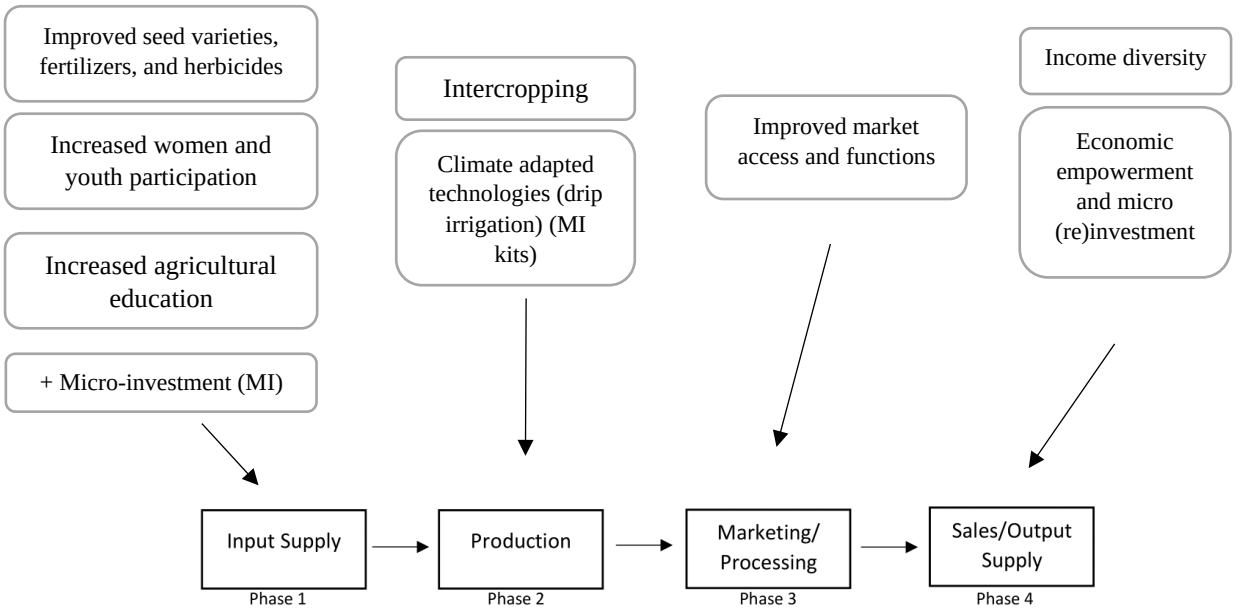


Figure 3. *Vegetable Value Chain with Interventions*

For input supply, with improved seed varieties, and access to affordable fertilizers and herbicides along with other plant materials, the set-up for production is already enhanced and holds greater potential. Through initiatives such as the TRANSFORM programme, there are agricultural and skills training to support farmers based on a holistic strategy to educate smallholders on

horticulture, processing, production, business skills and climate-adapted farming practices so help them achieve the best outputs on their farms. Building capacities is an invaluable contribution because it can continue to benefit the farmers long-term and can even extend to benefit other farmers at the community level. That said, encouraging participation for women and youths can have a positive influence on the agricultural sector. Increasing gender equality and participation of women and youths in agriculture can increase income generation and thereby contribute to the livelihoods and overall wellbeing of the household (Kamoto & Singini-Nyirenda, 2021). Combining training services and increasing participation from women and youths is an empowering choice that can benefit everyone.

Production techniques are ever-changing based on changing climates, species varieties, technologies and knowledge. Because of that, the interventions will continue to change overtime and in different regions. For this study and VVCs in Malawi, the main interventions for improved production are drip irrigation systems and intercropping farming methods. NCA's micro-investment programme is focused primarily on affordable drip irrigation systems. These consist of tubing systems and emitters that irrigate fields in such a way that maximizes uniformity and minimizes water use. This climate-adapted technology moves away from unpredictable rain-fed agriculture practices, provides sufficient water resources, and allows for up to three crop production cycles in a calendar year (Wondim, 2021). This adaptation technology would directly affect the rates of food deficiencies among smallholder farmer, by allowing for higher crop production during the dry season and therefore increased food security during the rainy season.

Along with drip irrigation systems, intercropping is another agricultural intervention to increase productivity and enhance climate resilience. Intercropping involves growing two or more crops in the same crop land (Makate, et al., 2016). Intercropping contributes to improved soil nutrients levels and water filtration, while increasing soil organic matter and soil coverage which acts as a natural pest repellent and reduces the spread of diseases (CIAT, 2018). Intercropping and drip irrigation together can make significant improvements to the farming system.

Following production, interventions on market linkages are critical. Lack of transportation and infrastructure is one of the greatest setbacks in reaching the market (Bhatti et al., 2022). In selling vegetable products, in this scope, the two main options are selling from home and selling

at the market. Home sales are prevalent in rural areas due to their inability to reach the market. Selling products from home is a good option; however, it does eliminate further sales opportunities in the market. Creating better linkages between rural farms and markets would significantly improve the income potential.

The output supply will be directly aligned with the other phases in the VVC. Therefore, if other elements of the VVC are improved, the sales or output supply will also reflect this improvement. If these interventions cannot be introduced, there are still opportunities at the end of the VVC to enhance the livelihoods of the smallholder farmers. Income diversity and economic empowerment can reduce the risk that are coupled with vulnerable sectors or environments. By diversifying income sources, if one source cannot provide what is needed, one can rely on other areas to generate the income that is required for food, health, and education, for example.

2.5. Economic Empowerment and Micro-Investment

The TRANSFORM programme targets five districts in Malawi and is built up of three consortium partners: Norwegian Church Aid (NCA), the Development Fund (DF) Norway, and the Norwegian University of Life Sciences[1]. Together, the implementing partners integrate action research, capacity building, climate adaptive practices, and improved food systems to aim for sustainable livelihoods and enhanced market value chains for smallholder farmers. NCA Malawi is using micro-investment (MI) initiatives to support the interventions, tools and MI programs based on learnings from the MI initiatives of NCA Tanzania. For this study, the implementing partners were critical in contributing knowledge, skills, time, assessments, adjustments, and continuous dialogue to achieve improved results. Using the MI approach as a framework and guidance through economic empowerment, TRANSFORM is designed to create profitable small-scale transitions from subsistence farming to commercial farming.

The MI approach with TRANSFORM, highlighted as an intervention in this study, aims to introduce smallholder farmers to simple, affordable, and profitable farming techniques. Micro-investments are innovative, “market-based solutions”, based on “initiatives that use the market economy to engage low-income people as customers, offering them socially beneficial products

[1] It is important to note that details and facts throughout this thesis regarding the TRANSFORM programme and the MI initiative are provided by NMBU, NCA or DF colleagues and internal documents, mainly (TRANSFORM programme, 2021) found in references.

at prices they can afford – providing them with improved incomes (Kubzansky et al., 2011, p.3).” This programme aims to reduce an overdependency on rainfed agricultural production by introducing micro drip irrigation systems. Smallholder farmers will also improve food security and livelihood with increased production and profits.

The structure of the MI approach with smallholder farmers enables the opportunity for economic empowerment. NCA and its partners aim to increase smallholder famers’ income, ensure climate-resilient production methods, and encourage opportunities created for youth. This can be achieved through proper implementation and integration for smallholder farmers and removing barriers to production, integration, and services necessary to succeed. With the MI approach, when smallholders identify opportunities to enhance their productivity and profitability, they will likely reinvest to continue such growth. This creates a cycle whereby MI allows for gradual increases in smallholder production. These gains continue to increase the capacity and resources of the farmers, which in turn leads back to more reinvestment.

The MI approach is applicable to both the input supply and the output supply of the VVC. The MI initiative can introduce enhanced input supplies that start the VVC process in a robust way, leading to higher production potential. At the end of the VVC, with approaches such as income diversity, economic empowerment, re-investment in MI initiatives and capacity building through the incubator model (Figure 4). These allow for long-term, continuous improvements that will encourage the farmer’s and their household’s growth while enhancing different aspects of their lives and the community over time, including increasing food security, and decreasing poverty rates.

The incubator business model, intended to strengthen the MI-initiatives and linkages with the local leadership, is an important aspect of the TRANSFORM programme. The incubator model (Figure 4) is multi-level structure organised to thoroughly integrate the micro-investment model and techniques and enhancing local ownership, both beyond the life of the project. At the community level, this approach will provide long-term learnings that can continue to be develop and expand along with interest in horticulture production. The incubator approach starts with the *Agronomist*, involved in the micro-investment model, to provide enhanced knowledge about local agricultural practices and improved practices aimed at increased production.

From the knowledge of the agronomists, there are teaching for the *Village Agro-Technicians* who are trained to provide support beyond the implementation and intervention period. This concept is designed to continue capacity building through peer learning among farmers as an effective and efficient way of transferring knowledge and skills to create sustainability. With the descending tiers, the positions include *Incubator Chairperson*, *Incubator Host*, *Incubator Treasurer*, *Incubator Secretary*, and *Incubator Marketing Representative*. As a cumulative unit, the incubator model, will build a network at the community level that will teach and encourage skills to build sustainability and local ownership for increased crop productivity and profitability to in turn, reduce poverty levels.

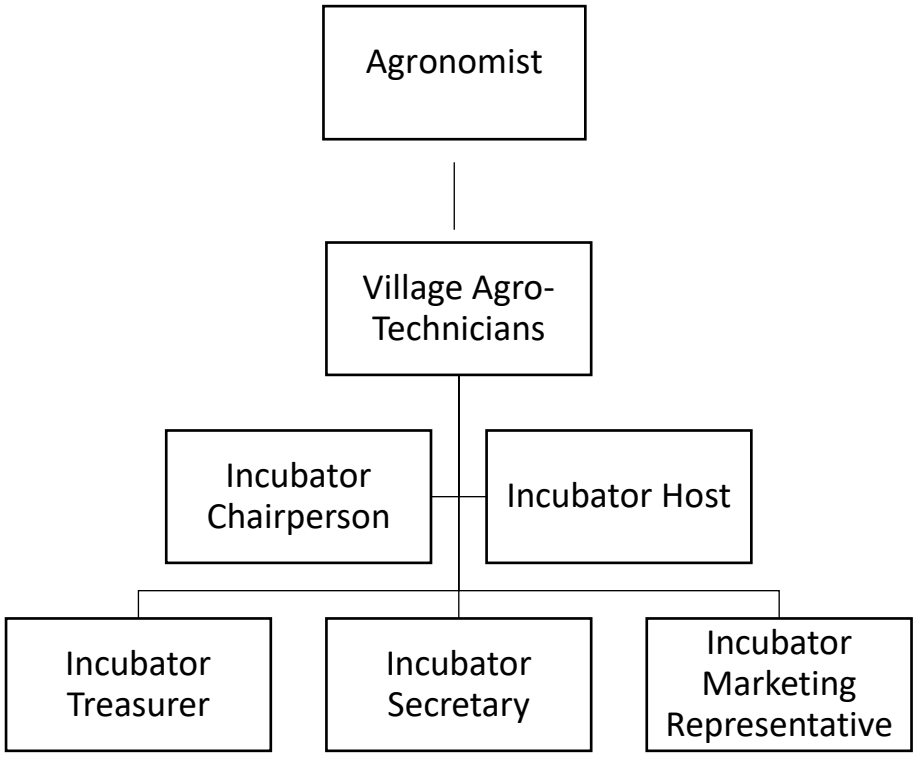


Figure 4. *The organisational structure of the* ***Incubator Model*** *in micro-investment at the community level*

The incubator model is a long-term intervention, through the TRANSFORM programme, for capacity building and community enrichment to improve aspects of the vegetable value chain (VVC). In order to implement such as model there must be guidance and resources through

initiatives such as micro-investment (MI). MI allows for financing aspects and interventions throughout the VVC to thereby aim for improvements, resilience, and sustainability. These aims are highlighted in the concept of economic empowerment in enabling people to lift themselves out of poverty by building community resilience.

Chapter 3

3. Methodology

This chapter describes the methodological approach to this study, including, research type, method of data collection, study area and population. As well, it describes the method of data analysis and discusses the ethical considerations and limitations within the study.

3.1. Research Type

To generate a broad understanding of micro-investment in drip irrigation for vegetable production, this study will take a quantitative research approach. Quantitative research methods are concerned with quantifiable data that evaluates facts about a social phenomenon through measurable results (O'Dwyer & Bernauer, 2014). This approach will allow for learning about a particular group of people, here being smallholder farmers in Malawi, to gather numerical data to identify patterns and averages to generalize results about the questions at hand towards the wider population. The participants for the study were gathered randomly through a pool of more than 3000 smallholder farmers in the records of NCA. In this study, the intervention group will be farmers who have micro-invested in the drip irrigation kits. Additionally, the randomization of this method creates probabilistically equivalent results which is critical in an evaluation identifying impacts on the general population (O'Dwyer & Berauer, 2014).

3.2. Data Method

In this study, a cross-sectional survey was conducted, whereby the quantitative data was collected at one point in time to detect patterns of association in connection with micro-investment and vegetable farming (Bryman, 2012). This questionnaire was developed in accordance with the research questions to contribute to an in-depth analysis and was reviewed by my supervisors and the programme colleagues, who provided feedback and comments as required. This included adding or removing questions for numerous reasons, rewording questions for a more precise understanding, and editing details within the questions or close-ended responses to make them more accurate for representing the sample population. After completing revisions and receiving the approval from all team members, the next step was to upload the questionnaire to the Kobo platform which was used by the NCA in TRANSFORM programme to then proceed with data collection.

The survey was conducted by the ten research assistants in Malawi using a Kobo that functioned with or without mobile or internet network, which allowed for data collection in rural areas. Prior to conducting the surveying, to familiarize with the questionnaire, a two-day pre-survey training was conducted for the data collectors in the field. There were several Malawian team members that visited farmers within the project to ensure their willingness and availability to take part in the surveying process. As well, proper verbal consent to participate in the survey was taken before the start of the survey. The survey was ethically approved by the Ethical committee in the Lilongwe University of Agriculture and Natural Resources (LUANAR) in Malawi. The questionnaires were administered to the randomly selected respondents by the NCA's research assistants (n=10). The data collection was completed over 10 working days, with approximately 30 farmers being surveyed each day (3 surveys each per days).

3.3. Location of Study Areas in Malawi

Figure 5. *Location of the two study areas, indicated by asterisks, on the map of Malawi.*

Adopted from d-maps.com (2022).

3.4. Study Area and Data

In this study, primary data was used following probability sampling. The cross-sectional survey was conducted in July of 2022. The study focused on two of the five districts in Malawi included in the TRANSFORM programme, which can be identified in Figure 5. These five districts were

districts of choice for the TRANSFORM programme because of their potential to have a meaningful impact. It was established that these districts have acute food shortages, and face challenges related to climate change, food and nutrition security, and poverty. With that said there is potential, through interventions to improve the value chains within these areas. It was the intention to survey all five districts for this study but due to COVID-19 restrictions data collection was only able to focus on two districts, Mchinji and Mzimba South (Figure 5).

Mchinji is in central Malawi and has a population of about 600,000 people. The rainy season is typically from mid November to mid April with humid climate, but year-round it is warm as the temperature almost always ranging from 10C to 29C, the rainy seasons being the warmest (WeatherSpark, 2022a).

While Mzimba South district is the Northern part of Malawi and has a population of about 610,000 people. The rainy season in Mzimba also runs from mid November to mid April, however, this area experiences less humidity and the temperature ranges from 10C to 31C. This subtle different might be because of a slightly lower altitude in the district (WeatherSpark, 2022b). These study districts were chosen to represent varying socio-economic, geographic, and age contribution to the data. This survey is a compiled of close-ended questions and was inclusive of 300 registered micro-investing smallholder farmers chosen by random sampling from the total available farmers to ensure equal probability from the two TRANSFORM implementation areas.

Figure 6 displays the sample population categorized by district and within that, categroized by gender. The micro-investing (MI) farmers in the sample population have invested in micro-investment drip irrigation kits aimed to provide resilience to climate change and improve production systems through enhanced farming techniques and resources. Within the MI kits, there is affordable drip irrigation kits, ameliorated seeds, plant nutrition, fertilizers, and herbicides. These resources provide an improved input supply to begin their vegetable farming.

To invested in these MI kits, farmers pay a fixed cost of 15,000 Malawian Kwacha (MWK) for the drip irrigation systems and a variable cost for the necessary planting materials based on their farming area. The unit used for the farming areas was in beds. One bed is 15 meter long, 1 meter wide, and 30 centimeters high. The beds were spaced 50 centimeters away from each other and a minimum of 1.5 meters away from the fence. Sunken beds were recommended during dry

periods and raised during rainy periods (Bhatti at el., 2022). Additionally, these farmers will be provided with knowledge and skills on the relevant techniques and entrepreneurial skills combined with support from local agronomists. With the help and guidance of the implementing partners, the MI farmers aimed to transform the food and agricultural systems.

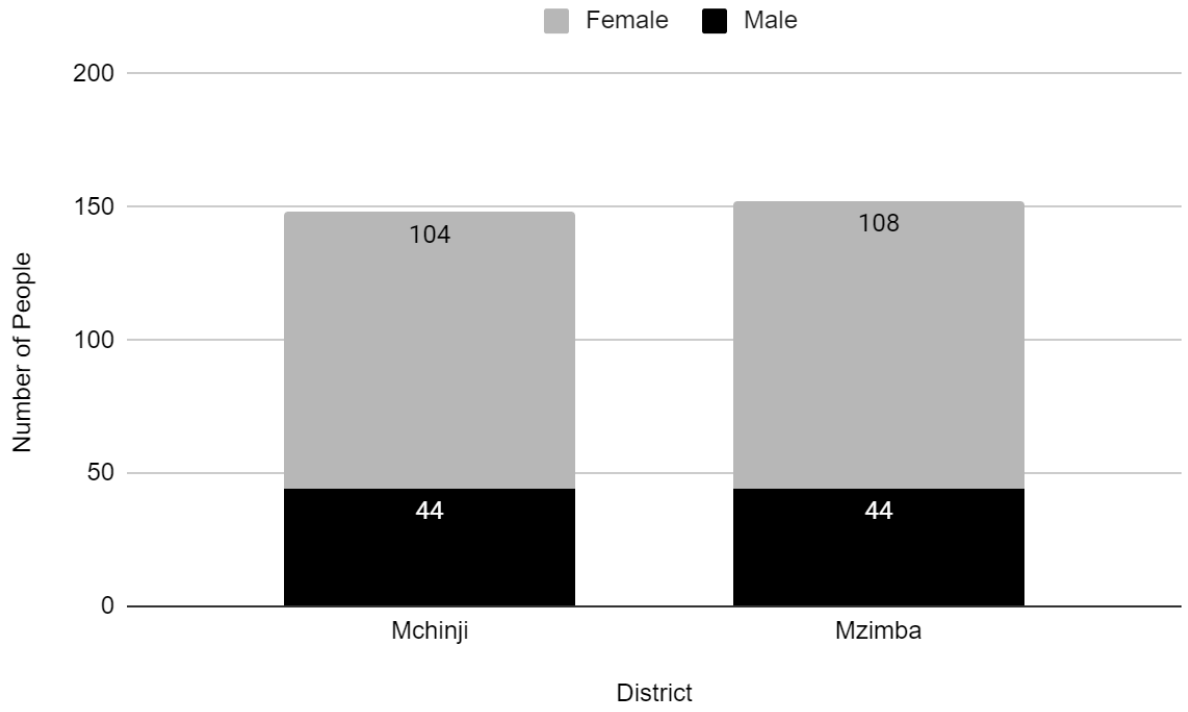


Figure 6. *Sample population for study categorized by district and gender*

In the cross-sectional survey, the questionnaire was focused on the following: questions related to cost, revenue, yield production, livestock farming, re-investment, and asset and land ownership in combination with concepts such as gender, poverty and food security. These topics broadly encapsulate the information necessary to gauge the impacts that the MI kits have had on the farmers' livelihoods.

3.5. Data Analysis

The data was cleaned of any errors or missing values, then input into Excel sheets for analysis. In the economic analysis, only those farm commodities that were grown by more than eight farmers were considered. With the seven (7) most commonly grown vegetable types among participating

farmers, a variety of analyses and calculations were conducted to understand the data. The mean, median, maximum, minimum and standard deviation for different aspects were all identified and calculated. The mean is the average of the dataset, calculated by the total divided by the number of values present, while the median is the midpoint in a distribution of values (Bryman, 2012). Whereas the maximum is the highest number in a given dataset and the minimum is the lowest number in the same set. The standard deviation is a representation of the how the data is dispersed in relation to the mean, where a low standard deviation indicates more clustering in the data set and a high standard deviation indicates a wide range in the numbers in the dataset.

The total variable cost (TVC) is the total of any variable costs involved in production, including fertilizers and herbicides. There were also fixed costs for the farmers that were not calculated and were assumed to be the same for all farmers. The unit of measurement varied among the vegetables based on the most appropriate for sales. Tomatoes were measured in 20-kilogram buckets, rapeseed, mustard greens, and okra in bundles, onions and cucumbers in kilograms, and spinach in bundles. Yields were measured in units per bed, per season. Price was calculated per bed. Price, TVC, revenue, gross margin, and break-even price were all measured in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

The revenue identified the earnings from the production of a given vegetable per bed. Revenue was calculated using the following formula:

$$Revenue = units\ of\ yield\ per\ bed \times sale\ price\ per\ unit$$

The gross margin (GM) calculated the total profit earned from the revenue of production after any expenses. GM was calculated using the following formula:

$$Gross\ margin = revenue - total\ variable\ cost$$

The gross margin analysis was used as described in Bhatti et al. (2022).

The break-even price represents the amount that each vegetable must be sold at to cover production costs. Break-even price was calculated using the following formula:

$$Break\text{-}even\ price = average\ total\ variable\ cost\ /\ average\ yield$$

And the break-even yield represents the yield amount required to cover production costs. Break even yield was calculated using the following formula:

Break-even yield = average total variable cost / average sale price

These equations will be used to analyse the results of the data collected for the various vegetables in this study. This will also allow for comparisons among the costs and earnings, as well as determining the vegetables that acquire the most gains or losses.

3.6. Ethical Considerations

Prior to conducting the questionnaires some ethical considerations were taken into account by myself, my supervisors and NCA colleagues. The NCA colleagues in Malawi ensured that informed consent was given by the participants. As an introduction to the survey with each participant, the surveyor introduced themselves and explained the purpose for the research. Additionally, anonymity of the participant was ensured with the individual to encourage the most honest answers and the most accurate data.

3.7. Limitations

It is important to mention that this research is subject to some limitations. Due to COVID-19 restrictions continually changing and complications repeatedly arising, travelling to the study sites was not possible to conduct the surveying myself and we therefore had to rely on o the colleagues in Malawi. With many difficulties arising with scheduling, having input from multiple partners, and other unexpected changes, the time liberties for data collection became more limited. As a result, we had to change from a mixed methods approach, involving focus groups, to a quantitative approach with only surveys. In addition, for convenience and time efficiency, we decreased the number of participants in the study and chose them using randomized sampling procedures. Therefore, this study focused only on smallholder farmers who were practicing the MI-interventions. The reduction in sample size may not accurately represent the entire population and the randomized sampling method may skew the data in unexpected ways but it can provide a snapshot and possible ways to improve the intervention. Therefore, an extensive study with a bigger sample size and involving more study areas can help to identify more success and learning lessons on the ground.

Chapter 4

4. Results and Discussion

This chapter presents the results of the study. Descriptive analysis is used to describe the data collected regarding gender and demographic characteristics, as well as to complete an economic analysis of the seven main vegetables. A combination of descriptive and inferential analyses is utilized to present the results and carry out a discussion on the topics of gender, production, market access, farming methods, and economic empowerment. This includes identifying opportunities along the vegetable value chain to increase production and profitability while discussing long-term practices for improved food security.

Malawi is a low-income country that is characterized by its high population growth rate (about 2.7%), high poverty levels, and agriculture-dependent households (CIAT, 2018; World Bank, 2022). According to CIAT (2018), the average land size for low-income households is about 0.23 hectares, while wealthier households average at 0.42 hectares. With a growing population coupled with limited and decreasing land sizes, the need for high productivity at the small-scale farm level is critical. Innovations, access, and empowerment all leading to sustainable food systems have the opportunity to improve the challenges that smallholder farmers face (FAO & INRAE, 2020). Willett and Rockström (2022) describe the importance of a substantial shift in food systems to prioritize vegetable value chains (VVC) to see a reduction in food losses and major improvements in food production practices. This approach benefits both human health and environmental health that can significantly transform vulnerable populations (Willett & Rockström, 2022). In shifting towards improving horticultural practices at the small-scale it is important to analyse its functions and the impacts of interventions to VVCs.

4.1. Gender Analysis

The demographic of the farmers in this study is shown in Figure 7. Two important groups in Malawi's growing population are women and youths. Women and youths are often categorized as further vulnerable groups because of traditional gender roles, social norms, and cultural impediments that hinder equality. However, they contribute significantly to agriculture as women in Malawi provide 70% of labour for smallholder crop production and approximately 56% of youth in Malawi engage in farming for employment (Kamoto & Singini-Nyirenda, 2021; Singh et al., 2020). As seen in Figure 7, 71% of this study's sample population were females and

38% were below 40 years old. Gender analysis is an important consideration in the TRANSFORM programme to promote equality, empowerment, and lasting developments. Building capacities and skills of all groups and people involved in agriculture is the only way to have significant growth in this sector.

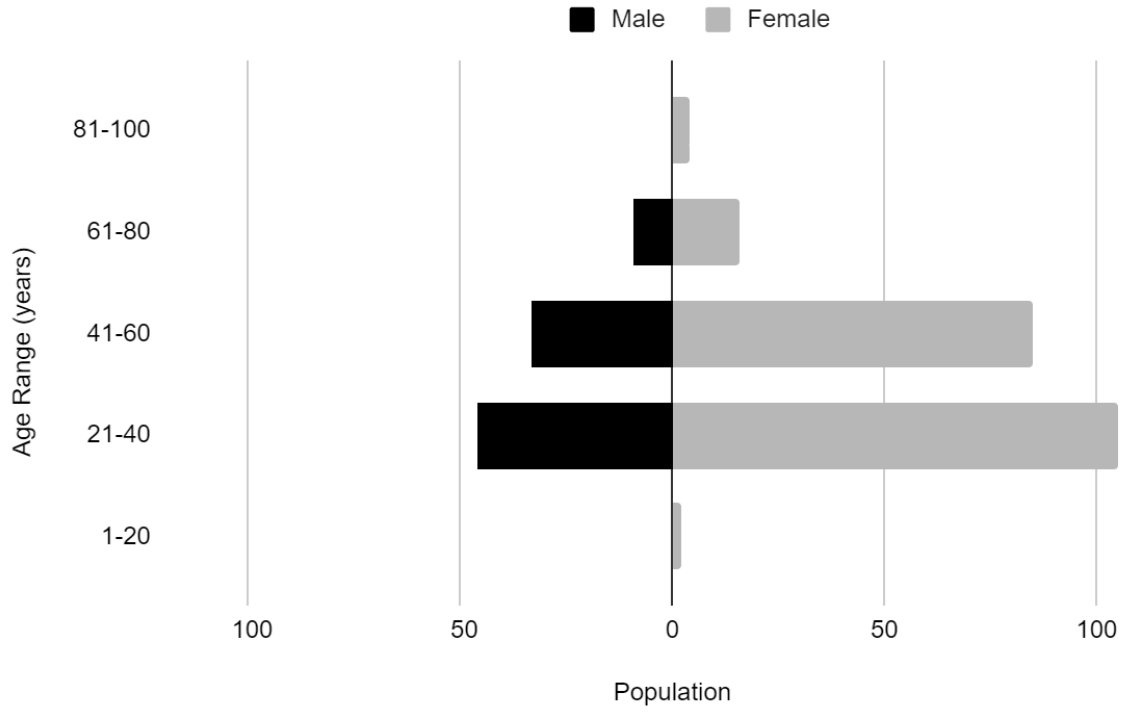


Figure 7. *Demographic of participating micro-investment farmers*

Table 1 displays the head of households (HH) for each participating smallholder farmer categorized by age and gender. This table shows that the most prevalent group for HH is males between the ages of 21-40, followed by males between the ages of 41-60. Males are grossly more common as the HH than females. The third most prevalent category is females aged 41-60. There are also HH for both women ages 21-40 and women and men ages 61-80. There are 5 female HH between the ages of 81-100 but there are no men in that same age range. There are no HH below the age of 20. There are 10 households that have shared HH, meaning both women and men identify as the head of household. There are 8 shared HH between the ages of 21-40 and there are 2 shared HH between the ages of 41-60.

Table 1. *Head of Household categorized by gender and age*

Age Range (years)	*Male*	*Female*	*Both*
1-20	0	0	0
21-40	101	15	8
41-60	93	37	2
61-80	29	10	0
81-100	0	5	0

In comparing Figure 7 (farmer demographic) and Table 1 (HH demographic) some differences can be observed. Although 212 participating farmers were female, there were only 67 households that identified women as their HH, 75 if shared HH is included. There are similar distributions in age among the participating farmer and HH, however the HH age was slightly higher. The average age for farmers was 42 and the average age for HH was 46. Identifying the difference between these two titles can be critical when understanding the function and decision-making aspect on the farm.

Comparing the HH and farmers demographics illustrates that even though women are more participatory in smallholder farming for this study, they are not necessarily equals or decision makers in their homes. It is not clear if the person(s) in charge of the farm, would also be the person(s) making decisions for the farm or the household, and this will likely vary from household to household. These decision-making powers will greatly affect the agricultural approach and functions, including input supply use, use of technology, and farming techniques to name a few.

Below, Table 2 displays the data determining the roles of men and women on their smallholder farm, presented in numbers and percentages. This data shows that the majority of respondents, 57%, answered that agricultural responsibilities are shared equally between men and women. At 26%, sharing roles between men and women but women being primarily responsible was the second most prevalent answer. Following this was sharing roles between men and women but men being primarily responsible, and the farm being completely run by women were strong

responses. There were responses of 1% or less for the last three categories of the farm being completely un by men, the farm being physically run by men but with women's input and the farm being physically run by women but with men's input. This presents another interpretation of who has what power on the farm, and this still might not be related to or aligned with who has power in the household.

Table 2. *Role of men and women on smallholder farm*

Role of men and women on smallholder farm	*Number*	*Percentage*
Completely run by men	3	1%
Completely run by women	17	6%
Physically run by men, with women's input	2	0.7%
Physically run by women, with men's input	1	0.3%
Shared roles between men and women but primarily men	28	9%
Shared roles between men and women but primarily women	78	26%
Split equally between men and women	171	57%

The traditional and domesticated role that women have in rural homes in Malawi dictates the how they contribute to their homes and in agriculture. Women are mainly responsible for domesticated and household chores, childcare, collecting firewood and water, while also trying to contribute to farming activities. According to Kamoto and Singini-Nyirenda (2021) this is considered having a 'double burden' as they have a domestic and reproductive workload as well as productive work. Moreover, the participation of women in agriclture is often limited because there is a cultural expectation that women do not work away from their homes (CIAT, 2018; Kerr et al., 2018). Because of this, women's ability to participate in income-generating activities and education is more difficult than men's and climate change is furthering these challenges as resources become scarcer.

Kamoto and Singini-Nyirenda (2021) emphasize that gender norms within a society influencing the work of men and women are significant impediments to household food and nutrition security. With women already having knowledge on local cuisine and market function, it would

be transformative to incorporate them further into agriculture. Encouraging such integration of women can be coupled with great difficulties because of cultural and social norms, but if gender integration was a priority in agriculture the improvement would be exemplary. Empowering women and strengthening their capacities can transform communities, agriculture, food systems and poverty levels in a sustainable way.

An effort to decrease a gender inequality as such is a priority for TRANSFORM which is why there is an emphasis on participation from women and youths as well as improving efficiency of smallholder farmer. This would ideally allow the crop beds to be located at or in close proximity to the home, allowing more involvement. This is supported by Chagomoka et al. (2014) who argues that women are becoming increasingly more involved in small-scale traditional african vegetable (TAV) for household consumption and local markets, whereas men are more active in commerical agriculture for resturants and exports for exmaple. This highlights the importance of increasing not only female participation but also capcity and knowledge building as it will strengthen local and household vegetable value chains.

In connection with the vegetable value chains (VVC), in the beginning phase of input supply is where increased participation of women and youths should happen. Gender can play a role in the functions and opportunities throughout the VVC. Therefore, increasing women's participation would expand income generating opportunities and it could share the agricultural duties rather than relying solely on men. In integrating women in the agricultural sector and increasing their skills and capacities, although it can come with its cultural and social barriers, it could also expand and empower women in their homes. This is not to say that women should overpower men in the household, rather with more education, could come more inclusion in agriculture or household decision making. As well, improving the farming capacities of women would theoretically increase the output supply and could contribute to improving food and nutrition security and a local level. And it could change the view men might have towards women and what they are capable of. Notably, this is only one possibility of how female empowerment in agriculture could move forward, there are many others and some that could be dangerous for woman and child, and it is to consider such real-life effects that could occur.

4.2. Vegetable Production

Agriculture's importance has expanded beyond income generation, as food security is Malawi's most pressing issue. Vegetables, among other crops, are important because of their high nutritional value and short growing season. Traditional African Vegetables (TAV), according to Chagomoka et al. (2014) refers to the principal and indigenous vegetables grown in African countries. Despite climatic stresses and limited arable land, Malawi provides a suitable environment to cultivate such vegetables (Chagomoka et al, 2014). This varies by country, but in general, nutrient-dense foods can contribute to improving malnutrition while also generating income, restoring biodiversity, preserving local customs, and empowering women and youths (Chagomoka et al, 2014; Mwadzingeni et al., 2021). For these reasons, the importance of local production and access to sustainable markets is vital.

In this study, there will only be data of eleven TAVs which are relevant and specific to the TRANSFORM programme, which has been collected from the participating smallholder farmers. This is not inclusive of all the vegetables or crops that are grown within Malawi. These vegetable types do contribute to households in Malawi as they are intertwined in the culture and cuisine, meaning they are good for marketing and consumption. Moreover, TAV provide necessary household nutrition to contribute to a balance diet (Chagomoka et al., 2014). In households where food and nutrient requirements are not always met, it is important to consume food with high nutrient content.

4.2.1. Profile of Vegetables Grown

Although this study included data from 11 different vegetable crops, seven (7) primary vegetables are represented and account for 95 percent of the data collected. Figure 8 depicts the percentage of farmers participating in this study that grew the seven main vegetables. Tomatoes (42.6%) are the most often planted vegetable, followed by rapeseed (25.1%), mustard greens (14.8%), okra (6.5%), onion (5.1%), cucumber (3.2%), and spinach (1.2%).

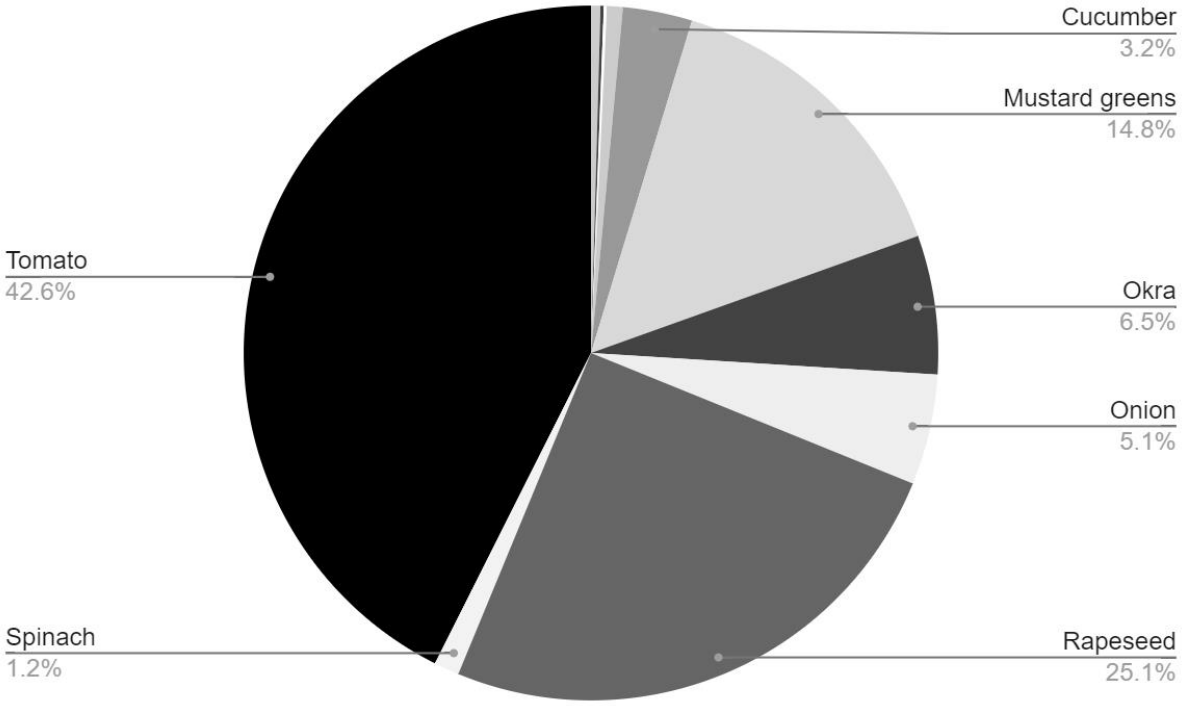


Figure 8. *Percentage of farmers growing each vegetable*

Displayed in Table 3, is all the vegetables recorded for this study, distributed between the two study districts. This is another way to see the most popular vegetables to grow and how that is distributed among the study areas. Bonogwe is the local name for a specific leafy green vegetable and cabbage and Chinese both refer to different types of cabbage. However, these three vegetables are not relevant for the in-depth analysis of the study.

Tomatoes, rapeseed, and mustard greens were the top three vegetables grown in both research locations and had similar figures in each district. There was cucumber and spinach only grown in Mchinji, and not in Mzimba. And there was only one person in Mzimba South that grew okra, while there was 43 people in Mchinji. Onions were grown in Mchinji district by 14 farmers, while in Mzimba district there were 21 farmers. It is worth noting that Mchinji district produced more vegetable crops than Mzimba South. Because Mzimba South had a slightly bigger number of participating farmers in this study, therefore the farmers in Mzimba South had fewer crops on average. The average number of crops grown per farmer ranges from 1.9 in Mzimba South to 2.6 in Mchinji. This was determined by dividing the total number of smallholder farmers in each district by the total number of vegetables grown in that district. It is important to note that these

are only averages but the distribution of crop to farmers in each district is much different. Based on the research of smallholder vegetable farming in Malawi, there is little information about growing specific vegetables in specific districts, therefore this study cannot determine the reason for particular vegetable crops being grown more in one district than the other.

Table 3. *Number of crops grown in each district*

Crop Name	*District*		*Total*
	Mchinji	Mzimba South	
Beans	1	2	3
Bonogwe	1	0	1
Cabbage	0	1	1
Chinese	5	0	5
Cucumbers	22	0	22
Mustard greens	51	50	101
Okra	43	1	44
Onions	14	21	35
Rapeseed	101	70	171
Spinach	8	0	8
Tomato	139	151	290

Similarly, Table 4 displays the distribution of vegetables grown by males and females. Following the same method as Table 3 to find the average number of vegetables grown by males and females, females grew an average of 2.3 vegetables per person, whereas males grew an average of 2.1 vegetables per person. Again, it is important to mention that this is simply an average and that the distribution varies greatly across farmers, with females growing the most crops and males growing the least. It can be observed in Table 4 that women grew significantly more leafy vegetables (mustard greens, rapeseed, and spinach) than men. As well, there was a much higher number of women growing tomatoes than men, 205 compared to 85. Onions had comparable figures among men and women. Okra had 20 more women than men growing the crop and cucumbers had 12 more women than men.

Table 4. *Number of crops grown classified by gender*

Crop Name	*Gender*		*Total*
	Female	Male	
Beans	3	0	3
Bonogwe	1	0	1
Cabbage	1	0	1
Chinese	5	0	5
Cucumbers	17	5	22
Mustard greens	79	22	101
Okra	32	12	44
Onions	19	16	35
Rapeseed	119	52	171
Spinach	7	1	8
Tomato	205	85	290

The following tables present an individual analysis of the seven most prevalent vegetables in the study. The total variable costs (TVC) vary based on the type of fertilizer used and the amount needed, determined by the number of beds used for the vegetable crop. As well as the amount of herbicides required per bed and for each vegetable.

4.2.2. Tomato

Because of its widespread culinary and nutritional significance in Malawi, tomatoes have become a staple crop for the country's smallholder farmers (Chadha et al., 2008). Tomatoes are extremely versatile as they contribute in different ways to local dishes and in general can be fresh or processed. That said, for sales in local Malawian markets, fresh tomatoes are desired. Because of this, Mango et al. (2015), explain that the marketing and processing involved in the VVC, specifically the transportation and infrastructure need improvement to optimize tomato sales. Tomatoes were also the most widely planted produce in this study.

Table 5 displays the data collected for tomatoes. In this study, tomatoes cultivated an average of 9.8 beds per farmer, the greatest of any region. The tomato yield of 20kg buckets ranged from 1.1 unit to 18 units (20kg buckets), with an average of 5 units. The average sale price per unit was 4,464 MWK, and the highest was 18,000 MWK per unit (20kg bucket). The TVC average was 4,669 MWK, which was very close to the median and maximum of 5,310 MWK, which illustrates that there was not much variation in the TVC. The average revenue per bed made from

tomatoes per was 22,821 MWK. The minimum revenue recorded was 3 MWK and the maximum was 150,000 MWK. After calculating the revenue, the gross margin could be calculated. The average gross margin was 17,741 MWK. The minimum and the maximum for the gross margin were drastically different, whereby the minimum was -5,311 MWK, meaning the farmer did not earn money and the maximum was 144,689 MWK.

Table 5. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (kgs), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of tomatoes.*

Tomato		*Area cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	9.8	5.0	4,464.7	4,669.4	22,821.1	17,741
	Minimum	3.0	1.1	1.5	1,530.0	3.0	-5,311.0
	Median	10.0	3.75	4,000.0	5,310.0	12,500.0	8,299.5
	Maximum	22.0	18	18,000.0	5,311.0	150,000.0	144,689.0
	Standard Deviation	2.7	5	2,512.0	1,134.5	25,552.0	25,410.3

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 20-kilogram bucket, and is calculated per bed per season.
***All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.3. Rapeseed

Table 6 displays for data collected for rapeseed. The data recorded for rapeseed shows that the average cultivated area for the crop is 2.5 beds per farmer. The minimum area cultivated recorded was 1 bed and the maximum was 12 beds. The average yield for this crop was 50.7 bundles. And the sale price average per bundle was 312.3 MWK, with a minimum of 50 MWK and a maximum of 5,000 MWK. The TVC ranged from 100 MWK to 240,000 MWK, with the average being 11,879 MWK. The average revenue was calculated as 3,857 MWK and the maximum revenue for this crop was 225,000 MWK. The average gross margin for rapeseed was 2,018 MWK and the maximum was 16,248 MWK.

Table 6. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (bundle), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of rapeseed.*

Rapeseed		*Area cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	2.5	50.7	312.3	11,879.9	-3,857.0	2,018.8
	Minimum	1.0	1.0	50.0	100.0	-20,186.0	15.0
	Median	2.0	20.0	100.0	2,000.0	-13,310.0	822.9
	Maximum	12.0	1,000.0	5,000.0	240,000.0	225,000.0	16,248.8
	Standard Deviation	2.1	123.8	813.9	32,873.1	32,956.2	2,914.7

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 bundle ≅ 1 kilogram, and is calculated per bed per season.
*** All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.4. Mustard Greens

The average area cultivated for mustard greens was 2.1 beds per farmer, as seen in Table 7. In each bed the average yield was 19.4 bundles, where the minimum was 1 bundle, and the maximum was 160 bundles. The sale price for mustard greens, on average was 397 MWK per bundle, which varied in a range from 10 MWK to 6,000 MWK. For this crop the TVC was 4,892 MWK, which had a huge range of costing between 50 MWK and 125,000 MWK. As a result, the revenue range was also large, where the minimum was -20,060 MWK and the maximum was 110,000 MWK. On average the revenue was -10,254 MWK. For the gross margin, the average was 3,079 MWK per bed. The minimum gross margin was 93 MWK, and the maximum was 15,000 MWK.

Table 7. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (bundle), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of mustard greens.*

Mustard greens		*Area cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	2.1	19.4	397.7	4,892.1	-10,254.3	3,079.7
	Minimum	1.0	1.0	10.0	50.0	-20,060.0	93.8
	Median	2.0	9.0	100.0	1,000.0	-14,000.0	1,666.7
	Maximum	12.0	160.0	6,000.0	125,000.0	110,000.0	15,000.0
	Standard Deviation	1.5	27.0	1,010.7	14,468.2	14,520.1	3,515.1

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 bundle ≅ 1 kilogram, and is calculated per bed per season.
*** All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.5. Okra

The average area cultivated for okra was 2.8 beds per farmer. This yielded an average of 11.7 bundles per bed as seen in Table 8. And the average sale price per bundle was 133MWK. The sale price for okra was relatively consistent as the minimum was 100 MWK and the maximum was 500 MWK. It can be understood that the sale price for okra does not have extreme variations. The average TVC for okra was relatively low at 1,579.4 MWK. From this, the average revenue was recorded as -13,903 MWK, where the minimum was -19,310 MWK and the maximum was -6,666 MWK, so all the revenues recorded were negative. In terms of the gross margin, the average was 3,543 MWK. The minimum calculated was 263 MWK and the maximum was 15,000 MWK.

Table 8. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (kgs), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of okra.*

Okra		*Area cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	2.8	11.7	133.3	1,579.4	-13,903.3	3,543.0
	Minimum	1.0	1.0	100.0	100.0	-19,310.0	263.2
	Median	2.0	7.5	100.0	1,000.0	-14,400.0	2,031.0
	Maximum	6.0	57.0	500.0	8,333.3	-6,666.7	15,000.0
	Standard Deviation	1.7	13.5	73.7	1,840.9	2,205.2	3,882.3

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 bundle ≅ 1 kilogram, and is calculated per bed per season.
*** All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.6. Onion

As seen in Table 9, the average number of beds for cultivating onions was 6 beds per farmer, where the minimum was 1 bed, and the maximum was 12 beds. From these beds the average yield produced was 36.8 kgs per bed. For the maximum capacity per bed, it was recorded to be 200 kgs. The average sale price per kg was 323.8 MWK. The minimum recorded was 50 MWK and the maximum was 800 MWK per kg. For farmers growing onions, the average TVC was 39,461 MWK. Yet the range was very wide where the minimum TVC was 214 MWK, and the maximum was 240,000 MWK. From the yield and the average sale price, the average revenue was calculated as 23,644 MWK. This helped in calculating the gross margin which had an average of 2,860 MWK per bed. All figures calculated for the gross margin were positive which explains that in all situations farmers were earning money from growing onions.

Table 9. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (kgs), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of onions.*

Onion		*Area cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	6.0	36.8	323.8	39,461.7	23,644.7	2,860.4
	Minimum	1.0	1.3	50.0	214.3	-19,811.0	75.0
	Median	6.5	20.0	250.0	11,562.5	-3,437.5	750.0
	Maximum	12.0	200.0	800.0	240,000.0	225,000.0	12,186.6
	Standard Deviation	4.5	54.1	199.2	64,145.8	64,667.9	3,774.7

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 kilogram, and is calculated per bed per season.
*** All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.7. Cucumber

For cucumbers, as seen in Table 10, the average number of beds for cultivating was 2.9 beds per farmer. And the average yield was about 10 kgs. The average sale price per unit fell almost directly in the middle of the minimum and maximum at 225 MWK. And the TVC was approximately 10,000 MWK, ranging from 200 MWK to 80,000 MWK. The revenue for cucumbers on average was -5,306 MWK. And the gross margin was an average of 3,852 MWK, where the minimum was 600 MWK, and the maximum was 15,000 MWK.

Table 10. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (kgs), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of cucumber.*

Cucumber		*Area cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	2.9	10.1	225.0	10,072.6	-5,306.7	3,852.4
	Minimum	2.0	1.0	50.0	200.0	-14,800.0	600.0
	Median	2.5	9.8	125.0	2,300.0	-12,700.0	1,539.5
	Maximum	5.0	25.0	500.0	80,000.0	59,690.0	15,000.0
	Standard Deviation	1.1	8.0	172.9	21,093.2	19,743.7	4,212.1

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 kilogram, and is calculated per bed per season.
*** All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.8. Spinach

Table 11 displays the analysis of spinach where yield was measured per bundle which is equal to approximately 1kg. The average area cultivated by participating farmers for growing spinach was about 3.4 beds per farmer. The average yield of spinach grown was about 480.9 kgs, with the minimum being 6 kgs and the maximum being 2,000 kgs. The sale price was consistently 100 MWK per bundle. And the TVC was an average of 48,085 MWK, where the minimum was 600 MWK, and the maximum was 200,000 MWK. The revenue range for spinach was quite wide, and the average revenue was 33,085 MWK. The gross margin for spinach as not particularly high as the average was 553 MWK.

Table 11. *Average, minimum, median, maximum, and standard deviation calculated for area cultivated (beds), yield (bundle), sale price per unit, total variable cost (TVC), revenue, and gross margin (GM) of spinach.*

Spinach		*Area Cultivated (beds*)*	*Yield** /bed*	*Sale price per unit** (MWK***)*	*Total Variable Cost (MWK)*	*Revenue (MWK)*	*Gross margin (MWK)*
	Average	3.4	480.9	100	48,085.7	33,085.7	553.2
	Minimum	1.0	6.0	100	600.0	-14,400.0	7.5
	Median	3.0	100.0	100	10,000.0	-5,000.0	150.0
	Maximum	10.0	2,000.0	100	200,000.0	185,000.0	2,500.0
	Standard Deviation	3.1	756.5	0	75,646.9	75,646.9	898.1

*One bed is 15 meters long and 1 meter wide.
**Yield measured in units, where 1 unit is 1 bundle ≅ 1 kilogram, and is calculated per bed per season.
*** All amounts are presented in Malawian Kwacha (MWK), where 1000 MWK ≅ 1 USD.

4.2.9. Vegetable Comparisons

The results of each vegetable can be compared to one another to establish relative strengths and weaknesses in the vegetable harvest. Tomatoes were the most widely planted vegetable, and they also occupied, on average, the largest share of each farmer's piece of land (bed). The yield was highest for spinach on average. The average selling price of tomatoes was over 4,000 MWK higher than any other commodity. The price was significantly higher than the previous sales. When comparing average TVCs, we found that onions and spinach have exponentially higher prices than okra. About 42,000 MWK separated the highest and lowest TVCs. A farmer's decision to grow a certain crop may be influenced by such a large disparity. Only spinach, onions, and tomatoes (in that order) had positive average revenues among the vegetables. Whereas okra brought in an average of nearly 47,000 MWK less revenue. Tomatoes had the highest gross margin, according to the analysis. Mid-range gross margins were calculated for okra, mustard greens, cucumbers, and onions, with the lowest gross margin calculated for spinach.

Table 12 displays the average break-even price and break-even yields calculated for each of the seven vegetables. The break-even price shows at what price, on average, each vegetable would

need to be sold per unit to have no profit and no loss. Therefore, in order for the farmer to earn money, they would need to sell the vegetable at any price higher than the one presented in the table. As displayed in the table, there is a variety of break-even prices (BEP) and break even yields (BEY) for the vegetables being evaluated. With the lowest BEP was spinach at 553 MWK per bundle and the highest being cucumbers at 3,852 MWK per kilogram, closely followed by okra at 3,543 MWK per bundle. Mustard greens also had a BEP of over three thousand MWK at 3,080 MWK per bundle. The middle BEPs are tomato, rapeseed, and onions at 1,641 MWK, 2,019 MWK, and 2,860 MWK, respectively. For the break-even yield the lowest was tomatoes, at 2 units and the highest was spinach at 150 units. Onion had a BEY of 71 units and cucumber at 92 units. Rapeseed, mustard greens, and okra were all within ten units of 140 units for their BEY.

Table 22. *Comparison of number of farmers growing each vegetable, as well as average values calculated for break-even price (MWK) and break-even yield (units) for each vegetable.*

	Vegetable	*Number of Farmers*	*Break-even price (MWK)*	*Break-even yield*
1	Tomato	290	1,641	2
2	Rapeseed	171	2,019	139
3	Mustard greens	101	3,080	148
4	Okra	44	3,543	132
5	Onion	35	2,860	71
6	Cucumber	22	3,852	92
7	Spinach	8	553	150

From Table 12, it can be deduced that okra required the highest price to cover the production costs, while spinach required the least. That said, spinach had the highest BEY, meaning the farmer would need to sell the most yield of spinach to break even. Therefore, spinach would require a lot of sales at a low price to earn back the money for input supplies and production. Tomatoes had the lowest BEY, meaning the farmer needed to sell only 2 units of tomatoes to break even. However, tomatoes have a higher unit measurement at 20 kilogram buckets,

therefore it can be understood that 2 units of tomatoes is 40 kilograms, which would be the BEY. Even with that conversion, tomatoes still have the smallest BEY by approximately 30 kilograms, comparing to onions, the next lowest BEY. As the most popular vegetable to grow is tomato, referring to Figure 8, this may be attributed to having the least BEY or possibly being prominent in cooking and therefore easier to sell locally. Although tomatoes BEP compared to spinach, is higher. It was surprising that the leafy greens (rapeseed, mustard greens, and spinach) did not have similar BEP, however they did all have similar BEY, between 139-150 bundles.

Vegetables are not always the desired crop for production in Malawi. Tobacco is popular because it is the primary export in Malawi; therefore, a main agricultural driver and maize is the most prominent food crop (CIAT, 2018). However, for smallholder farmers vegetables are very suitable for amateur farming practices on the small-scale. In a time of changing climates and prioritising adaptability, concentrating on vegetable farming for income and nutrition can be a way forward. According to Willett and Rockström (2022), plant-based foods are beneficial for human and environmental health. Additionally, edible horticulture crops provide more food security than cash crops such as tobacco which is prominent in Malawi, because even if the farmer is unable to sell the horticulture production, it will still provide a food source for the household. Moving towards resilient and improve VVCs will contribute to local and sustainable food systems that will improve mainly food and nutrition security but also increase income for smallholder farmers.

Growing a variety of vegetables can be beneficial for the farmers income and can contribute to intercropping farming methods. Along VVC, the success of the vegetable production is a direct result of in the input supply and contribution to the production. It can be observed through the vegetable results that every vegetable is different in terms of cost, production, demand, and profit. With the MI programme through TRANSFORM, it is intended that improved input supplies will positively contribute to production and lead to improved output supply.

4.3. Market Access

Market access is one of the greatest challenges for smallholder farmers in rural areas and a significant hinderance along the vegetable value chain (VVC). The greater the distance between the farm and the market, the more difficulties the farmer will face in selling their vegetables at the market. This will affect their ability to reach a variety of consumers. As previously

mentioned, women tend to have an extra impediment in reaching markets, especially if they are far away because of priorities to stay at home.

4.3.1. Markets and Distance

Figure 9 shows the average distance in kilometers (km) to the nearest market for each vegetable. This graphs shows that cucumber requires the longest distance to reach the market with an average distance of 13.3 km. Followed by onions that require an average of 9 km to reach the market. Mustard greens and tomatoes have a similar average distance of 6.3 km and 6.8 km. And rapeseed required about 5 km to reach the market. The closest average market distance is for okra and spinach which take only 2 km and 1 km. The challenges for getting vegetables like cucumbers and tomatoes might be an issue of freshness. These crops generally need to be fresh and in good condition when being sold at the market but with poor transportation, it might cause most smallholder farmers to sell those vegetables from their homes.

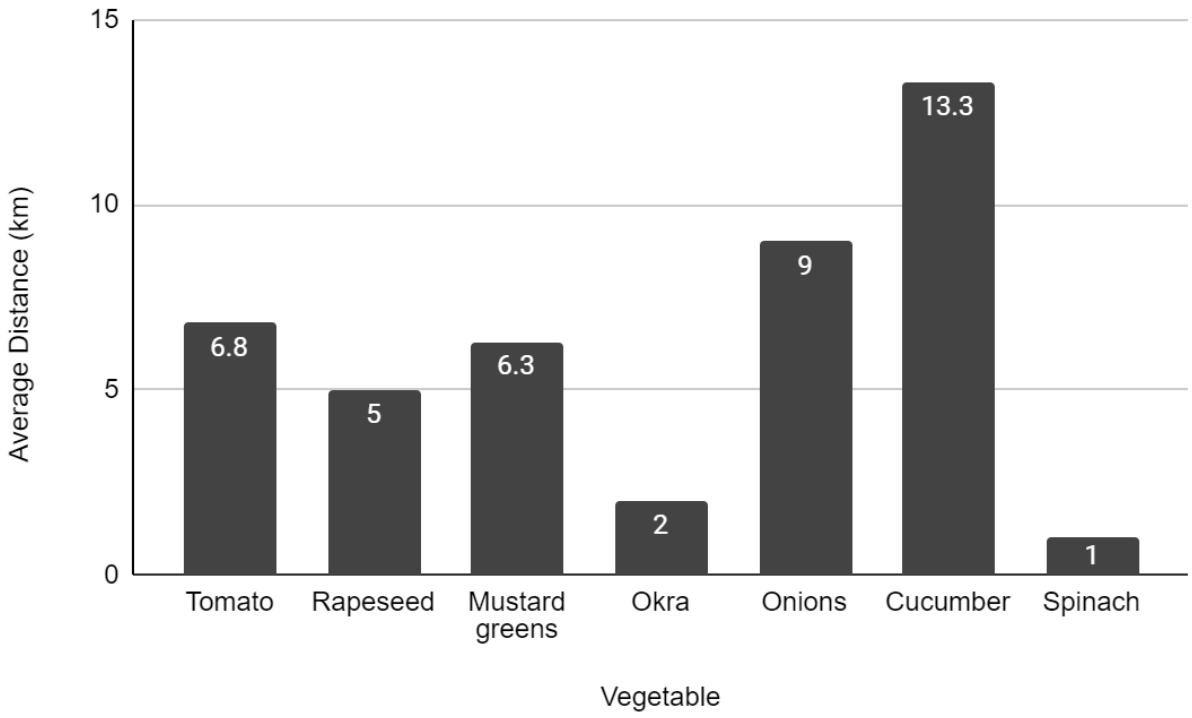


Figure 9. *Average distance to market in kilometers for each vegetable*

Table 13 continues this analysis more in-depth to determine where people are selling their products based on each vegetable. The places to sell the vegetables are at the market, at their home, at the market and their home, and there is data recorded for those farmers that did not answer questions on this topic. It is important to note that in collecting this data, there was about 12% of the smallholder farmers that did not record answers. Therefore, the responses could be skewed.

These results show that selling from home was the most common for all vegetable sales. There was a fair distribution among farmers selling tomatoes at the market, at their homes, and at both. However, selling from home was the most common with 62%, then selling at market and selling at both places were similar at around 19%. There is a significantly higher number of farmers selling rapeseed at home than other places, with 113 farmers, but selling at both comes second, with 25 farmers. Similarly for mustard greens, the number of farmers selling from home is significantly higher than other places at 71 farmers but selling at the market is the second highest with 9 farmers. Almost all farmers sell okra from home, at 84%. Onion had more of a distribution, where 15 farmers sold from home, 6 sold at home and at the market and 5 sold at the market. Cucumbers were mostly being sold at home at 75% and only 3 farmers combined selling at the market or selling from both. And spinach had almost all farmers selling from home as only one was selling at both the market and their home, and nobody selling spinach at the market.

Table 13. *Number of each vegetable sold at the market, at home, at both, and at neither.*

	Number of Farmers Selling at the Market	*Number of Farmers Selling from Home*	*Number of Farmers Selling at Home and the Market*	*Number of Farmers that did not Answer*
Tomato	50	167	52	21
Rapeseed	9	113	25	24
Mustard greens	9	71	7	14
Okra	1	32	5	6
Onion	5	15	6	9
Cucumber	2	9	1	10
Spinach	0	5	1	2

By comparing the data on where vegetable sales are most prevalent (Table 13) and what the average distance to the market is for each vegetable (Figure 9), some insights can be made. Cucumbers had the highest average distance to the market and one of the fewest numbers for farmers selling at the market in any capacity. It is likely that very few farmers sell cucumbers at the market because the distance to travel is far. Similar insights can be made for okra in terms of where the farmers sell, however, it had one of the lowest distances to the market, so the same assumption cannot be made. It is possible that cucumber is more popular in certain parts of the regions, thus the farmer must travel farther. Whereas okra is in high demand in more areas, therefore selling from it is possible to sell from home and for the farmers to make a sufficient number of sales.

Additionally, the perishability of a vegetable is important to consider. Cucumbers must be sold fresh, yet they have the highest average distance to the market. Farmers are likely influenced by market accessibility when deciding to sell cucumbers who choose to grow cucumbers. Similarly, tomatoes and the leafy vegetables (rapeseed, mustard greens, and spinach) are expected to be fresh. As demand for them is higher compared to cucumbers, influenced by cuisine in Malawi, sales opportunities will also be higher. This suggests that even if the average distance to the market is medium to high for those vegetables, it will be possible to sell from their home and maintain freshness.

Moreover, in comparing Table 4, which shows the number of males and females that grew each vegetable, to Table 13, it is also possible that okra and cucumbers are more often sold at home because they are primarily grown by women, who may have obligations to stay home. In continuing this analysis, a similar conclusion can be made for mustard greens and rapeseed as the number of women growing those crops and the number of farmers selling from home were comparable.

It is not determined through these results the reasoning behind significantly higher numbers selling from home. However, it is likely, that distance to the market and market access is highly influential. It is likely that the perishability of the vegetables, along with market constraints is a factor. It is possible that along the vegetable value chain, not thoroughly considered in this study, there is a middleman between the farmer and the market or consumer. This middleman would create a linkage between that farmer and the consumer, whereby the smallholder farmer would

sell their vegetables from home to the middleman and the middleman would sell the vegetables however suitable.

Below, Table 14 displays by district the number and percentage of farmers that sell their products at the market, those that sell them from their home and those that sell from both places. There was about 14% of the respondents that did not provide data for these questions. This shows that 7% of farmers in Mchinji sell their products at the market, 75% of farmers sell their products from their home, and 18% sell their products at both the market and home. While in Mzimba South, 20% of farmers recorded selling products at the market, 65% recorded selling from their home, and 15% were selling from their home and at the market. This data confirms that in both district the majority of participating smallholder farmers sell their products from their homes. In Mchinij, 11% more farmers sold products from both locations rather than only selling from the market. Whereas in Mzimba, 15% more people sold products at the market than from both locations. Therefore, it can be determined that farmers in Mzimba are more inclined to sell either from their home or at the market, but a low percentage of people do both. However, in Mchinji, more farmers diversify their locations and utilize opportunities to sell products from home and at the market.

Table 14. *Number and percentage of farmers in each district that sell their products at the market and at home.*

District	*Mchinji*		*Mzimba South*	
	Number of farmers	Percentage of farmers	Number of farmers	Percentage of farmers
Selling products at the market	21	7%	56	20%
Selling products at home	236	75%	181	65%
Selling products at market and home	57	18%	40	15%

Overall, Mzimba South had slightly more farmers selling at the market in some aspect. This could be because there is better access to markets in Mzimba, the distances to the markets are shorter, or there is more desire to reach the market potentially for more sales. One notable

observation, in comparing Figure 9 (average distances per vegetable) and Table 3 (number of vegetables grown in each district), cucumbers are almost exclusively grown in Mchinji district. Cucumbers also have the furthest distance to the market. This could be a reason for farmers in Mchinji to sell their products from home more than in farmers in Mzimba.

In improving the phase of marketing and output supply in the vegetable value chain, market improvements would have the greatest effect. Firstly, improving market access through improved transportation and infrastructure. Mango et al., 2015 suggested refrigerated vans as an intervention to keep the vegetables as fresh as possible during transportation. Creating more reliable markets with more consistency would also be a useful intervention. Not only is there poor infrastructure at markets as a hinderance, that makes it difficult for farmers to store and display their products, but there is also not always consistent time or place for the market to be held. This creates a problem for the farmer, with their schedule and organizing transportation, but there are also challenges for the consumers to get to the market if it is not occurring on a regular basis. These improved interventions would significantly improve market function and access.

4.3.2. Markets and Gender

Through a gender lens, Table 15 analyses the number of female and male farmers that sold products at the market, from home and from both. Because the number of female and male farmers is different it is important to consider the percentage to have an accurate comparison. The percentages were calculated based on comparing females and males separately, not considering the farmer population as a whole. These calculations did not account for farmers that did not provide information on this topic.

Table 15 displays many similarities among males and females. The percentages for each category were within 9% of each other. That said, females had a higher percentage of selling products at the market and selling at the market and from home. Whereas men had a higher rate of selling products from home.

Table 15. *Comparison of female and male farmers based on where they sell their products*

	Female		*Male*	
	Number of farmers	Percentage of farmers	Number of farmers	Percentage of farmers
Selling products at the market	118	24%	24	15%
Selling products at home	309	63%	108	66%
Selling products at market and home	65	13%	32	19%

Below, Figure 10 shows the comparison of the average distance to the market in kilometers for each vegetable among females and males. This figure displays females having a shorter average distance for tomatoes, rapeseed, mustard greens, and okra. Whereas males have a lower shorter average distance for onions and cucumbers. Males had no market data for spinach. The difference between the distances for tomatoes was only 1 km, where females had an average of 6.5 km and males had an average of 7.5 km. For rapeseed, there was a 2 km difference where women had an average of 4.1 km and males had an average of 6.1 km. For mustard greens, men had more than double the average distance than women. Men had an average distance of 13 km, and women had an average difference of 5.4 km when selling mustard greens.

Similarly, men had exactly double the distance to the market when selling okra. Men had to travel 3 km on average to the market and for women it was only 1.5 km. Onions presented the opposite, where women had to travel almost double the distance as men. On average, for women to sell onions at the market they travelled 12.2 km, however men travelled only 6.3 km. Cucumber had a big difference between females and males, as females had to travel more than triple the distance than men to sell cucumbers. Females travelled an average of 17.5 km to the market and men travelled 5 km on average to sell cucumbers. Lastly, women travelled an average of 1 km to sell spinach at the market, and there were no men that recorded selling spinach at the market. This graph shows that the average distances for tomato, rapeseed and okra among men and women are comparable, however, the distances for men and women between mustard greens, onions, and cucumbers are drastically different.

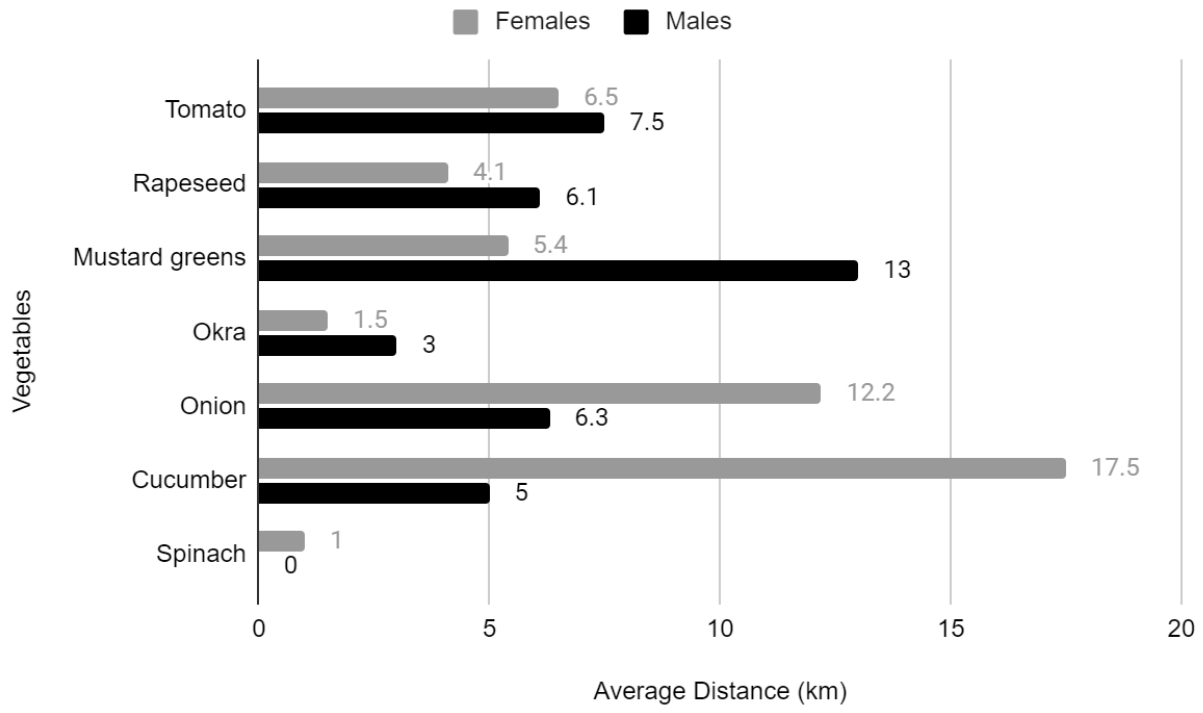


Figure 10. *Comparison of average distance to market in kilometers for each vegetable among females and males*

Overall, this data displays that women had a higher average distance to their market than men. The total average distance for women was 6.9 km and the average for men was 5.8 km. Although the majority of the vegetables proved to have shorter distances for women, the ones that were longer distances had much higher measurements, which increased the average for women.

Although there were significantly more women overall selling from their homes than at the market, these results are somewhat surprising as it would be expected that females sell more from home and less at the market than men. Perhaps, based on Figure 10, for most of the vegetables women had a shorter average distance, they were able to travel the short distances to sell at the market. It is also possible that women prioritize selling from the market, regardless of the distance for a variety of reasons, including increased income opportunity and engaging with the community. Whereas the data illustrates that men had higher averages for individual vegetables to travel to the market. This might deter them from selling at the market or this might be a result of challenging travel to the market, which would not be ideal for transporting vegetables.

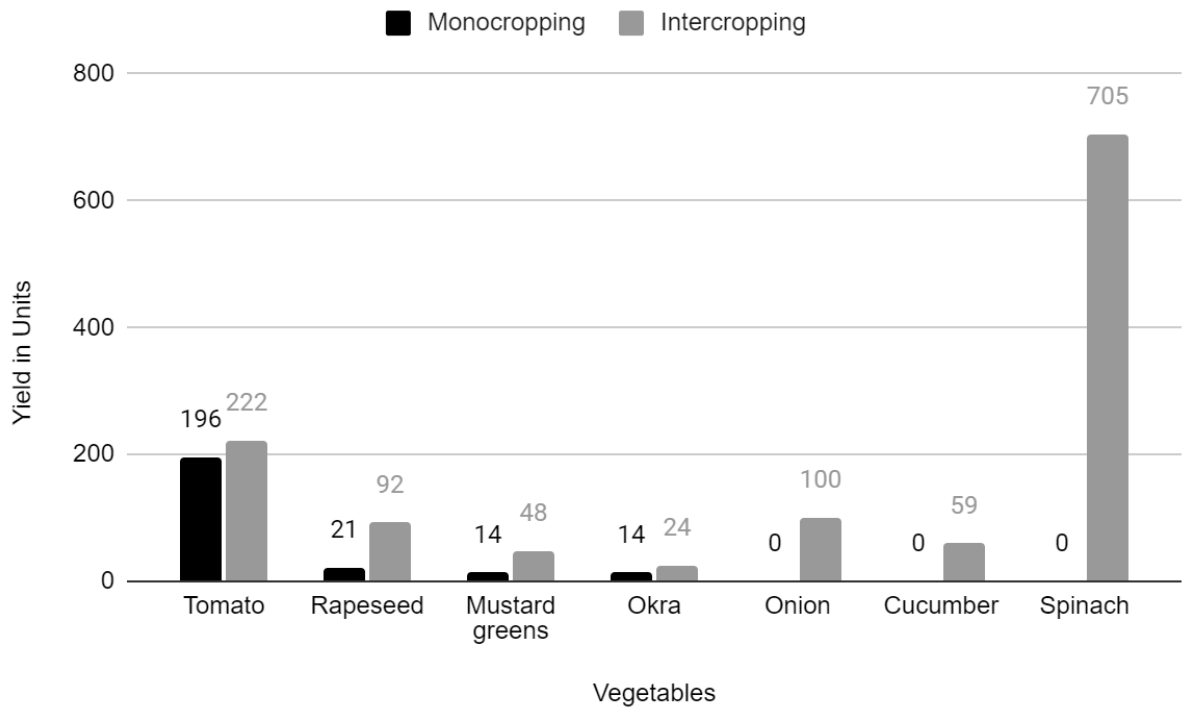
4.4. Intercropping vs. Monocropping

One of the interventions for enhanced resilience that the TRANSFORM project introduces aimed towards increasing productivity, production, and diversification is intercropping. Intercropping refers to the practice of growing two or more crops on the same cropland in an integrated fashion, whereas monocropping is the method of growing only one crop species in a given area (Waha et al., 2013). Intercropping methods aim to improve nutrient levels, increase production, maximize space, and reduce total yield loss (Makate et al., 2016; Waha et al., 2013). For smallholder farmers, intercropping has the potential to make substantial differences in yield compared to monocropping, but this is not the case for all crops, it is important to analyse. For MI interventions and for the analysis of vegetable value chains (VVC) intercropping and monocropping will be analysed in terms of their output yields.

For this study, in Mchinji district, 77% of participating farmers recorded using intercropping while 23% recorded using monocropping. And in Mzimba South, 86% of farmers reported using intercropping methods and 14% reported using monocropping.

Displayed in Figure 11 is a comparison of the average yields in units per bed produced from intercropping and monocropping methods for the seven main vegetables in this study. The graph shows that tomatoes, rapeseed, mustard greens, and okra all had higher average yield when using intercropping methods than monocropping. For tomatoes, the average yield was 196 units per bed with monocropping and 222 units per bed with intercropping. Rapeseed had an average of 21 units per bed with monocropping and an average of 92 units per bed with intercropping.

Monocropping for mustard greens produced an average of 14 units per bed and intercropping produced an average of 48 units. While okra also produced an average of 14 units per bed with monocropping, intercropping produced 24 units per bed. For onion, cucumber, and spinach there was only intercropping methods used, therefore there was no comparison in the graph only the presentation of the intercropping average. With intercropping the average yield per bed was 100 units for onion, 59 units for cucumber, and 705 units for spinach. Rapeseed showed the more significant improvement with intercropping as the average yield was 4 times larger than with monocropping. Similarly, mustard greens produced more than 3 times more with intercropping, and okra’s average yield doubled with intercropping. While tomatoes did have in increase using intercropping, as well, it was not as substantial as the other vegetables.



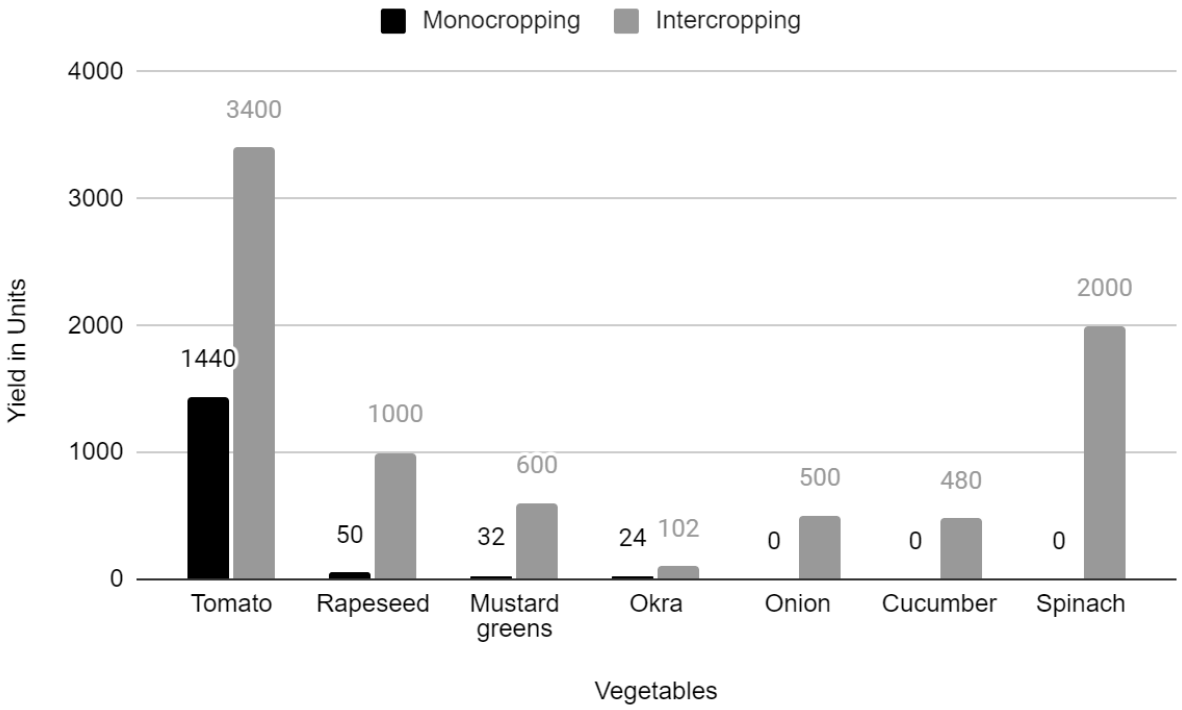
Note: Tomatoes are measured in units of 20-kg buckets. Rapeseed, mustard greens, okra, and spinach are measured in units of bundles which is equal to approximately 1kg. Onions and cucumber are measured in units of 1kg.

Figure 11. *Comparison of average yield per bed (per unit) using monocropping and intercropping methods*

Similarly, Figure 12 compares the maximum yield produced through intercropping and monocropping methods with the seven main vegetables in the study. The difference between the maximum yield per crop using monocropping and intercropping methods is evident. For tomatoes the maximum yield was 1,440 units with monocropping whereas the maximum was 3,400 with intercropping. For rapeseed the maximum yield with monocropping was 50 units and the maximum with intercropping was 1000 units. Mustard greens recorded a maximum yield of 32 units per bed with monocropping and 600 units per bed from intercropping. And okra had a maximum of 24 units with monocropping methods and a maximum of 102 units with intercropping.

Onions, cucumbers, and spinach did not have any comparisons as there were not any farmers that used monocropping methods with these vegetables, however the maximum yields per bed from intercropping were recorded. Onions produced a maximum of 500 units, cucumber produced 480

units and spinach produced 2,000 units per bed. For the vegetables that had both monocropping and intercropping, tomato produced more than double for the maximum yield, whereas rapeseed produced 20 times more. Mustard greens' maximum yield was more than 18 times while using intercropping methods and okra's maximum was about 5 times more with intercropping. Overall, the maximum yields from intercropping were significantly more improved than from monocropping.



Note: Tomatoes are measured in units of 20-kg buckets. Rapeseed, mustard greens, okra, and spinach are measured in units of bundles which is equal to approximately 1kg. Onions and cucumber are measured in units of 1kg.

Figure 12. *Comparison of maximum yield per bed (per unit) using monocropping and intercropping methods*

From Figures 11 and 12, it can be deduced that intercropping does have a positive impact on yield outputs, only showing improvements from monocropping. As an intervention, this was an expected result because the purpose is to integrate enhanced farming methods (Sitko & Jayne, 2018). This is one of the most effective interventions that can be contributed to the vegetable value chain in terms of production. Not only does this provide improved agricultural land by boosting the nutrients and reducing pest damage, but it is an efficient use of land to produce a

variety of crops. For smallholder farmers, crop diversification can improve the profits from the production because it will increase the number of consumers that can be reached.

4.5. Economic Empowerment Through Diversification of Income Sources

The benefits of diversification go beyond only diversifying crops. Diversifying incomes is another important concept that can lead to improved and sustainable livelihoods. Diversifying livelihoods is one of the integral elements of economic empowerment that is highlighted by NCA under the TRANSFORM programme. This aspect is not only helpful as a climate change coping strategy but also in the case of dealing with any economic hardships or unexpected production difficulties. Risk and vulnerabilities can present themselves in many ways and at unforeseen times, however, diversifying one's income and thereby strengthening one's economic empowerment can reduce the severity of the impacts.

Figures 13 and 14 display the number of farmers in each district that recorded their primary income sources, which included up to three different sources for each farmer. Both figures include the categories of crop production and sales, casual labour, petty trading, livestock production and sales, other, which is inclusive of artisan skills, fish production, natural resource sales, semi-skilled work, formal employment, entrepreneurship, and other unspecified income, and lastly, none, meaning no income source. Within the two districts, all participants recorded having one source of income, 96% recorded having two income sources and 75% recorded having three income sources. In comparing income sources in the two districts, 97% of farmers in Mchinji had two income sources and 79% had three different income sources. While in Mzimba South, 95% of the farmers had two incomes and 72% of farmers had income from three different sources.

Figure 13 displays the income sources for farmers in Mchinji district. It is clear that crop production and sales were the most common first source of income, and it remains popular as a second and third source of income. Casual labour was the highest recorded second and third source of income. Pretty trading had the next highest recordings, though not as high as crop production and sales and casual labour. The 'other' category had 44 people recorded that as their third source of income which was the highest. And the second highest for third income source was no income source.

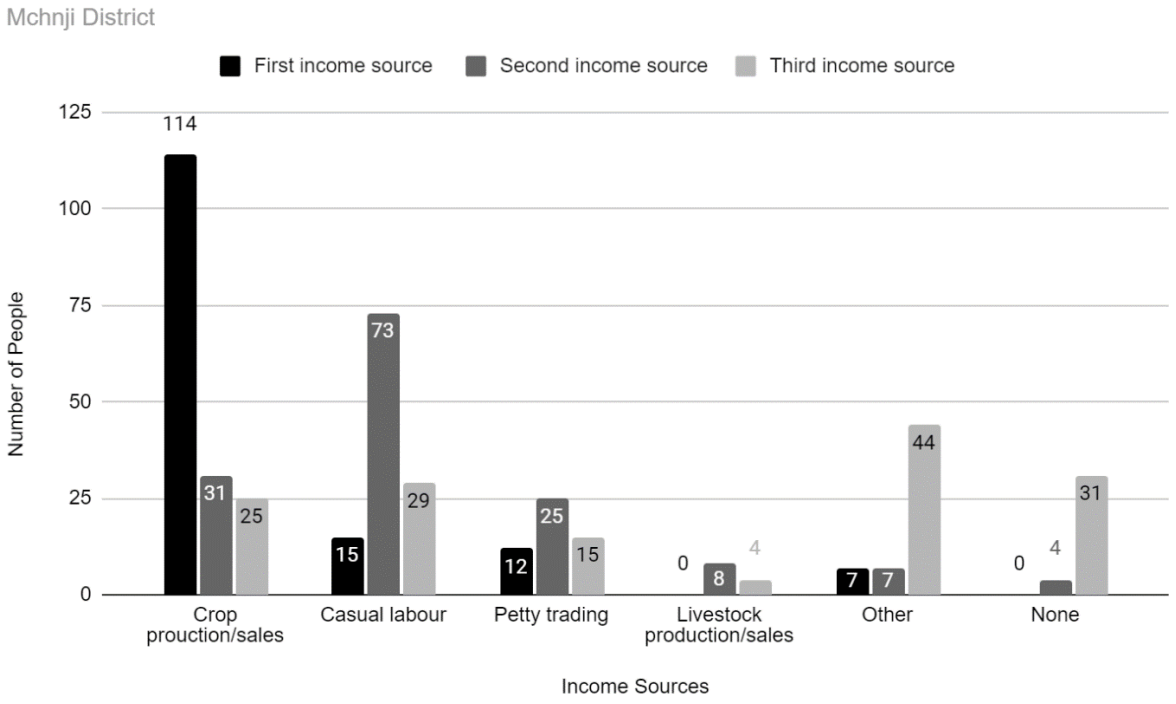


Figure 13*. Number of farmers in Mchinji based on primary income sources (3)*

Similarly, Figure 14 shows the top three primary income sources for the farmers in Mzimba South district. The most popular first income source was also crop production and sales, at 82%, followed by casual labour. The second most common source of income was casual labour, followed by crop production and sales and the next closest being other income and petty trading. The third income source had more of a diversity of responses, however, the ‘other’ source of income was the most common answer. Followed by no income source and there were similar numbers among crop production and sales, casual labour, and petty trading.

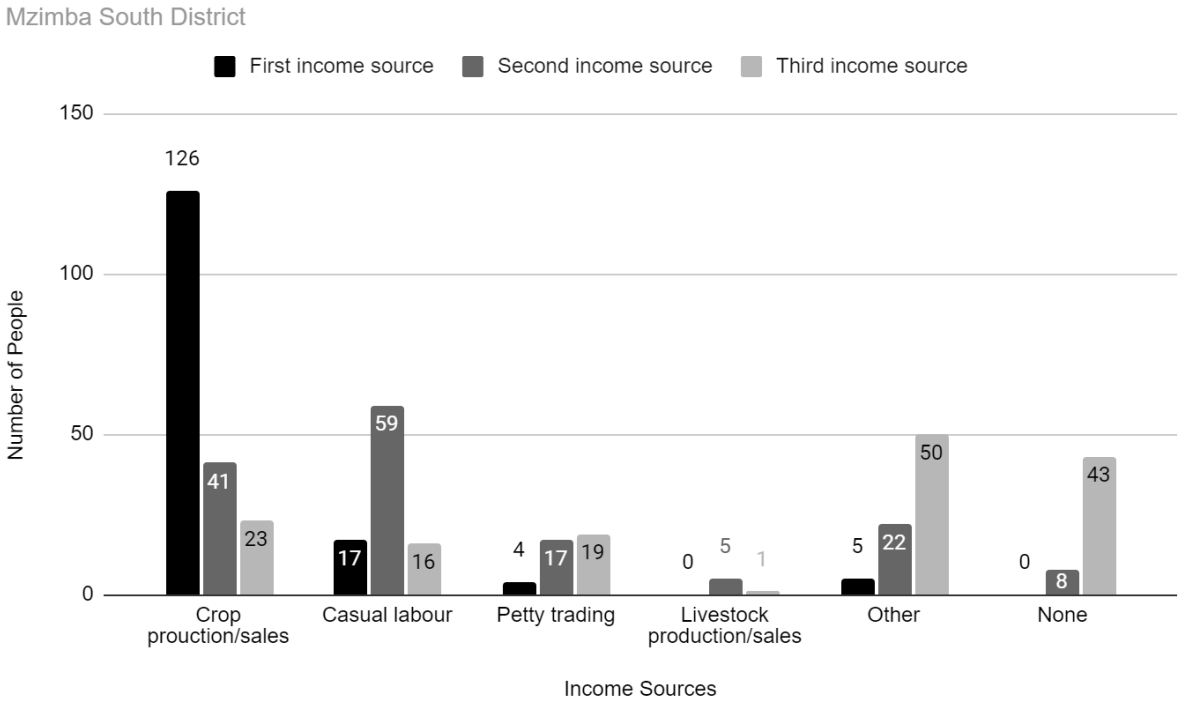


Figure 14. *Number of farmers in Mzimba South based on primary income sources (3)*

In both districts crop production and sales largely led as the main source of income with a cumulative 80% of participants. Followed by casual labour as the second most popular main income source with a cumulative 11%. In inquiring about a second source of income it was recorded that 12 participants did not report having a second source of income. Casual labour was recorded as the most popular second source of income in both districts, with crop production and crop sales as the second and petty trading and business as the third. The percentages in the two districts for the top three sources of second income were all comparable. A notable difference here is that the third and fourth source of second income in Mzimba South were close numerically, the fourth being livestock production and sales. Whereas in Mchinji there were varied remaining sources. In terms of the third most important source of income, 74 participants did not record a third income. Those who did record a third source of income had the highest number of participants identifying in the ‘other’ category, with the second and third being between casual labour and crop production and crop sales and the fourth most popular form of third source of income being petty trading and business.

A notable concern from this data is that participants may have recorded the same source of income multiple times for different positions of importance. This is concluded by finding the sum of one income source in all three positions to be higher than the number of participants in that district. For example, the number of participants in Mchinji was 148, however the total number of participants that recorded crop production and sales as their first, second, and third source of income was 170. As for Mzimba South, the total number of participants was 152, however the total number of participants who recorded crop production was 190. This information demonstrates that participants recorded the same income source in multiple rankings.

Table 16 displays the number of farmers that only have crops, farmers that have crops and livestock, farmers with crops and poultry, and those with crop, livestock, and poultry. These are further categorized by district and by gender. These two categories are exclusive from each other, the sum of both districts will be the total or a given category and the sum of females and males will equal the total in that same category. The greatest number of farmers have only crops with 106 out of 300. This is the most prevalent in Mzimba South district and with females. Then farmers who have crops and poultry is second highest with 88 out of 300. The highest number of farmers keeps crops and poultry is found in Mchinji and among with females. Following that is farmers that have crops and keep livestock and poultry with 71 out of 300. The highest number of that category is found in Mchinji and among women. Lastly, the number of farmers that keep crops and livestock is 35 out of 300. The distribution among districts and genders are relatively similar but the most is found in Mzimba South and among females.

Table 16. *Number of farmers with or without livestock and/or poultry.*

	Total Farmers	*Mchinji*	*Mzimba South*	*Female*	*Male*
Farmers that have only crops	106	38	68	76	30
Farmers that have crops and livestock	35	15	20	22	13
Farmers that have crops and poultry	88	53	35	65	23
Farmers that have crops, livestock & poultry	71	42	29	49	22

An opportunity for smallholder farmers in Malawi, is working towards economic empowerment by investing in livestock or poultry. Not all rural farmers are financially able or have the space to keep animals, but it is another form of potential income. As seen in Table 16, about 64% of the participating farmers, which is a strong figure, however it could use improvement. Based on Figures 13 and 14, there is a total of only 18 out of a possible 900 responses that stated that livestock production and sales was one of their top three sources of income. Therefore, it is possible that many participating farmers keep livestock and/or poultry but very few acknowledge it as a significant form of income. There are several ways that livestock and poultry can generate income for farmers, and they can provide improved food security if they are not used for selling.

Similarly, another approach that is recommended by the TRANSFORM programme is the whole-farm approach. Rather than focusing on one practice or specific interventions, the whole-farm approach promotes the integration of at least one crop and one livestock value chain coupled with technologies and services to provide several products for their livelihoods and thereby reducing risk.

Economic empowerment in the form of diversifying livelihoods as well as the whole farm approach are both forms of risk management. The underlining objective is the ability to adapt to change or stress. These approaches diversify or expand income generating activities to create various opportunities for improved livelihoods. In Malawi and in agriculture in particular where

production can be uncertain due to climatic factors, seasonal changes, and market uncertainties, having multiple sources of income is imperative to withstand vulnerabilities.

4.6. MI Reinvestment

One of the main ways towards economic empowerment for smallholder farmers mentioned in this study is the micro-investment (MI) approach through the TRANSFORM programme. For continual access to resources, skills growth, and moving towards improved and eventually sustainable livelihoods, MI reinvestment is proposed for farmers who have success in this approach. However, in implementing a MI initiative there will be setbacks for some micro-investors. As a result, the data revealed that there were farmers that were interested in reinvesting and there were farmers that were not interested in reinvesting. That does not necessarily correlate with the farmer's satisfaction level of their micro-investment experience. However, it is important to carefully consider critiques and difficulties among the participating farmers to develop a strong and versatile approach.

The total number of respondents for the 'motives for re-investment' this part of the survey was 172 out of 300. Which means that 128 participants did not express interest in re-investing in micro-investment kits. For this question, participants were able to choose any of the provided responses that were relevant for them, therefore, the sum of the data will be greater than 100%. For those who said they would reinvest in Mchinji district, 92% (54/59) reported it created a good source of income, 80% (47/59) reported the desire to get out of poverty, 61% (36/59) expressed the desire to reach specific financial, personal, or social goals. Nobody reported the motivation for improved access to healthcare or education, 5% (3/59) wanted to purchase necessary assets, 27% (16/59) reported a growing interest in farming and 15% (9/59) reported convenience in using the MI kits and experienced successful farming.

While in Mzimba South 77% (87/113) reported their motivation being a good source of income, 75% (85/113) expressed a desire to get out of poverty, and 54% (61/113) expressed the desire to reach specific financial, personal, and social goals. Moreover, 6% (7/113) were motivated by improved access to healthcare or education and 14% (16/113) reported the kits allowed for them to purchase necessary assets. 32% (36/113) reported a growing interest in farming, 35% (39/113) reported convenience in using the MI kits and experienced successful farming and 1 individual reported the reason as 'other'. Among the different reasons for the farmers desire to reinvest, the

most popular motivation in both districts were that the MI kits were a good source of income, and they were motivated by the desire to get out of poverty.

On the other hand, there were 125 farmers among the two districts that expressed not having interest in re-investing in the MI kits, displayed in Figure 15. More than half of this group, at 56.8% said their reason for not re-investing was that the MI initiative was not profitable enough for them. Around 17% reported having other, unspecified reasons for not re-investing. While 16% said it was related to problems with pests and diseases. Seven per cent of this group stated that they needed money for other things such as health or education rather than micro-investment. And 1 participants, or 0.8% of the group felt each that the MI programme was too expensive, their production loss was too high, and they had a lack of technical support (not labelled in Figure 15).

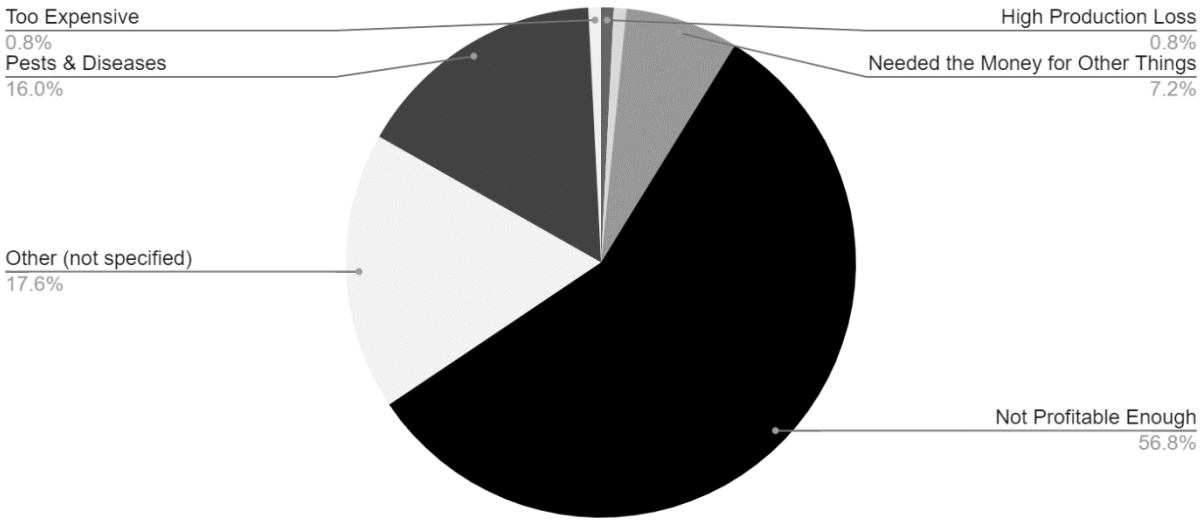


Figure 15. *Reasons for not re-investing with MI initiative in percentages*

Figure 15 displayed the data of farmers not re-investing with MI from both districts together. It is also useful to analyse this data as two separate districts. In Mchinji district, there was 87 people who reported not wanting to re-invest. One person stated there was a lack of technical support, while 2 expressed needing to use the investment money in other ways. 64% (56/87) said the kits were not profitable enough, 14% (13/87) reporting having issues with pests and diseases, while the other 15 people said there were other reasons for not re-investing. In Mzimba South district,

where there was 38 farmer who did not want to re-invest, 1 person claimed there was a high production loss and another one said the kits were too expensive. While 18% (7/38) stated in each area, that they needed to use their money in other ways, there were pests and diseases, or there were other reasons. Lastly, 39% (15/38) said the investment was not profitable enough for them.

As previously mentioned, out of the 300 participants, 172 said they would reinvest in the MI kits. Of those 59 were from Mchinji district and 113 were from Mzimba South. Of the 128 who said they would not reinvest, 87 were from Mchinji and 38 were from Mzimba South (there were 4 participants that did not respond to this question). Perhaps there was a greater success with the kits and higher crop production in Mzimba South. In Mchinji, 65% (97/148) of the participants were investing for the first time, 36% (39/148) were investing for the second time and 7% (10/148) were investing for the third time. In Mzimba South, 38% (57/152) of the participants were investing for the first time, 62% (94/152) were reinvesting for the second time and no one reported reinvesting for the third time. From both districts there were only 3 and 4 participants who reported being dissatisfied with their re-investment experience. While the majority of participants reports being primarily satisfied (42%) and secondarily very satisfied (34%). There were also some that felt only moderately satisfied with their re-investment experience (20%). With a high number of the participants feeling satisfied or very satisfied, it can be assumed that the reinvestment experience for farmers has been majority positive.

Overall, there are many factors that can influence a farmer's desire to or not to reinvestment in the MI initiative. This MI initiative is intended to build capacities that transform into long-term sustainable practices, rather than being a 'quick-fix'. Because of that, farmers might not initially see optimal results when introducing improved agricultural interventions. Whether continuing with MI or not, it is beneficial to learn from the challenges and improve the following time. Identifying the challenges and implementing learned interventions, especially caused by climate change, is the best practice to managing risk and improving household livelihoods, income, and food security (Bie et al., 2007). This also applies to the MI initiative and the TRANSFORM programme. It is important to learn from the challenges expressed by the participating farmers and apply the programme's own interventions to avoid facing them again in the future.

Chapter 5

5.1. Conclusions

This study aimed to identify gaps in vegetable value chains and to analyse interventions and opportunities for smallholder farmers in Malawi. As a result of this research, it was determined that interventions on vegetable value chains have a significant impact on food security and livelihoods for smallholder farmers in Mchinji and Mzimba districts in Malawi.

As survey results revealed, gender plays a significant role in smallholder agriculture and vegetable production. More than half of the participating farmers were women, and a large portion were under 40. However, the results for the heads of household proved different. This difference was significant in deducing that the head of the household and the farmer are not necessarily the same person. As women primarily stay at home due to traditional roles and responsibilities, this presents an emerging potential to enhance female engagement in smallholder agriculture and increase income generating activities.

This study has completed an economic analysis of the seven main vegetables, tomatoes, rapeseed, mustard greens, okra, onions, cucumber, and spinach. The results showed that among the districts, farmers in Mchinji grew more vegetables, and women grew more between men and women. The most prevalent vegetable grown was tomatoes, followed by rapeseed and mustard greens. And tomatoes had a significantly higher gross margin than any other vegetables and the lowest minimum yield necessary to break-even. The overall variable cost and yield per bed for both rapeseed and mustard were similar, however the latter had a far lower break-even price because of its higher yield. Rapeseed was higher for both and in turn had a significantly lower break-even price. Okra had the highest break-even price and cucumber and onion had low break-even yields. Spinach had the lowest break-even price but the highest break-even yield, revealing that spinach sales are high-volume at a low price.

Results of market access showed that the average distance to sell each vegetable varies significantly, with spinach being the shortest and cucumber being the longest distance to the market. When the market results were further analysed, there was a great deal of variation in farmers selling from their homes, selling at the market, or selling at both, cross-examined with vegetable type, gender, and district. Overall, selling from home was the most popular choice. In

Mzimba, however, there was more market access than in Mchinji. And, despite having to travel a greater distance on average, more women were selling products at the market than men.

The data showed that intercropping produced a significantly better yield in most cases than monocropping. Although farmers only used intercropping for onion, cucumber, and spinach, the other vegetables all displayed improvements. The most notable increases in average yield were for rapeseed and mustard greens, where the yields were approximately four times as much for both vegetables. Further, the results for maximum yield showed that all results were at least three times more with intercropping. In fact, rapeseed and mustard greens, were approximately thirty times greater. This increase highlights the substantial improvement from intercropping.

Through examining data on diversifying incomes, it became clear that many farmers had two sources of income, and the majority even had three. With crop production and sales being the primary source, followed by casual labour and then 'other' sources, both districts strongly participated in multiple income sources. Economic empowerment was also shown through farmers keeping livestock and poultry, which provides an alternative income source and means for another food source.

Finally, the micro-investment initiative in drip irrigation through the TRANSFORM programme proved to have mainly positive results. There were strong indications that there was satisfaction with the investment in both district, and more than 57% of participants stated that they would re-invest with the drip irrigation kits. That said there was about 42% of the participants that were not interesting for various reasons, the most common being that micro-investment initiative was not profitable enough.

5.2. Recommendations

Based on the findings of this study the following recommendations are made for policy makers, development actors, and researchers who have a strong interest in enhancing smallholder farming and vegetable value chains in Malawi.

1. More women and young people should be involved in smallholder agriculture practises and in learning agricultural skills. Raising this group's capabilities will boost household and community incomes.

2. Improving access to affordable input supplies and planting materials, such as improved seed varieties, fertilizers, and herbicides. Additionally, improving access to low-cost climate-adapted technologies and skills training, such as drip irrigation systems. Combined, these will lead to optimal vegetable productions, that are of high quality and yield, high output supply and in turn high profit.
3. If rural farmers are to succeed, they need better access to markets and stronger market function. Unpredictable market circumstances and inadequate transportation options make it difficult for farmers to maximize their profits. Smallholder farmers in Malawi might greatly strengthen their ties to market customers with the assistance of government and institutional actors.
4. Although intercropping is a great enhancement in smallholder farming, adopting a whole farm approach would allow for even more all-encompassing farm improvements. This wholistic concept encourages every aspect of the farm to function in an integral way that is inclusive of enhanced, more sustainable processes and business planning, while aiming for increased food security.
5. Increasing food security and reducing poverty may be accomplished in large part by encouraging farmers to diversify their sources of income. Economic empowerment can help people move away from unstable income sources and toward more sustainable lifestyles by providing choices when they face financial difficulties. Increasing efforts like micro-investment techniques can help by creating capacity and aiming for long-term success.
6. Micro-investment in drip irrigation is beneficial to smallholder livelihoods; yet the risk associated with each smallholder enterprise is raised because of variable climatic conditions in the region. As a result, micro-investment in a variety of smallholder food production practices, such as the whole farm approach, would reduce risk associated with micro-investing in a single smallholder commodity
7. Finally, more research on vegetable value chains and smallholder livelihoods in Malawi is required in order to identify best practices for improving market functioning and accessibility, increasing vegetable output, and improving food security.

References

Bhatti, M. A., Godfrey, S. S., Ip, R. H., Kachiwala, C., Hovdhaugen, H., Banda, L. J., Limuwa, M., Wynn, P. C., Ådnøy, T. & Eik, L. O. (2021). Diversity of Sources of Income for Smallholder Farming Communities in Malawi: Importance for Improved Livelihood. *Sustainability*, 13 (17): 9599.

Bhatti, M. A., Godfrey, S. S., Divon, S. A., Aamodt, J. T., Øystese, S., Wynn, P. C., Eik, L. O. & Fjeld-Solberg, Ø. (2022). Micro-Investment by Tanzanian Smallholders' in Drip Irrigation Kits for Vegetable Production to Improve Livelihoods: Lessons Learned and a Way Forward. *Agriculture*, 12 (10): 1732. doi: 10.3390/agriculture12101732.

Bie, S. W., Mkwambisi, D. & Gomani, M. C. (2008). Climate change and rural livelihoods in Malawi : review study report of Norwegian support to FAO and SCC in Malawi, with a note on some regional implications.

Bryman, A. (2012). *Social Research Mehtods 4th Edition*. New York: Oxford University Press.

Chadha, M., Oluoch, M., Saka, A., Mtukuso, A. & Daudi, A. (2008). *Vegetable Reserach and Development in Malawi*. Shanhua, Taiwan: AVRDC - The World Vegetable Center.

Chagomoka, T., Afari-Sefa, V., & Pitoro, R. (2014). Value Chain Analysis of Traditional Vegetables from Malawi and Mozambique. *International Food and Agribusiness Management Review*, 17 (4): 59-86. doi: 10.22004/ag.econ.188710.

CIAT, The World Bank. (2018). *Climate-Smart Agriculture in Malawi*. In Series, C. C. P. f. A. (ed.). International Center for Tropical Agriculture (CIAT). Washington D,C.

Connolly-Boutin, L. & Smit, B. (2016). Climate change, food security, and livelihoods in sub-Saharan Africa. *Regional Environmental Change*, 16 (2): 385-399.

D-maps.com. (2022). *Map of Malawi.* Available at https://d-maps.com/carte.php?num_car=4780&lang=en (accessed: 05.10.2022)

FAO and INRAE. (2020). *Enabling sustainable food systems: Innovators' handbook.* Rome. https://doi.org/10.4060/ca9917en

Food, Agriculture, and Natural Resources Policy Analysis Network (FANPRAN) & Earth System Governance Project. (2017). *CLIMATE-SMART AGRICULTURE IN MALAWI*: Food, Agriculture, and Natural Resources Policy Analysis Network (FANRPAN), 2017, JSTOR. Available at http://www.jstor.org/stable/resrep16463 (accessed: 10.02.2022)

Giertz, A., Caballero, J., Galperin, D., Makoka, D., Olson, J., & German, G. 2015. *Malawi Agricultural Sector Risk Assessment.* Agriculture global practice technical assistance paper;. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/23678 License: CC BY 3.0 IGO

Hertz, D., Bhatia, S. (2010). *Guidance note on recovery: Livelihood*. In Secretariat, I. R. P. (ed.). Japan: International Recovery Platform & United Nations Development Program

Kamanga, T. F., Tantanee, S., Mwale, F. D. & Buranajarukorn, P. (2020). A mutli hazard perspective in flood and drought: Case study of Malawi *Geographia Technica*, 15 (1).

Kamoto, J. & Singini-Nyirenda. (2021). *A Gender Analysis Study for TRANSFORM Programme.* Internal DF Norway and NCA Report: unpublished.

Kerr, R. B., Nyantakyi-Frimpong, H., Dakishoni, L., Lupafya, E., Shumba, L., Luginaah, I. & Snapp, S. S. (2018). Knowledge politics in participatory climate change adaptation research on agroecology in Malawi. *Renewable Agriculture and Food Systems,* 33 (3): 238-251.

Knoema. (2021). *Malawi - Agricutlural land as a share of land area*. Available at: https://knoema.com/atlas/Malawi/Agricultural-land-as-a-share-of-land-area (accessed: 10.02.2022).

Kubzansky, M., Cooper, A., & Barbary, V. (2019). Promise and Progress: Market-based solutions to poverty in Africa. https://doi.org/10.21955/gatesopenres.1115857.1

Madsen, S. (2022). Farm-level pathways to food security: beyond missing markets and irrational peasants. *Agriculture and Human Values*, 39 (1): 135-150. doi: 10.1007/s10460-021-10234-w.

Makate, C., Wang, R., Makate, M. & Mango, N. (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change. *SpringerPlus*, 5 (1). doi: 10.1186/s40064-016-2802-4.

Mango, N., Mapemba, L., Tchale, H., Makate, C., Dunjana, N. & Lundy, M. (2015). Comparative analysis of tomato value chain competitiveness in selected areas of Malawi and Mozambique. *Cogent Economics & Finance*, 3 (1): 1088429. doi: 10.1080/23322039.2015.1088429.

Mwadzingeni, L., Afari-Sefa, V., Shimelis, H., N'Danikou, S., Figlan, S., Depenbusch, L., Shayanowako, A. I. T., Chagomoka, T., Mushayi, M., Schreinemachers, P., et al. (2021).

Unpacking the value of traditional African vegetables for food and nutrition security. *Food Security*, 13 (5): 1215-1226. doi: 10.1007/s12571-021-01159-7

O'Dwyer, L. M. & Bernauer, J. A. (2014). *Quantitative Research for the Qualitative Researcher*: SAGE.

Singh, B., Safalaoh, A., Amuri, N., Eik, L., Sitaula, B. & Lal, R. (2020). Climate Impacts on Agricultural and Natural Resource Sustainbaility in Africa. *Earth and Environmental Science, Earth and Environmental Science.* Springer, Cham. https://doi.org/10.1007/978-3-030-37537-9

Sitko, N., & Jayne, T. (2018). Integrating climate- and market-smartness into strategies for sustainable productivity growth of african agri-food systems Research in Agricultural & Applied Economics 94. doi: 10.22004/ag.econ.188710.

Tamene, L., Mponela, P., Ndengu, G. & Kihara, J. (2016). Assessment of maize yield gap and major determinant factors between smallholder farmers in the Dedza district of Malawi. *Nutrient Cycling in Agroecosystems*, 105 (3): 291-308. doi: 10.1007/s10705-015-9692-7.

TRANSFORM Programme. (2021). *Sustainable Food System for Rural Resilience and Transformation.* Internal NMBU, NCA, and DF report: unpublished

Waha, K., Müller, C., Bondeau, A., Dietrich, J. P., Kurukulasuriya, P., Heinke, J. & Lotze-Campen, H. (2013). Adaptation to climate change through the choice of cropping system and sowing date in sub-Saharan Africa. *Global Environmental Change*, 23 (1): 130-143. doi: 10.1016/j.gloenvcha.2012.11.001.

WeatherSpark. (2022a). *Climate and Average Weather Year Round in Mchinj*i. Available at: https://weatherspark.com/y/97182/Average-Weather-in-Mchinji-Malawi-Year-Round#:~:text=In%20Mchinji%2C%20the%20wet%20season,or%20above%2092%C2%B0F. (accessed: 08.08.2022)

WeatherSpark. (2022b). *Climate and Average Weather Year Round in Mzimba*. Available at: https://weatherspark.com/y/97541/Average-Weather-in-Mzimba-Malawi-Year-Round#:~:text=In%20Mzimba%2C%20the%20wet%20season,or%20above%2088%C2%B0F. (accessed: 08.08.2022)

Willett, W. & Rockström, J. (2022). Healthy Diets from Sustainable Food Systems. Summary Report of the EAT-Lancet Commission: EAT-Lancet Commission.

Wondim, D. (2021). Value chain analysis of vegetables (onion, tomato, potato) in Ethiopia: A review. International Journal of Agricultural Science and Food Technology: 108-113. doi: 10.17352/2455-815x.000096.

World Bank. (2022). *The World Bank in Malawi - Overview*. Available at: https://www.worldbank.org/en/country/malawi/overview#1 (accessed: 30.04.2022).

You, L., Ringler, C., Wood-Sichra, U., Robertson, R., Wood, S., Zhu, T., Nelson, G., Guo, Z. & Sun, Y. (2011). What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach. *Food Policy*, 36 (6): 770-782. doi: https://doi.org/10.1016/j.foodpol.2011.09.001.

Appendix

Micro-Investment Survey

Date yyyy-mm-dd

Farmer's National ID _____

Micro-investment status

- Registered (micro-investment) farmer
- Non-registered farmer (control)

Name of farmer _____

Age _____

Gender

- Male
- Female

District

- Mzimba South
- Rumphi
- Kasungu
- Mchinji
- Dowa

Contact Number _____

Education Level

- No formal education
- Primary
- Secondary
- College/university

Head of Household

Age of Head of Household

Micro-investment Questions

1. Are you a registered micro-investment farmer? (yes/no)

2. How long have you been involved in micro-investment? _____

3. How much is the cost of micro-investing kit? _____

4. How many kits have you invested in for this season? _____

5. Do you use chemical fertilizers? (yes.no)

6. Fertilizer name (nitro/potash)

7. When is the dry season (no rains) in your area? (Select all relevant months)

8. How you do you get water, for farming/irrigation during the dry seasons?

- Tube well or borehole
- Protected shallow well
- Harvested rain water
- Piped water/public tap
- Surface water source (river, streams, ponds, puddles, unprotected spring water?)
- Cart with small tank/ drum
- Other (specify)

9. Do you have to pay for the mentioned irrigation/farming water during the dry seasons? (yes/no)

10. Name of crop/vegetable _____

11. Water Source _____

12. How much (MWK) _____

13. Do you have to pay for water during the dry season? (yes/no)

14. Do you own any agricultural land? (yes/no)

15. How many acres? _____

16. Do you lease agricultural land? (yes/no)

17. How much (MWK)? _____

18. Do you have any loans?(yes/no)

19. How much _____

20. Purpose of taking loan? _____

21. What is the source of the loan? _____

22. What is the role of women in the household's agricultural system?

- Completely run by women
- Completely run by men
- Shared roles between men and women but primarily women
- Shared roles between men and women but primarily men
- Physically run by men, with women's input (decision making)

- Physically run by women, with men's input (decision making)
- Split equally between men and women

Re-investment

23. Are you investing in the veggie kit for the first time? (yes/no)

24. Did you re-invest in more veggie kits? (yes/no)

25. Are you satisfied with re-investing?

- Very satisfied
- Moderately satisfied
- Satisfied
- Dissatisfied

26. If you are re-investing, what is your motive?

- Created a good source of income
- Desire to get out of poverty
- Desire to reach specific financial/personal goals
- Improved access to healthcare or education
- Allowed for purchase of necessary assets
- Growing interest in farming
- The veggie kits are well rounded and easily provide all necessary tools for farming success (convenience)
- Other (specify)

27. If you are not re-investing what is your motive?

- Not profitable enough
- Needed the money for other things
- Too expensive
- High production loss
- Limited access to market
- Pests and disease
- Not enough water
- Other (specify)

28. Is re-investing a long-term option for your future use? (yes/no)

Household 5 key vegetables and crops

29. Crop/vegetable name _____

30. Area cultivated (acres) _____

31. Cropping season (total months) _____

32. How many harvests per year? _____

33. Seeds use (kg/bed) _____

34. Net yield (kg/bed) _____

35. Sale price per keg? (MWK) _____

36. Are you selling the crop product at the market? (yes/no)

37. Distance to the nearest market (km)? _____

38. Does the buyer pick up products from farm? (yes/no)

39. How much of this crop or by-product do you consume at home (kg)? _____

40. Total kg stored for consumption_____

41. Amount of crop lost/damaged in storage (kg) _____

42. Are you using monocropping or intercropping methods?

- Monocropping
- Intercropping

43.Water purchased? (yes/no)

44. Fertilizer used (kg/bed) _____

45. Herbicide used (kg/bed) _____

46. Contract labour? _____

47. Energy used (fuel/lubricant) (yes/no)

48. Irrigation method _____

*Same questions were repeated for fruits and cereals

<u>Livestock/poultry farming</u>

49. Name of livestock/poultry kept by the household in the past 12 months? _____

50. Total number of the mentioned livestock/poultry kept by the HH currently? _____

*Questions regarding livestock/poultry sales, slaughtered animals, diary production, and dung, egg productivity and sales were also included here but but were not relevant for this study's data

<u>Assets (please indicate the assets your household has a provide the necessary information)</u>

51. Asset/item _____

52. Quantity owned _____

53. Age of item _____

54. Owner of item (male/female)

Food security, child nutrition and poverty

55. In the past 7 days, how many days has your household had to rely on less preferred and less expensive food?

56.In the past 7 days how many days has your household had to borrow food or rely on help from friends and families?

57. In the past 7 days, how many days has your household had to limit portion size at mealtime?

58. In the past 7 days, how many days has your household had to reduce the number of meals eaten in a day?

59. Over the past 7 days how many days did you or others in your household consume the following food groups?

- Cereals
- Pulses and nuts
- Vegetables
- Fruits
- Mears and fisd
- Diary products
- Sugar/honey
- Oil, fat, and butter

60. How many meals per day are eaten in your household?

61. In the past 12 months, were there months in which you did not have enough food to meet your household needs? (yes/no) (select relevant months)

62. Does your household food security vary based on months or season? (yes/no)

63. How is the overall health situation of your household, including children?

- Optimal
- Good, with few health problems
- Satisfactory
- Below average, often having health problems
- Poor

64. On average, in a 4 months period, how often do you seek medical attention for your child?

65. How many meals in a week do you prepare at home?

66. How many meals per day do you offer your children?

67. Are there any health-related reasons that prevent your child from attending school? (yes/no)

Specify _____

68. What was your household's main source of drinking water during the past season?

- Tube well or borehole
- Protected shallow well
- Harvested rain water
- Piped water/public tap
- Surface water source (river, streams, ponds, puddles, unprotected spring water?)
- Cart with small tank/ drum
- Other (specify)

69.Is water from the source you mentioned usually accessible every day?

70. How long does it usually take you to get to the water source, collect water, and bring it home?

- 30 minutes or less
- More than 30 minutes

71. Do you use the same water source for drinking and irrigation? (yes/no)

72. How many household members are 16 years old or younger? _____

73. Are all household members under the age of 18 currently in school? (yes/no)

74. What material is used for the walls of the main building for your household?

75. What materials are used for the floor of the main building?

76. What materials are used for the roof of the main building?

77. What is the main fuel used for cooking?

78. What type of toilet does your household use?

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