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MA – Developing Countries

Thesis

To what extent are farmers interested in providing field data and receiving advice, and how does this differ across methods and populations? A case study of tomato growing smallholder famers in Malawi.

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In addition, I wish to thank my friends and classmates who formed the Project Team in Malawi who assisted me in countless ways, from venturing to remote sites, conducting hundreds of interviews in Chichewa, and encouraging me throughout any obstacles. This research would not have been possible without your help.

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With heartfelt thanks and appreciation,

Nicole Bery Liberman

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Abstract

Extensive research has been conducted on the importance of improving access to information to increase agricultural productivity among smallholder farmers. However, there are lingering questions regarding which are the best methods to achieve this, how smallholder farmers' interest varies across such methods, and according to what these variations in interest take place. The objective of this study is to determine the extent to which farmers are interested in providing field data and receiving advice, and how such interest differs across methods and populations. The literature examines smallholder farmers' differing levels of interest in extension services according to a number of extrinsic and intrinsic factors, generally agreeing that male farmers with larger farms and higher education have the highest levels of interest. This study brings these questions to the Malawian context, employing scouts, a call center operator and lead farmers to monitor farms and provide advice to tomato producing farmers in the Malawian districts of Dedza and Mchinji.

Through one-on-one surveys with the participating farmers, this study attempts to understand the farmers' attitudes towards farm monitoring and advice. The results determine that, in theory, farmers will claim to be interested in the services of the scout, call center and lead farmers in numbers close to 100%. Throughout the surveys, a majority of the farmers declared explicitly their preference for the services of the scout in monitoring their farms and providing them with advice. However, in practice, when interest was defined in actual willingness to pay the results were more complex. The outcome of this study shows that, in this context, the main determinants of interest were levels of exposure and interactions with the service providers, especially the call center. In this study, the call center was based on a relatively uncommon approach of actively initiating the calls to farmers instead of waiting for them to call. The farmers were not exposed to this type of service before the project. The study determines that farmers'

willingness to pay for the service of the call center increased as they interacted with the call center. The other determinant of interest was farmers' age, with younger farmers showing the highest willingness to pay for all services. This study also shows great promise in employing scouts for extension services due to their high levels of coverage, farmers' preferences, and generally superior levels of willingness to pay associated with the scout among farmers across different demographic characteristics. Furthermore, in regards advice from the scouts to reduce spraying frequency that actually led to a reduction in spraying, this study shows that providing advice to farmers can bring about significant change in their behavior. This study is part of a wider body of research in the area of extension services for smallholder farmers and aims to contribute to further research on similar topics.

Introduction

Malawi is a small landlocked country in south-east Africa, and, according to the World Bank's 2022 Poverty Assessment Report, it's one of the poorest countries in the world, with 50.7% of its population living below the international poverty line. Its economy is agriculturally based, with smallholder farmers constituting the bulk of Malawi's agricultural sector. According to the World Bank (2022), agriculture in Malawi accounts for about 80 percent of employment, and 80 percent of the country's total exports. However, the agricultural productivity is very low, as Malawi presents significant yield gaps in virtually all crops. Increasing agricultural productivity of smallholder farmers is key to improving Malawi's economy, and one of the most important factors to do so is by improving smallholder farmers' access to information and advice.

The importance of access to information and advice is clear from a number of studies. For example, according to Tchale, 2009: "Informal sources of learning and information sharing also increase efficiency, as is demonstrated by the positive and significant relationship between technical efficiency and the cumulative percentage of farmers who adopt various crop technologies within the farming community (…) Availability of extension services and information about technical aspects of crop technologies plays an important role ..." The mission of extension workers is to assist farmers in farm management, introduce them to new knowledge and technologies, and help increase productivity. However, the ratio of extension workers to farmers in Malawi is of one to between 2500 and 3000 farmers (Chavula, 2020). This seriously limits smallholder farmers' ability to access information and, therefore, increase efficiency and improve productivity.

Therefore, there is a need to implement a method of efficiently assisting Malawian farmers to access information, implementing a system that will help farmers better monitor their farms, and provide them with real time recommendations and assistance. Achieving this objective is not an easy task in Malawi due to poverty, lack of infrastructure and technology as detailed by the World Bank (2022). To achieve this objective of assisting smallholder farmers in the Malawian context, some options include assigning lead farmers to help with extension services, hiring dedicated scouts, making call centers available, and implementing technological options such as apps, as explored in the 2020 study by Mendelson et. al. from Tel Aviv University and International Center of Insect Physiology and Ecology in Kenya, which was fundamental in modeling this study. Even if scouts, call centers and lead farmers can all offer solutions for farm monitoring and provision of advice, each method is unique and has its own advantages and limitations. Furthermore, farmers' interest in each of them may vary according to different parameters.

Interest can be measured in many ways, and one of the methods is through willingness to pay. As described by Stobierski (2020), this is a good indicator to show how much people are willing to pay for or invest for a product of service, reflecting extrinsic differences like age, gender or education, and intrinsic differences like their "risk tolerance, desire to fit in with others, and level of passion about a given subject" (Stobierski, 2020). Furthermore, smallholder farmers are very cautious about their income and generally declare low willingness to pay for services like extension, as shown in a similar study of smallholder farmers in Nigeria by Akinnagbe and Adesina, 2018. Therefore, willingness to pay can be a good indicator of true interest on the Malawian smallholder farmers' part, and it is fundamental to determine which factors shape such interesting, whether its gender, household size, age, farm size, education level, or others.

The literature indicates that tomato is one of the most important vegetables in Malawi, as it is one of the most commonly grown crops, both for income and for food, due to its high profitability and nutritional value (Nyalugwe et. al., 2022). However, its production is dominated by smallholder farmers who are poorly resourced both when it comes to access to material resources, finance and information. Tomato farming is an example of the aforementioned agricultural productivity gap mentioned earlier. “The current production levels of tomato in Malawi fail to satisfy local demand in terms of volume and quality. The total area under cultivation is estimated at 30,361 acres (ha) and yield at 20.7 metric tons per hectare (mt/ha) [MoA, 2020]. Field trials by the Department of Agriculture Research Services (DARS) in Malawi indicate that yields could potentially be increased to 50 mt/ha with adherence to recommended practices.” (MoA, 2020, in Nyalugwe et. al., 2022). Therefore, this study focuses specifically on tomato smallholder farmers, given the importance of the crop and the potential benefits of increasing productivity in tomato farming.

Literature Review

There is numerous research on the topics of extension services for smallholder farmers, farmers' interest in terms of willingness to pay, and the factors shaping such willingness to pay.

A similar study to the one conducted in this research is that by Mendelson et. al. (2020) which compared the efficiency of different methods of farm monitoring. For this purpose, paid scouts, volunteer lead farmers and call center operators were hired and provided with training, a smartphone, and an app to use to monitor farms. On one hand, the paid scouts and volunteer lead farmers reached the farms and recorded data from their observations in the app. On the other hand, the call center was made available for farmers to reach via phone calls at their own initiative, and the call center operator recorded the data they provided in the app as well. The objective of the study was, specifically, to record fall army warm infestation levels through the aforementioned methods and compare the results. "General farmers provided very limited data to the call center despite attempts to generate awareness" (Mendelson et. al., 2020), and only 160 observations (out of 8650 total reports) were collected via this method. The paid scouts collected the largest levels of data (more than 8000 observations and 30000 images), at a 96% accuracy level. Volunteer lead farmers collected close to 1000 observations, at 87% reliability, showing a cost-efficient method for farm monitoring. Lessons from this study demonstrate that paid scouts and volunteer lead farmers can complement each other as, while they record less observations, volunteer lead farmers can reach areas that paid scouts might not" (Mendelson et. al., 2020). Furthermore, while farmers did not make significant use of the call center, the results encouraged the exploration of an alternative where the call center operator calls farmers instead of the other way around. This would help overcome the barrier of farmers having to take initiative to reach the call center since, just as the scout or the volunteer lead farmer; the call center would reach the farmers.

In regard to apps, the literature describes that "the expansion of internet-connected devices is increasing opportunities to apply digital tools and services on smallholder farms, including monitoring" (Anthony et al., 2020). The 2020 study by Mendelson et. al. adapted a commercially used app by the name Agritask to the Kenyan context, which allowed to record 8650 observations of the fall army warm between May 2019 and April 2020. The scout and volunteer lead farmers used the app to record their observations and were able to quickly learn how to manage it with ease. Their engagement with the app, their motivation to participate, and the large levels of infestation recorded, all showed promise that an app can be beneficial in farm monitoring.

While there is huge prospect for the potential benefits of technology for field monitoring of smallholder farms, the question remains whether the farmers will be interested in welcoming the aforementioned technological methods, such as the app, and whether the information recorded will be put to use. In other words, the question remains whether smallholder farmers will adopt these technologies, with adoption referencing their willingness to provide and receive information. Mwangi and Kariuki (2015) argue that "the rate of adoption of these technologies has remained low in most of these [developing] countries" due to many factors. However, they argue that the main factors can be categorized into technological, such as type of technology as a precondition to adopt it, economic, such as farm size, institutional, such as access to extension services, and household specific such as gender, household size and education. They argue that the most determinant factor in technology adoption for smallholder farmers is type of technology. Contrarily, Chuang's study of adoption of smart agriculture technology in smallholder farmers in Taiwan was determined by knowledge, perceived importance, and adoption behavior (2020). In other words, the study argued that the farmers' knowledge and attitude was the true determinant in technology adoption, as opposed to technical factors. In addition, Meijer (2014) suggested that

“the uptake of agricultural technologies is a complex process influenced by both extrinsic and intrinsic variables [such as knowledge and perceptions of the potential adopter] and recommend that future studies aiming to understand the adoption process of agricultural innovations take into account both sets of variables [extrinsic and intrinsic].” It was emphasized that intrinsic values have been less studied. Therefore, the literature fails to reach a general conclusion when addressing which factors could affect smallholder famers’ adoption of technological monitoring methods.

It is important to emphasize that the technological monitoring methods discussed above are meant to benefit smallholder farmers and therefore it is crucial to know if and how they will welcome such interventions. The use of information technology can lead to concerns, such as detailed by Kos and Kloppenburg (2019): “In several application areas, such as the use of drones, satellites, and mobile phones, data about smallholders’ activities, their farms and products is collected, which is subsequently processed, and often monetized, by other parties. The data may, for example, be used to generate new services that can be sold to smallholders, but it may also be used by third parties for other purpose [such as to assess creditworthiness].” Therefore, it is important to focus on the smallholder farmer as the ultimate beneficiaries of the technologies for farm monitoring.

Since it’s clear that the smallholder farmers and their interests are of major importance in this study, it’s important to determine which factors shape and affect such interest. The existing literature on the relationship between interest (defined in willingness to pay) and demographic factors such as gender, number of people in household, age, farm size and education level provides some background for the research. The existing literature generally agrees that female farmers are less likely to be willing to pay for extension services and agricultural technologies. A study by Anugwa et. al (2022) on the topic of “Farmers’ preferences and willingness to pay for climate-

smart agricultural technologies on rice production in Nigeria" explored many of these factors. The study found that the willingness to pay for such technologies was lower for females in the study and mentioned that this could be due to women being more risk averse or having less access to disposable income. This is similar to the findings of the study by Oladele (2008), exploring "Factors determining farmers' willingness to pay for extension services in Oyo State, Nigeria", which found that: "The issue of gender having an inverse relationship with willingness to pay for extension services should be properly considered such that women farmers who play prominent roles in agriculture will not be marginalized." Lastly, Fletschner et. al.'s 2010 research of women's likeliness to take risks and compete in rural Vietnam also concluded that women are more risk averse than men. Therefore, there seems to be a general agreement in the literature that willingness to pay is generally higher for men than for women.

Then, in the topic of number of people in household, the literature shows mixed results in regard to the relationship between increasing household size and willingness to pay. Angwa et. al. (2020)'s research determined a positive relationship between household size and willingness to pay for agricultural technologies. Contrarily, the study by Onoh et. al (2012) determining farmers' willingness to pay for agricultural extension services in South-Eastern Nigeria, declared that "This inverse relationship implies that farmers that have more persons in their household size were less willing to pay for extension services than farmers that have few persons in their households in the study area." As described in the study, this may be because even if larger households have access to family labor, they also have less disposable income as there are more family members to account for financially. These contradictory results are further evident in the study by Mwaura et.al. (2010) in 2010, concluding "marital status, household size and location of household were not significant in influencing the willingness to pay."

As for age, the existing literature generally agrees that there is an inverse relationship between age and willingness to pay, with older farmers being less willing than younger ones. The same study from Nigeria by Augwa et. al. (2022) found a significant decrease in willingness to pay for agricultural technologies as the farmers' age increases. A 2010 study from Uganda by Mwaura et. al (2010) also found that "Increasing age is associated with reducing likelihood of willingness to pay for extension services […] The young people are willing to pay because they are ready to adopt the new technologies that are provided in the extension services to improve their agricultural practices." The study attributes factors such as younger farmers' larger willingness to take risk, higher access to information, and higher likelihood to change their mind, and more disposable income, to their increased willingness to pay (Kaliba, et al. 1997, in Mwaura et.al. 2010). Finally, the study by Umar et.a.l (2014) assessing farmers' willingness to pay for demand-driven extension services in Nigeria determined that "The inverse relationship could be attributed to belief; elderly farmers are not familiar with the method of paying for extension services and thus, they are less likely to pay for demand driven extension services." Therefore, the literature generally agrees that for younger farmers, willingness to pay will be higher than for older farmers.

In addition, in the topic of farm size, the literature generally agrees that there is a positive relationship between increasing willingness to pay and farm size. The study by Umar et.a.l (2014) determined that farmers with larger farms are more willing to pay for extension services than farmers with smaller farms. The same was shown in the study by Oladele et.al. (2008) who determined the reason to be that "As the farm size increases, the probability of the willingness to pay for extension services also increases as farmers would tend to be commercial oriented due to large farm sizes." The same was concluded in a study by Onoh. et.al. from 2012, finding a positive and significant relationship between farm size and willingness to pay. Therefore, the literature

generally demonstrates that willingness to pay will be higher among farmers with larger farms than among those with smaller farms.

Lastly, in the topic of education, the literature generally agrees on a positive relationship between a higher level of education and higher willingness to pay for agricultural technologies and extension services. This was the conclusion of the studies by Oladele (2008) and Onoh et.al. (2012). The study by Anugwa et.al. (2022) said that this is so because a higher level of education can be linked to the farmer's increasing abilities to understand, process, and implement the information. Similarly, Mwaura et.al. (2010) assured that "The more educated people are more enlightened about the importance of the extension services unlike people with little formal education." Therefore, according to the literature, the more educated farmers will be more willing to pay than the less educated farmers.

To summarize, the literature describes the importance of improving Malawi's agricultural productivity and the role of technology, information, and extension services in that pursuit. It provides examples where both paid scouts, volunteer lead farmers and call center operators can contribute, while encouraging to continue exploring the role of general farmers in this pursuit. Furthermore, the literature describes the benefits and past successes of using apps and technology in agriculture, but not specifically in field monitoring in the Malawian context. In regard to the role of farmers, the literature seems conflicted in regard to what the most important factors are in smallholder farmers' adoption of new technologies, but does highlight the importance of using data to benefit smallholder farmers, as opposed to third parties. Furthermore, there is extensive literature about the relationship between farmers' willingness to pay for extension services and agricultural technologies, and demographic factors. The literature generally agrees on the following statements: male farmers are more willing to pay than female farmers, there is an unclear

relationship between willingness to pay and household size, younger farmers are more willing to pay than older ones, farmers with larger farms are more willing to pay than those with smaller farms, and more educated farmers are more willing to pay than less educated ones.

After examining the available literature, this research aims to answer the following question: **“To what extent are farmers interested in providing field data and receiving advice, and how does this differ across methods and populations? A case study of tomato growing smallholder famers in Malawi.”**

Research Methodology

Farm monitoring via scout, lead farmer and call center

To answer the research question, a case study was performed focusing on tomato growing smallholder farmers in Malawi. The study took place in two different districts in Malawi: Dedza, in the southeast region, and Mchinji, in the west-central region. Each of these districts were assigned paid scouts, volunteer lead farmers, and a call center operator to conduct routine farm monitoring and provide advice to the smallholder farmers. The focus of the study was on tomato-producing smallholder farmers.

The experiment took place over 4 months, between the 1st of July to the 31st of October of 2022. Due to logistical constraints, actual scout, lead farmer and call center activity only took place over the last three months of the project, between the beginning of August and the end of October.

For Mchinji, 143 farmers were included in the study. One paid scout was hired, and three volunteer farmers were recruited. For Dedza, 134 farmers were included in the study. One paid scout was hired, and two volunteer farmers were recruited. One call center operator was recruited for both districts. The call center operator was specifically instructed to take the active approach of calling the farmers as opposed to waiting for them to call. For the purpose of conducting the study, they were all provided with a smart phone containing the Agritask app, airtime, and were trained on how to use the app. Furthermore, they were all provided with a list of the farmers in the district and their contact information. They received instructions to monitor the farms weekly; scouts and lead farmers through a physical visit, and the call center operators through a phone call, and record the observations in the app. This information is summarized in the table below:

	Dedza	Mchinji
Number of Farmers in the project	134	143
Scouts	1	1
Lead Farmers	2	3
Call Center Operators	1	1

Surveys

At the same time, two surveys were conducted to determine the smallholder farmers' willingness to provide information and receive advice from the scout, lead farmers and call center operators. Each survey took place at a central meeting point in the relevant district. To conduct the surveys, each districts' scout was asked to invite the farmers in the project (meaning, the same farmers that they, the lead farmers and call center, were in contact with). Due to logistical issues, not all farmers arrived when invited; therefore, the surveys were conducted in several rounds. For the purpose of the surveys, farmers were interviewed one on one in their native language (Chichewa) by one of the team members who then recorded their responses on English with the SurveyCTO software.

The first surveys' objective was to gather the demographic information of the participants, understand their farm monitoring habits and their willingness to provide information about their farms to a scout, lead farmer or call center operator. The first survey took place at the beginning

of the project. In Dedza, 59 participants took part in the first survey. It took place in two separate visits on the 19th of August and 22nd of September of 2022. In Mchinji, 102 participants took part in the first survey. It took place on seven separate visits between the 2nd of August and 2nd of September.

The second survey's objective was to gather information about the farmers' advice reception, preferences, and willingness to pay for the different services. The second survey took place at the end of the project. In Dedza, 55 participants took part in the second survey. It took place in a single visit on the 7th of October of 2022. In Mchinji, 100 participants took part in the second survey. It took place in six separate visits between the 6th of October and 3rd of November of 2022.

This information is summarized in the table below:

	Dedza	**Mchinji**
Number of Participants Survey 1	59	102
Dates of Survey 1	19/08/2022 22/09/2022	02/08/2022 02/09/2022

Number of Participants Survey 2	55	100
Dates of Survey 2	07/10/2022	06/10/2022 03/11/2022

The plan in this research was that the famers participating in the project (meaning, being visited by the scout, lead farmer, or called by the call center), would be the ones participating in the survey. However, due to logistical and communication issues, not all the farmers that participated in the project participated in the survey, and vice versa. Similarly, not every farmer participated in both surveys: some participated only on the first and some only on the second. This information is detailed in the following table:

	Dedza	**Mchinji**
Farmers who partook in survey 1 or 2 but were not part of the project	56	30
Total farmers who only participated in the 1st survey	7	39

Total farmers who only participated in the 2nd survey	3	28
Total farmers who participated in both surveys	52	63
Famers who participated in both surveys AND were part of the project	40	49

For the accuracy of this research, most of the data analysis was conducted with information pertaining to the farmers who participated both in the project and the survey unless indicated otherwise.

Provision of Advice

Throughout the project, the scout, call center operator and lead farmer provided advice to the farmers for farm management according to their background, criteria and experience. At the later stages of the project, on week 39 of the year (corresponding to the week of the 26th of September), the scouts were instructed to specifically recommend the farmers to spray their fields once every two weeks as a measure to prevent over spraying, increase the quality of their tomatoes and prevent wasting their resources. In practice, the Dedza scout refused to provide such an advice,

arguing that, if spraying less caused any damage to the Dedza farmers, he would not be able to insure or compensate them. The Mchinji scout did agree to provide the advice as instructed.

Results

Section 1- Survey Results

Section 1.1: Survey 1- Demographic Data

During the first survey, the farmers were asked a number of demographic questions relating to their gender, number of people in their household, age, farm size, and education level). For the purpose of this research, it is useful to understand the demographic similarities and differences between the farmers in Dedza and Mchinji. Furthermore, since not all farmers who participated in the survey were part of the project (meaning, visited by the scout of lead farmers or called by the scout), it is useful to understand the demographic similarities and differences between the farmers who partook in the survey (in the Figures, "all farmers"), and those who partook in the survey and also in the project (in the Figures, "in the project").

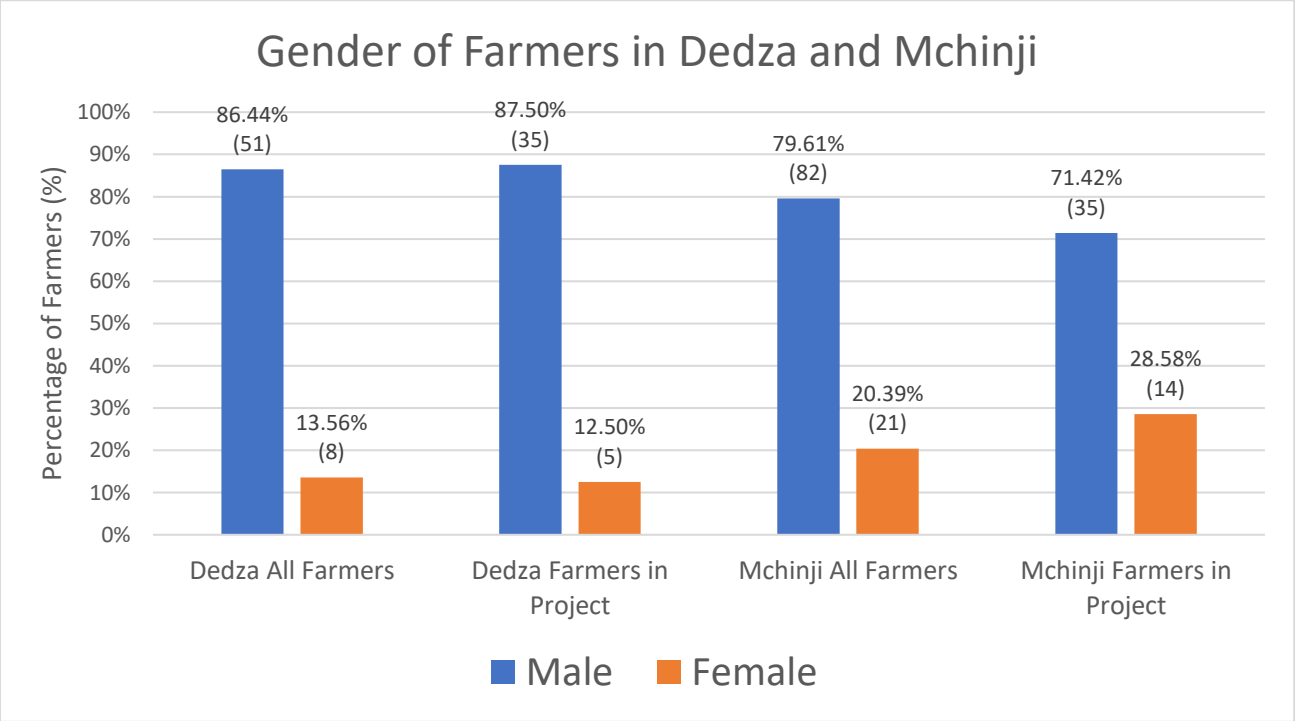

Figure #1: Gender of Farmers in Dedza and Mchinji. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Both in Dedza and Mchinji there were many more male than female farmers participating both in the project and in the survey. In Dedza, the ratio of men and women farmers was similar between all the farmers surveyed and the farmers in the project (less than 1% difference). However, in Mchinji, there were fewer male farmers in the project (8.19% less) than all farmers surveyed, and more females (8.19% more). Furthermore, Dedza had slightly more male farmers than Mchinji in all the farmers surveyed (6.84% more) and also in the farmers in the project (16.08% more).

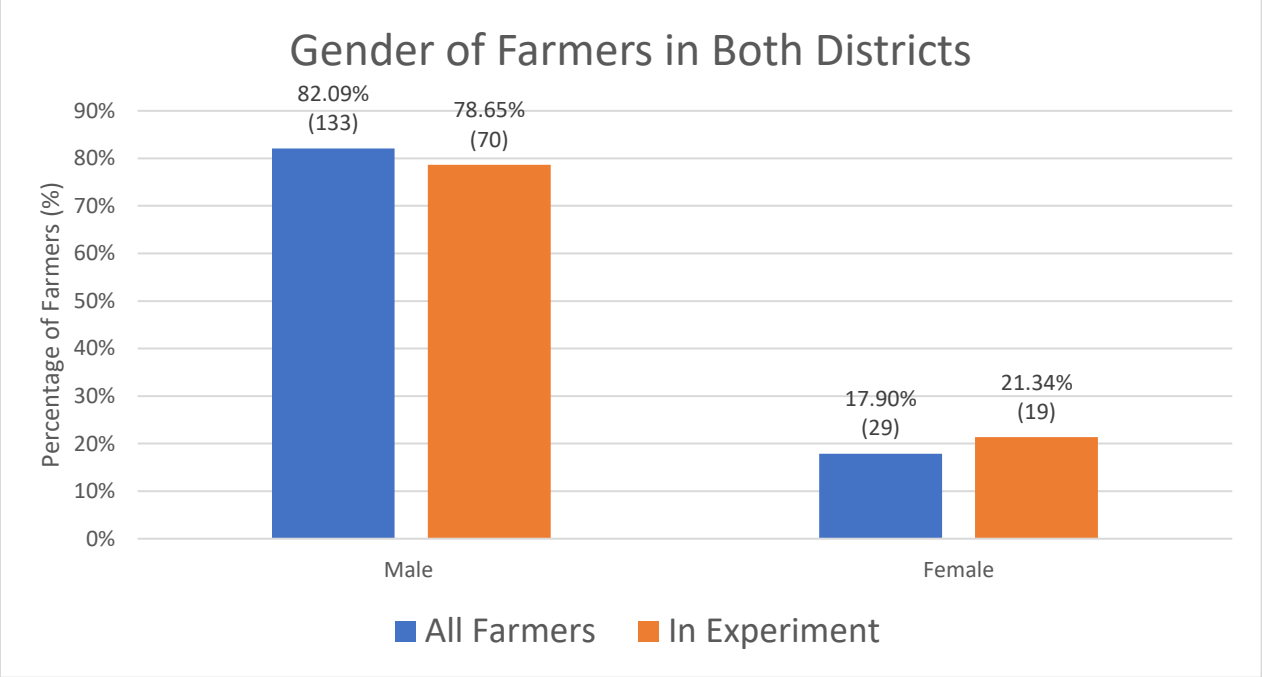

Figure #1.1) Gender of Farmers in Dedza and Mchinji combined. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Figure above shows a large difference in number of men and women in both districts (82.09% men as opposed to 17.9% women in all farmers surveyed and 78.65% men as opposed to 21.34% female in farmers in the project). It is important to note that the gender demographics were very similar between all farmers surveyed and the farmers in the project, with less than 4% difference in number of males and females as well).

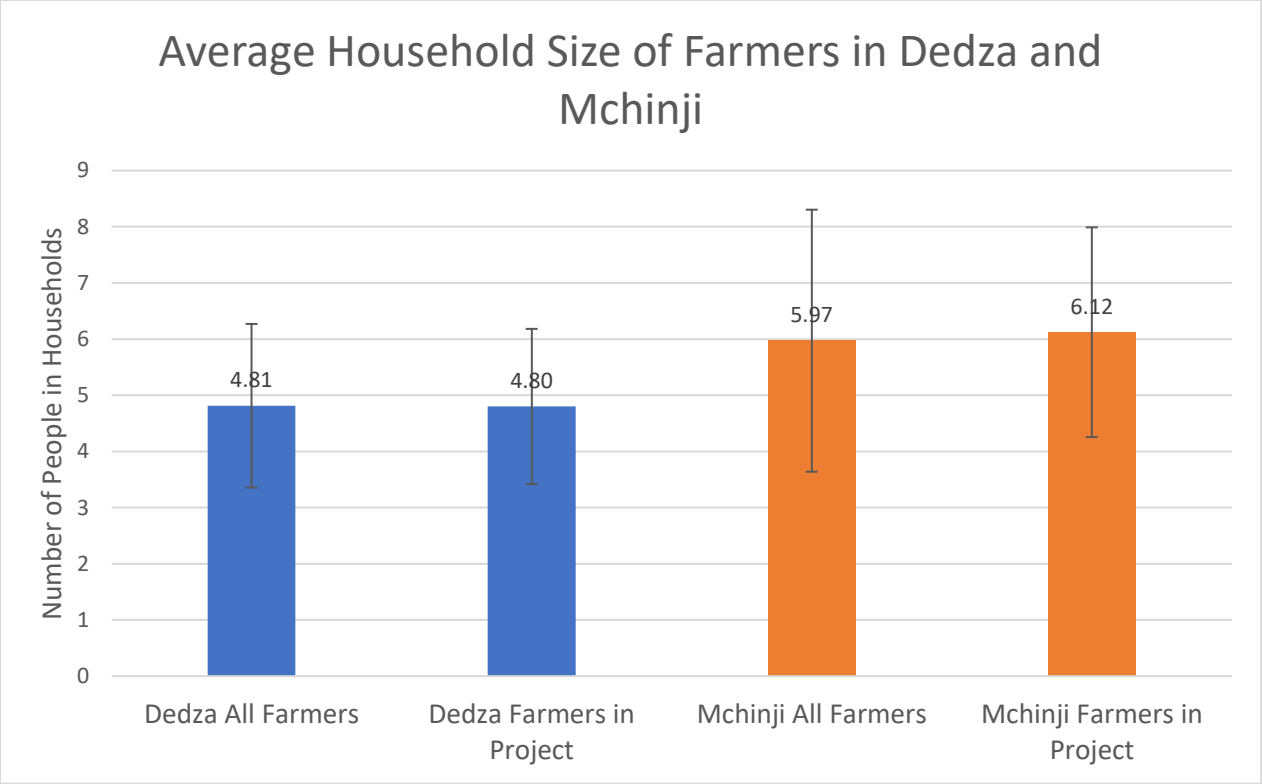

Figure #2: Average Household Size of Farmers in Dedza and Mchinji. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Generally, Mchinji's farmers had more people in their households than those in Dedza (1.1 average more for all farmers and 1.3 for those in the project).The average people in the household of farmers in Dedza was similar between all the farmers surveyed and the farmers in the project (less than 0.1% difference). The average people in household in Mchinji was also similar between all the farmers surveyed and the farmers in the project (less than 1% difference).

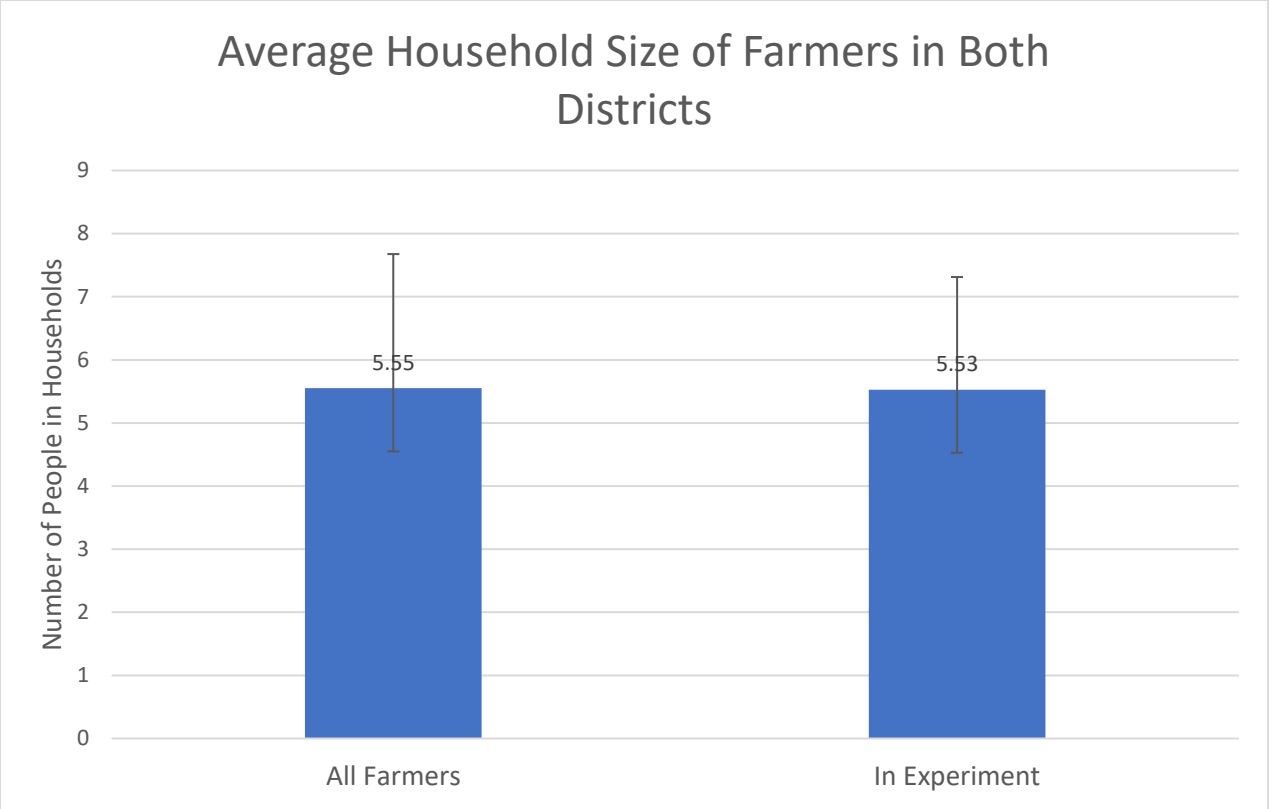

Figure #2.1) Household Size of Farmers in Dedza and Mchinji combined. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The size of the household of all farmers surveyed in both Dedza and Mchinji combined and those participating in the project was very similar, with a difference of about 0.02.

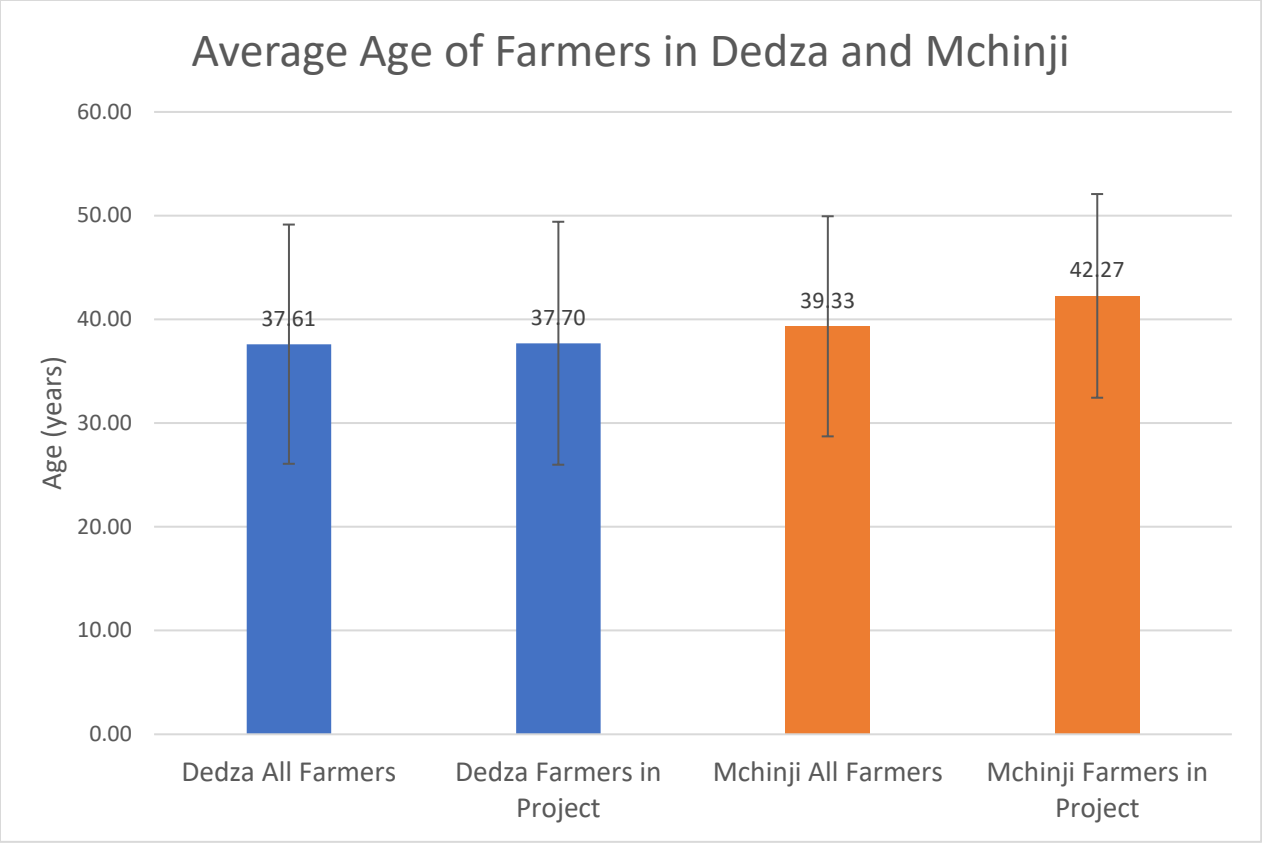

Figure #3: Average Age of Farmers in Dedza and Mchinji

Generally, the farmers in Mchinji were older than those in Dedza (an average of 1.7 years older for all farmers surveyed and 4.5 years older for those who were part of the project). The average age of the farmers in Dedza was similar between all the farmers surveyed and the farmers in the project (less than 0.1 years difference). In Mchinji, the average age of farmers in the project was 2.93 years older than those surveyed.

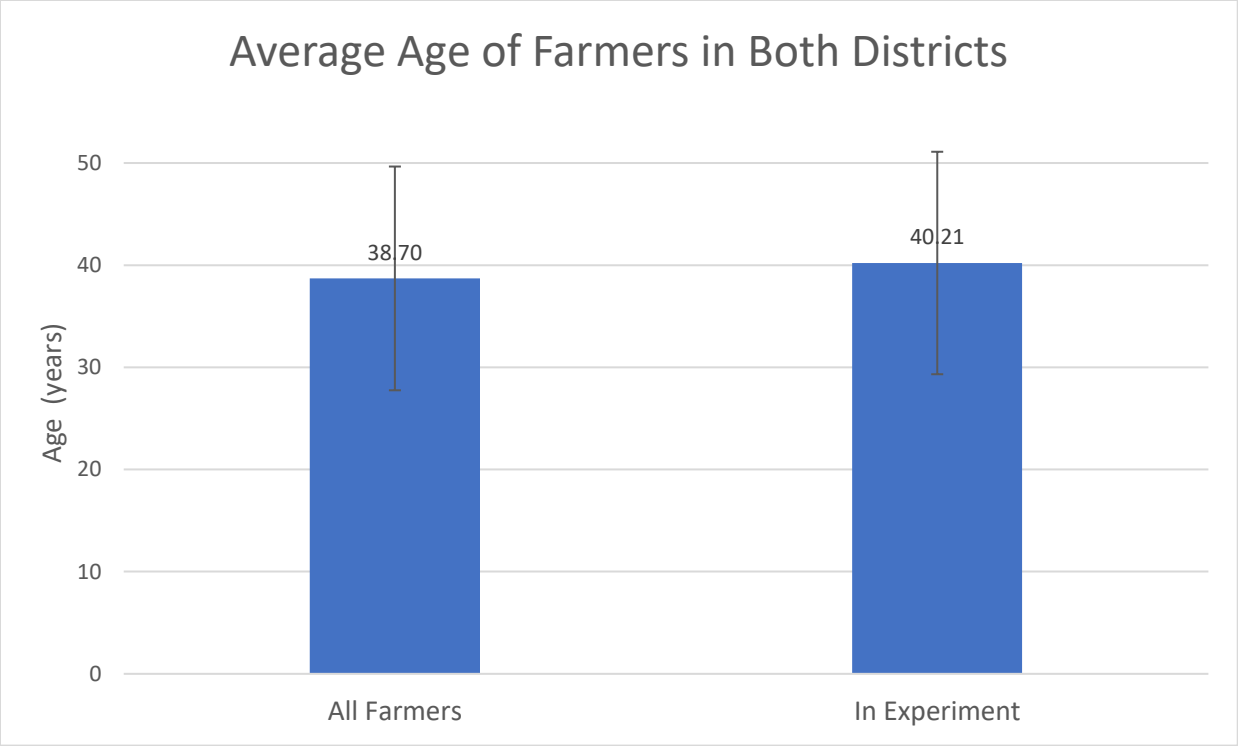

Figure #3.1) Average Age of Farmers in Dedza and Mchinji combined.

The average age of all farmers surveyed in both Dedza and Mchinji combined and those participating in the project was very similar, with a difference of an average of about 1.5 years.

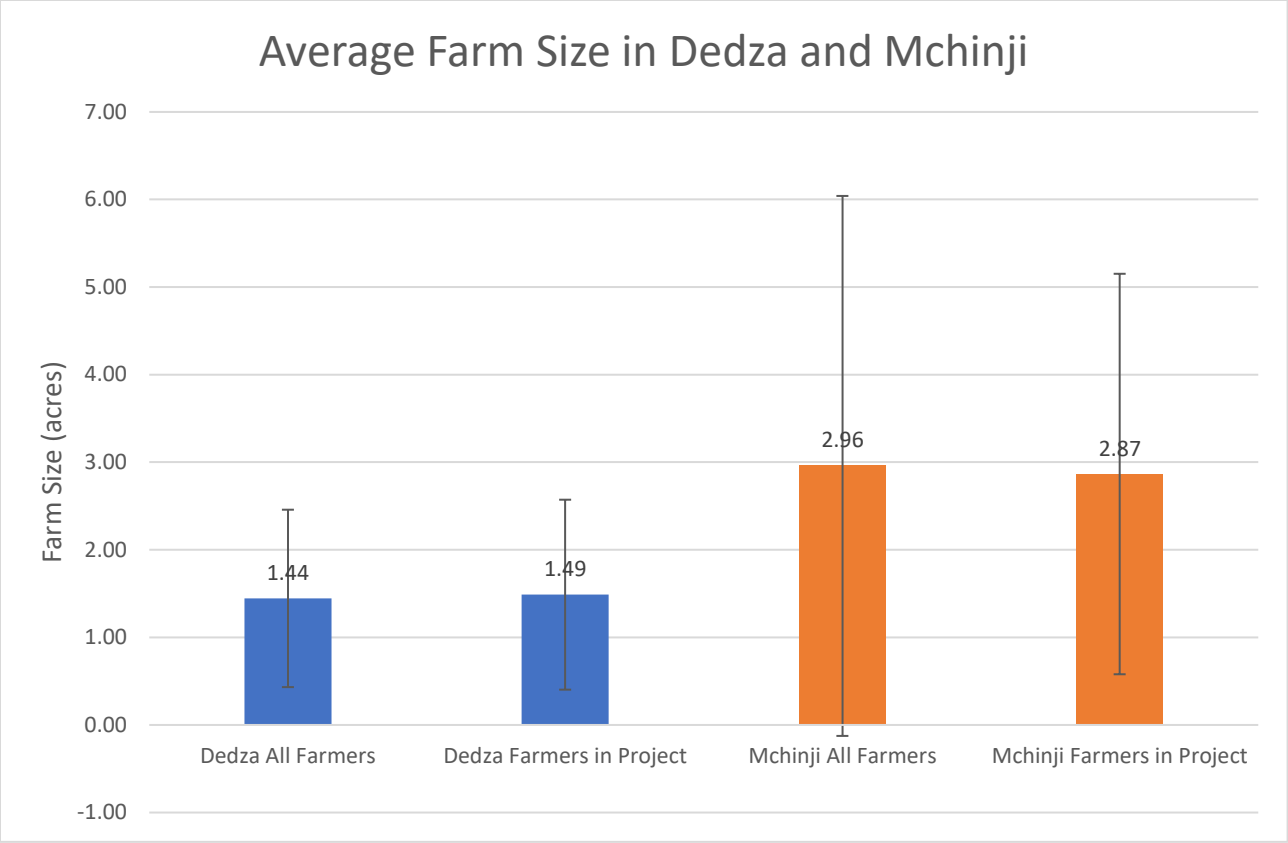

Figure #4: Average Farm Size (in acres) of Farmers in Dedza and Mchinji.

Generally, the farmers in Mchinji had larger farms than those in Dedza (an average of 1.51 acres larger for all farmers surveyed and 1.38 acres larger for those in the project). The average farm size of farmers in Dedza was similar between all the farmers surveyed and the farmers in the project (less than 0.04% difference). In Mchinji, the average farm size of farmers was similar between all the farmers surveyed and the farmers in the project (less than 1% difference).

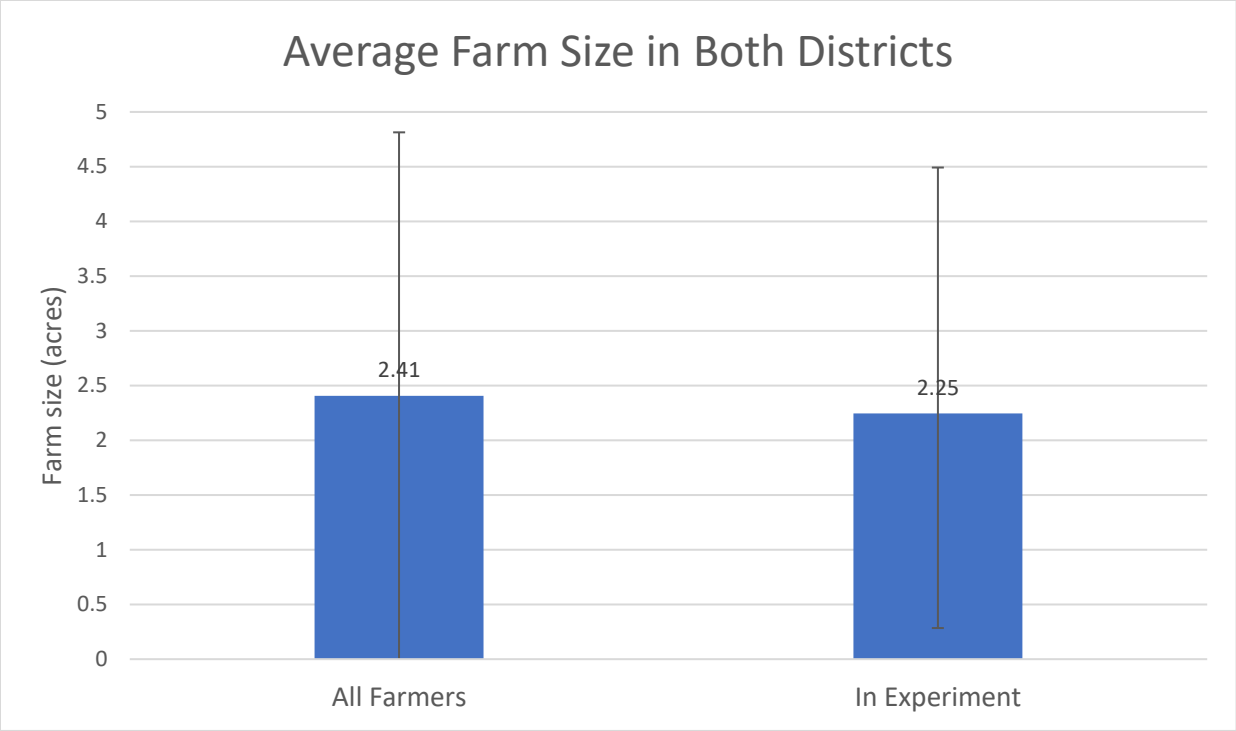

Figure #4.1: Average Farm Size (in acres) of Farmers in Dedza and Mchinji combined.

The average farm size of all farmers surveyed in both Dedza and Mchinji combined and those participating in the project was very similar, with a difference of an average of about 0.16 acres.

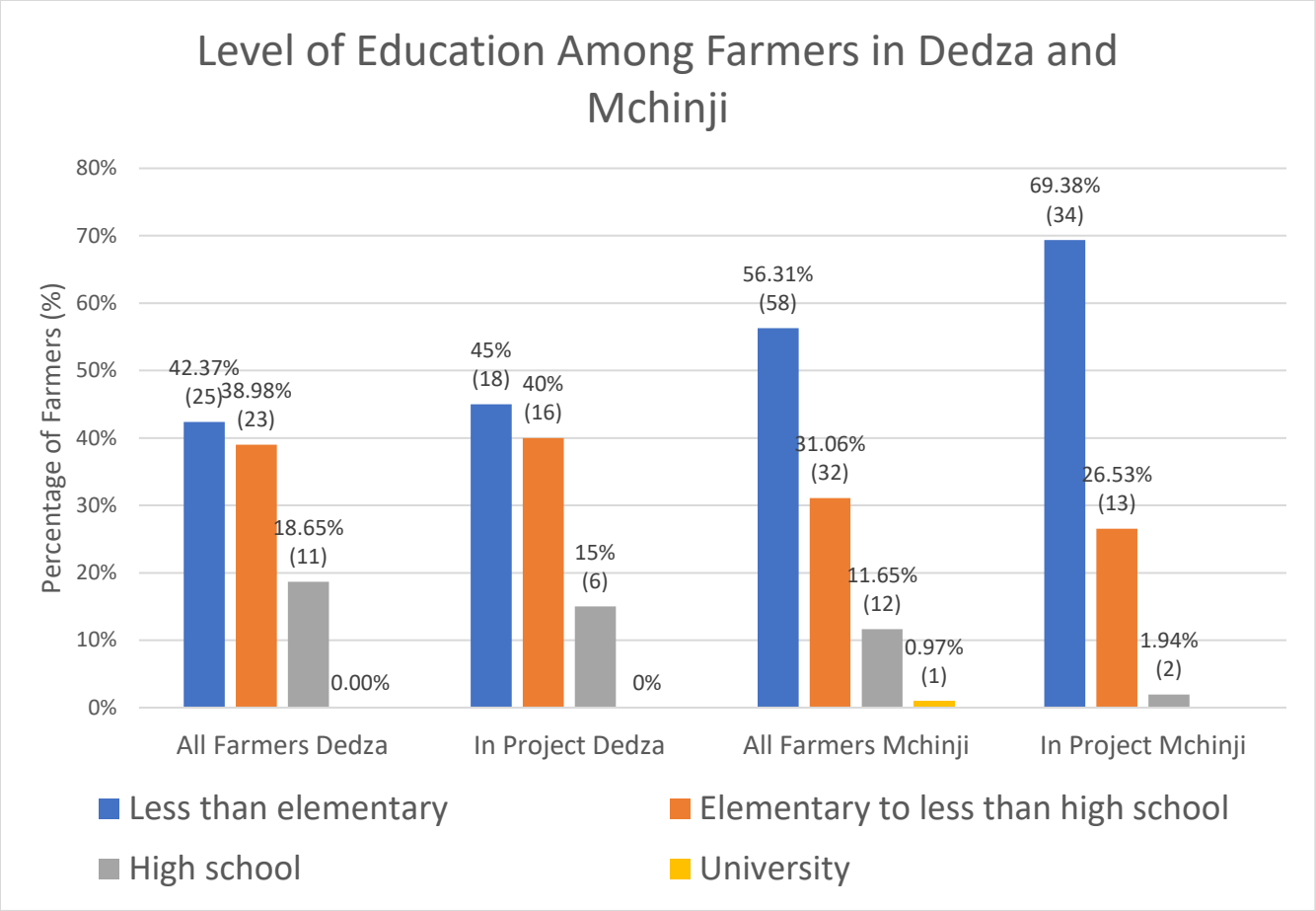

Figure #5: Level of Education Among Farmers in Dedza and Mchinji. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Generally speaking, farmers in Dedza were more educated than those in Mchinji (13.94% less had less than an elementary education from all farmers surveyed and 24.38% less farmers in the project; 7.92% more had an elementary to less than high school education from all the farmers surveyed and 13.47% more farmers in the project; 7% more had a high school education from all farmers surveyed and 13.06% more farmers in the project). In Dedza, the level of education of farmers was slightly different between all the farmers surveyed and the farmers in the project. The farmers in the project had 2.63% more farmers with less than an elementary education, 1.02% more farmers with an elementary to less than high school education, and 3.65% less farmers with

a high school education. In Mchinji, the level of education of farmers was slightly different between all the farmers surveyed and the farmers in the project. The farmers in the project had 13.06% more farmers with less than an elementary education, 4.53% less farmers with an elementary to less than high school education, and 9.71% less farmers with a high school education. Additionally, the farmers in the survey had a farmer with a university degree who did not participate in the project.

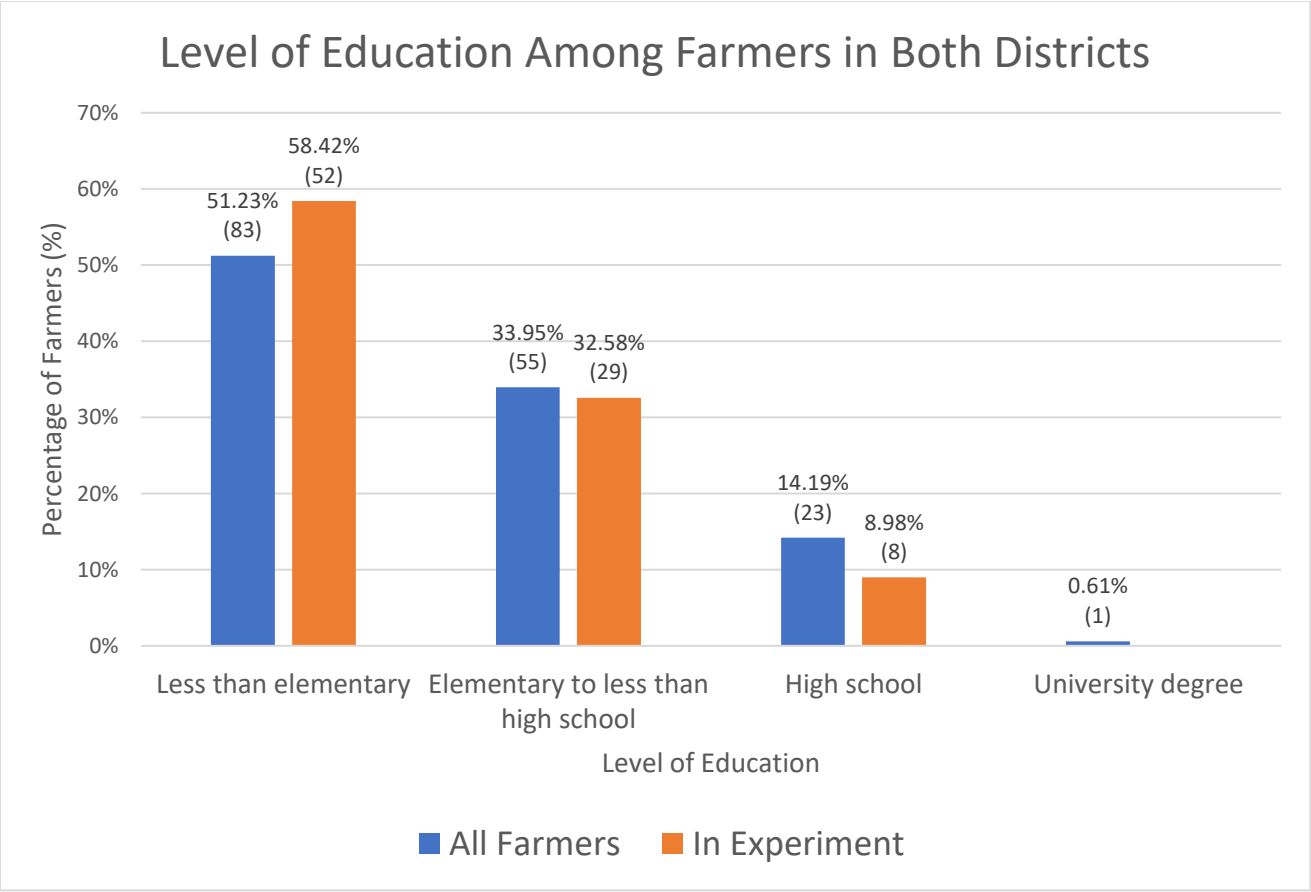

Figure #5.1) Average Level of Education of Farmers in Dedza and Mchinji combined. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The average level of education of all farmers surveyed in both Dedza and Mchinji combined and those participating in the project was mostly similar, especially when it comes to

farmers with an elementary to less than high school education (less than 1.37% difference). All farmers surveyed were slightly more educated than the farmers participating in the project, with 7.19% less farmers with less than an elementary education and 5.92% more farmers with a high school education.

Table #1: Summary of Demographic Results

Comparison between Dedza and Mchinji, all farmers surveyed	**Comparison between Dedza and Mchinji, farmers in project**	**Comparison within Dedza, all farmers surveyed and farmers in project**	**Comparison within Mchinji, all farmers surveyed and farmers in project**
6.83% more males in Dedza	16.1% more males in Dedza	Less than 1% difference in male to female ration	8.19% less male farmers in project than all farmers surveyed
Average of 1.1 more people in Mchinji households	Average of 1.3 more people in Mchinji households	Less than 0.1% difference	Less than 1% difference
Mchinji farmers were an average of 1.7 years older	Mchinji farmers were an average of 4.5 years older	Less than 0.1% difference	Farmers in project were an average of 2.93 years older than all farmers surveyed

Mchinji farms were an average of 1.51 acres larger	Mchinji farms were an average of 1.38 acres larger	Less than 0.04% difference	Less than 1% difference
Less than an elementary education: Dedza has 13.94% less. **Elementary to high school education: Dedza had 7.92% more** **High school education: Dedza had 7% more**.	Less than an elementary education: Dedza had 24.38% less. Elementary to high school education: Dedza had 13.47% more. High school education: Dedza had 13.06% more	Less than an elementary education: farmers in the project had 2.63% more. Elementary to high school education: farmers in the project had 1.02% more. High school education: farmers in the project had 3.65% less	Less than an elementary education: the farmers in the project had 13.06% more. Elementary to high school education: farmers in the project had 4.53% less. High school education: farmers in the project had 9.71% less

Section 1.2: Survey 1 Behavioral Data- Dedza

The results of the surveys in the following sections (section 1.2, 1.3, 1.4 and 1.5) reflect all the farmers that participated in the surveys and not only those that also participated in the project.

Table #2: Results of Survey 1 in Dedza

Question	Results in Dedza
Spraying Habits	
Reason for spraying	• 96.61% spray routinely, not only when witnessing pests
Spraying frequency	• 100% weekly
Factors preventing spraying	• 84.75% - absence of pesticide • 1.69% - recommendations from extension officers
Expenditure on pesticides	• 35.59% - less of 30% of growing expenses on pesticides • 33.90% - between 30% and 40%
Farm Monitoring	
Farm monitoring	• 89.93% don't do it regularly
Importance of farm data tracking	• 52.54% - don't find it important. • 47.46% - find it important
Reasons for lack of importance of farm monitoring tracking	• From the 52.54% above- 29% said it's a source of frustration • Two farmers listed "fear of committing suicide" • Two farmers listed "fear of depression due to losses" • One farmer listed "fear of heart attack"
Sources of Information for Farm Management	
Sources of information for farm management	• 62.71% - other farmers • 18.64% - extension officers
Following professional recommendations	• 59.32% do not follow

Reasons not to follow professional recommendations	• From the 59.32% above- 100% do not get to talk to information providers
Contact with extension officers	• 91.53% are not
Farm Management Coordination	
Farm management coordination	• 52.54% - coordinate with others • 47.46%- don't coordinate with others
Partners for farm management coordination	• From the 52.54% above- 70.97% coordinate with neighbors
Methods for farm management coordination	• From the 52.54% above- 100% do it sporadically and informally
Topics of farm management coordination	• From the 52.54% above- 90.32% pest and disease management • 82.65%- input use
Reasons for lack of farm management coordination	• From the 47.46% above- 75% don't see potential benefits in farm management coordination
Willingness to Provide Information and Trust Recommendations	
Scout - willingness to provide information	• 100% willing
Scout - willingness to trust recommendations	• 100% willing
Scout - willingness to follow advice	• 96.61% willing

Call center - willingness to provide information	• 100% willing
Call center - willingness to trust recommendations	• 98.31% willing
Call center - willingness to follow advice	• 100% willing
Lead farmer - willingness to provide information	100% willing
Lead farmer - willingness to trust recommendations	98.31% willing
Lead farmer - willingness to follow advice	98.28% willing

The first survey revealed that most farmers in Dedza spray their fields weekly and routinely, as opposed to when witnessing a pest. About a third of the farmers said that about 30% to 40% of their expenses correspond to pesticides. Most farmers in Dedza don't track information in their farms, and half of them said that farm monitoring is not important to them, describing farm monitoring as a source of frustration and noting it as damaging to their mental health. Furthermore, 60% said that they learn about farm management from fellow farmers. Close to 60% of respondents said that they don't follow professional recommendations because they are not in contact with information providers, and almost all the farmers said that they are not in contact with extension officers. In addition, only about half of the farmers said that they coordinate farm management with other farmers, focusing mostly on pest management and use of inputs. Finally, almost all

farmers said that they are willing to provide information to a scout, call center operator or lead farmer, and almost all the farmers said that they would trust and follow recommendations from them.

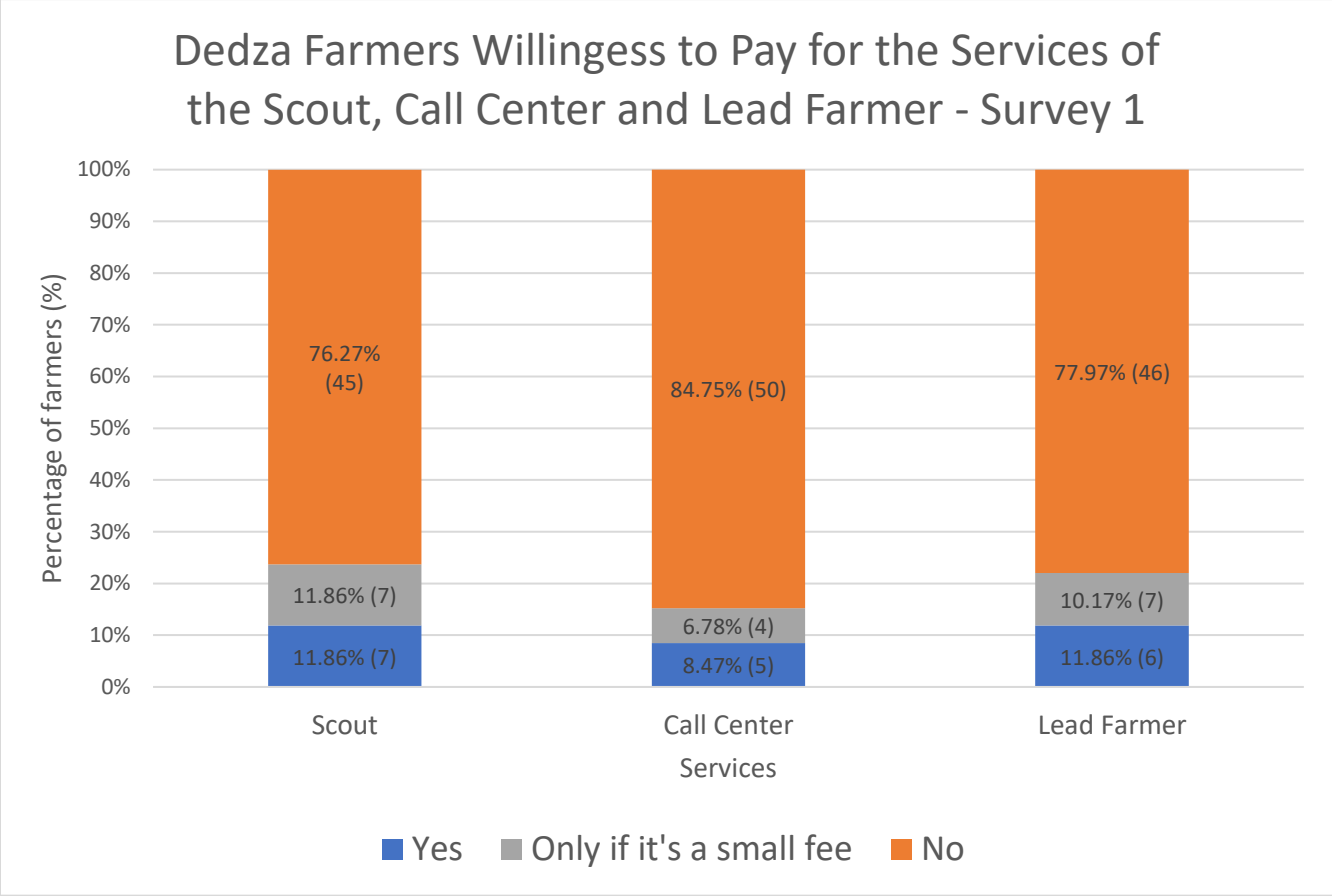

Figure #6: Willingness to Pay for the services of the Scout, Call Center Operator and Lead Farmers' farm monitoring and advice services in Dedza as declared in Survey 1. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

A great majority of the Dedza farmers surveyed declared that they were not willing to pay for the services of the scout, call center operator or lead farmer. A minority of the farmers said that they would pay, or that they would if it was a small fee. The farmers were slightly more in favor of paying for the services of the scout or lead farmer as opposed to the call center.

Section 1.3:Survey 1 Behavioral Data- Mchinji

Table #3: Results of Survey 1 in Mchinji

Question	Results in Mchinji
	Spraying Habits
Reason for spraying	• 76.47% - spray routinely, not only when witnessing pests • 18.63%- spray only when witnessing pests
Spraying frequency	• 67.65%- weekly • 19.61%- twice a month
Factors preventing spraying	• 52.94% - absence of pesticide • 22.25%- absence of pests • 5.88% - recommendations from extension officers
Expenditure on pesticides	• 41.18% - less than 30% of growing expenses on pesticides • 38.24% - between 30% and 40%
	Farm Monitoring
Farm monitoring	• 53.92%- do it regularly • 46.08%- don't do it regularly
Elements in farm monitoring	• From the 53.92% above- 92.73% fertilizer use • 80%- pesticide use • 69/09%- income • 54.55%- yield

Methods for farm monitoring	• From the 53.92% above- 92.73% write the data in paper
Importance of farm data tracking	• 85.29% - find it important for calculating expenses and profits and to aide decision making
Sources of Information for Farm Management	
Sources of information for farm management	• 75.53% - extension officers • 44.12%- other farmers • 39.22%- product suppliers
Following professional recommendations	• 82.35% follow
Contact with extension officers	• 52.94% in contact
Frequency of contact with extension officers	• From the 52.94% above- 35.19% 12 times a year • 14.81%- 24 times a year • 12.92%- 10 times a year
Farm Management Coordination	
Farm management coordination	• 72.55% coordinate with others • 27.45% don't coordinate with others
Partners for farm management coordination	• From the 72.55% above- 52.5% coordinate with neighbors
Methods for farm management coordination	• From the 72.55% above- 89.19% do it sporadically and informally
Topics of farm management coordination	• From the 72.55% above- 85% input use • 81%- pest and disease management

Reasons for lack of farm management coordination	• From the 27.45% above- 78.57% don't see potential benefits

Willingness to Provide Information and Trust Recommendations

Scout - willingness to provide information	• 100% willing
Scout - willingness to trust recommendations	• 100% willing
Scout - willingness to follow advice	• 100% willing
Call center - willingness to provide information	• 99.02% willing
Call center - willingness to trust recommendations	• 99.02% willing
Call center - willingness to follow advice	• 99.02% willing
Lead farmer - willingness to provide information	100% willing
Lead farmer - willingness to trust recommendations	98.04% willing
Lead farmer - willingness to follow advice	100% willing

The first survey revealed that about three quarters of farmers in Mchinji spray their fields weekly and routinely, and a quarter only when witnessing a pest. Over a third of the farmers said

that less than a third of their expenses are on pesticides. About half of the farmers in Mchinji track information in their farms, and over 80% said that it's important to them to track profits and make decisions. Furthermore, about three quarters of the farmers said that they obtain farm management information from extension services. Most farmers, over 80%, said that they follow professional recommendations, and over half of the farmers said that they are in contact with extension officers. In addition, about three quarters of the farmers said that they coordinate farm management with other farmers, focusing mostly on input use and pest and disease management. Finally, all farmers said that they are willing to provide information to a scout, or lead farmer, and all the farmers said that they would trust and follow recommendations from them. Almost all farmers said the same for the call center.

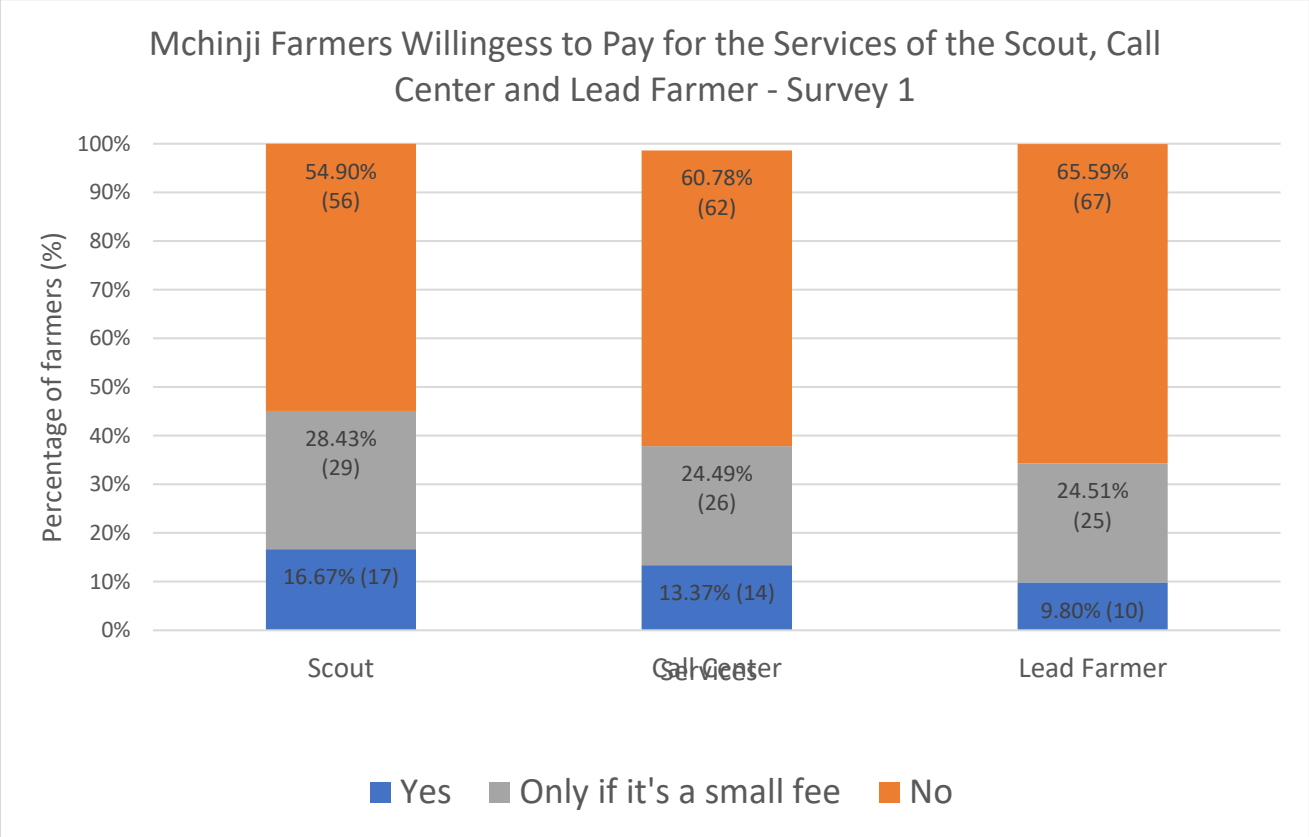

Figure #7: Willingness to Pay for the services of the Scout, Call Center Operator and Lead Farmers' farm monitoring and advice services in Mchinji, as declared in Survey 1. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Most farmers were not willing to pay for the services of the scout, call center or lead farmer. However, farmers showed higher willingness to pay for the services of the scout and less for the services of the lead farmer.

Section 1.4: Survey 2 – Advice Reception and Application – Dedza

Table #4: Results of Survey 2 in Dedza

Question	Results
Pest Management Advice	
Advice reception over the last month	• 76.36%- received advice
Topic of advice reception	• From the 76/36%- 83% related to pest management and spraying application
Source of advice	• 47.67%- the scout • 45.24%- the call center • 9.52%- the lead farmer
Following the advice	• 88.10%- followed advice
Advice Sharing and Coordination	

Coordination of applying the advice	• 45.24%- did not • 42.86%- coordinated with friends
Reasons for not coordinating applying the advice	• From the 45.24% above- most did not see the need of sharing the advice.
	Overall Preferences
Overall preferences for farm monitoring	• Scout- 65.45% • Call center- 18.18% • Lead farmer- 16.38%
Overall preferences for source of advice	• Scout- 52.73% • Call center-43.64% • Lead farmer- 3.64%

Survey number two revealed that over three quarters of the farmers surveyed in Dedza received advice, most of it regarding pest management and spraying application. About half of the advice came from the scout and half from the call center operator, with the least amount of advice coming from the lead farmer. About half of the farmers in Dedza coordinated applying that advice with others. Over half of the farmers declared that their favored source of farm management information was the court, followed by the call center. The same is true for their preferences regarding a source of advice.

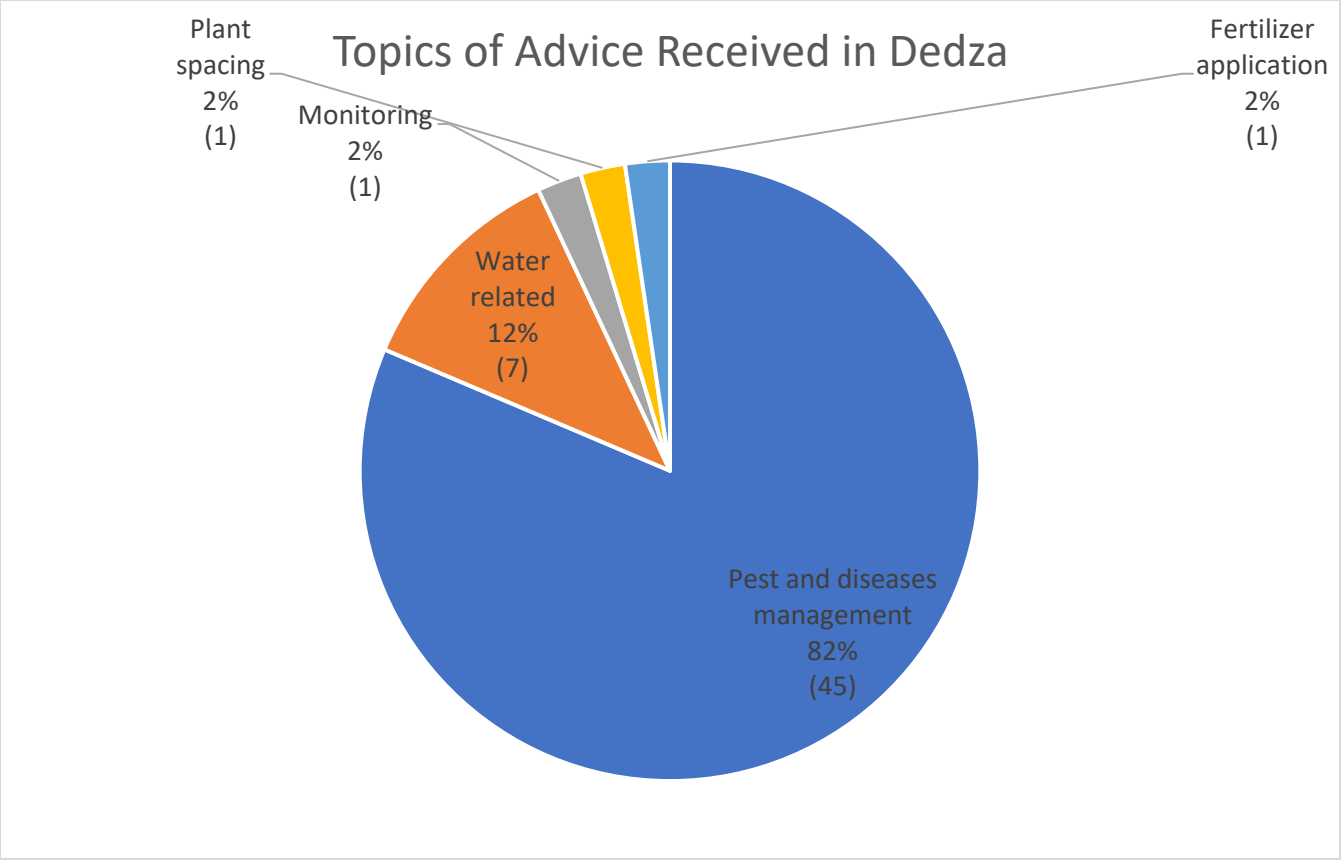

Figure #8: Topics of Advice Received in Dedza. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Most farmers in Dedza who declared that they received advice from the scout, call center or lead farmer said that the advice was on the topic of pest and diseases management (82%).

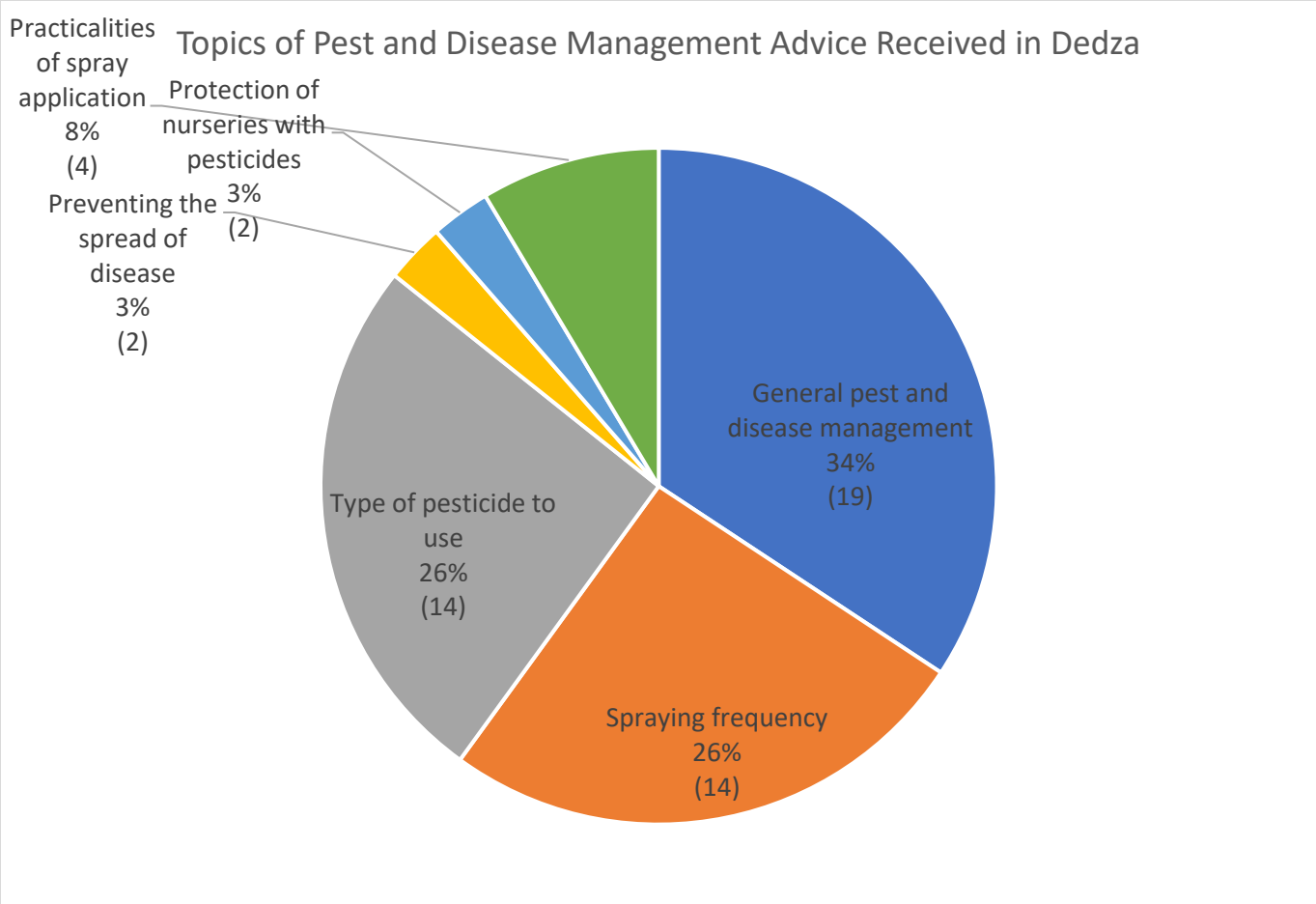

Figure #9: Breakdown of Pest and Disease Management Related Advice Received in Dedza. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Within the pest and disease management advice, 5 farmers said specifically that they were advised to spray once every two weeks, and 4 said that they were advised to reduce pesticide application rate without providing additional details.

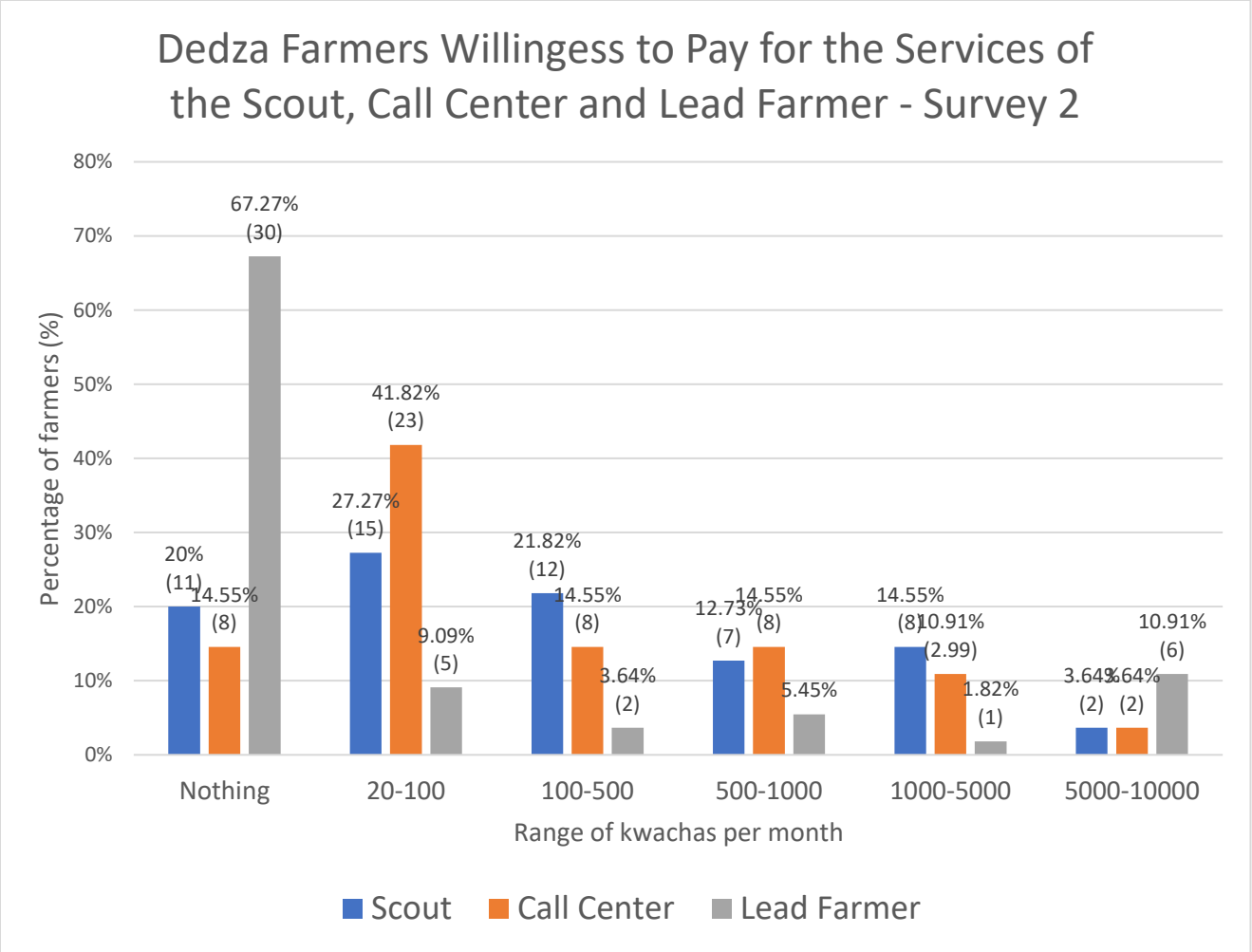

Figure #10: Willingness to Pay for the Services of the Scout, Call Center, and Lead Farmer in Dedza as declared in Survey 2. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Dedza, the farmers showed the least willingness to pay for the services of the lead farmer and a similar willingness to pay for the services of the scout and the call center operator, coinciding with their preferences declared in the survey above.

Section 1.5: Survey 2 – Advice Reception and Application – Mchinji

Table #5: Results of Survey 2 in Mchinji

Question	Results
Pest Management Advice	
Advice reception over the last month	• 79%- received advice
Topic of advice reception	• From the 79% above- 59% related to pest management and spraying application
Source of advice	• 69.35%- the scout • 41.77%- the call center • 13.92%- the lead farmer
Following the advice	• 98.73%- followed advice
Advice Sharing and Coordination	
Coordination of applying the advice	• 75.15%- coordinated with friends
Overall preferences for farm monitoring	• Scout- 77% • Call center- 20% • Lead farmer- 3%
Overall preferences for source of advice	• Scout- 79% • Call center- 17% • Lead farmer- 4%

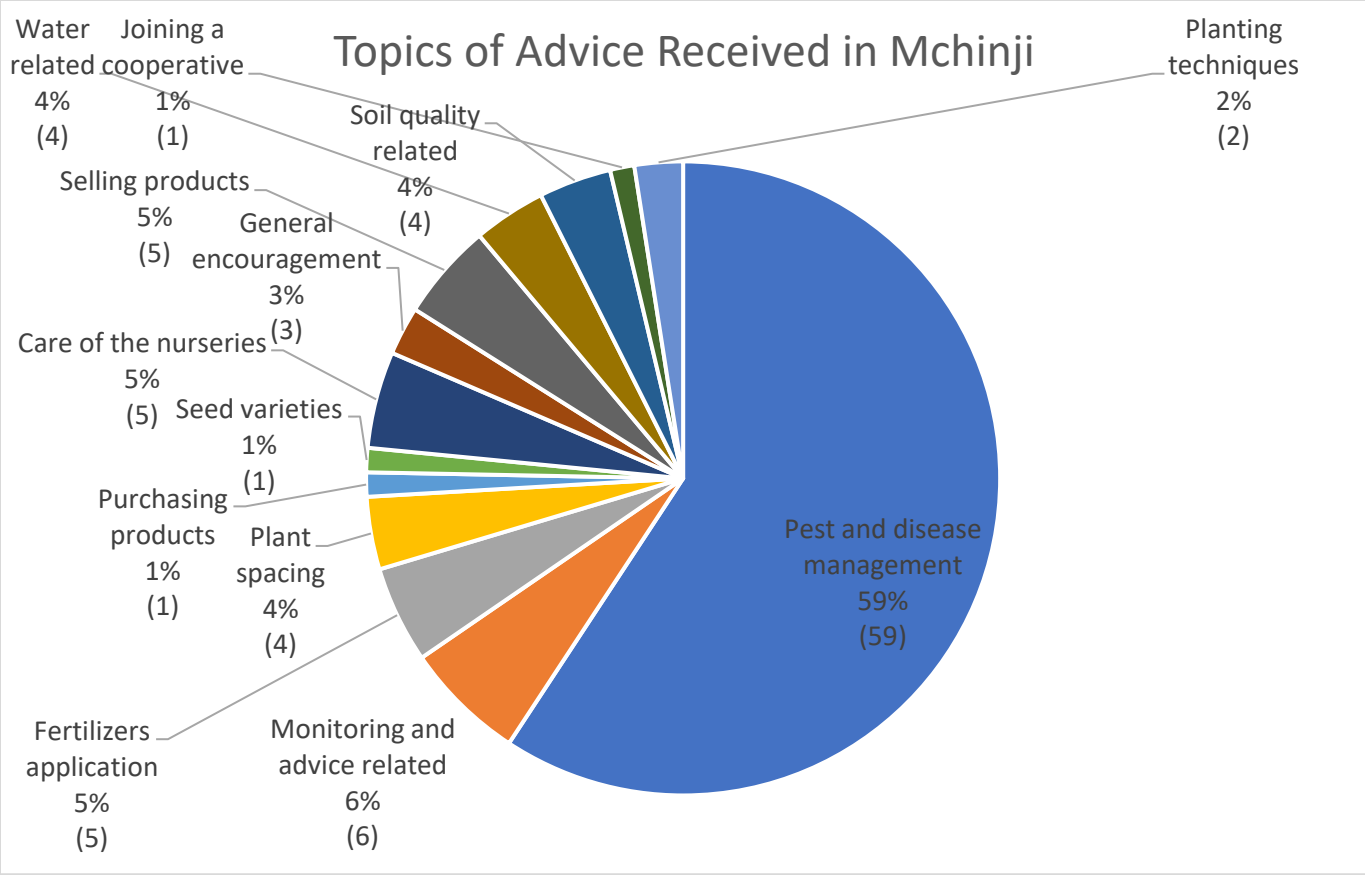

Figure #11: Topics of Advice Received in Mchinji. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Most farmers in Mchinji who declared that they received advice from the scout, call center or lead farmer said that the advice was on the topic of pest and diseases management (59%).

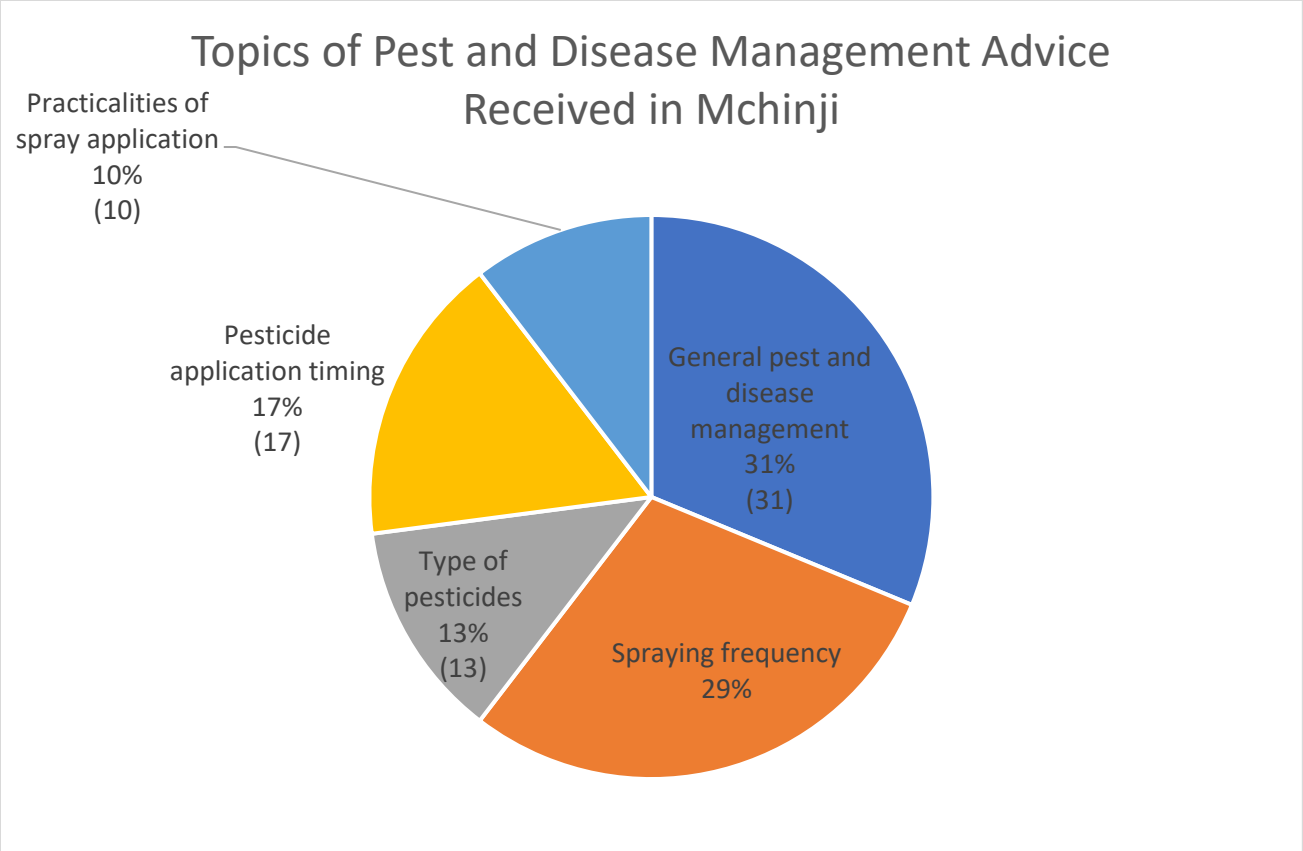

Figure #12: Breakdown of Pest and Disease Management Related Advice Received in Mchinji. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

Within the pest and disease management advice, 5 farmers said specifically that they were advised to spray once every two weeks, and 9 said that they were advised to reduce pesticide application rate without providing additional details.

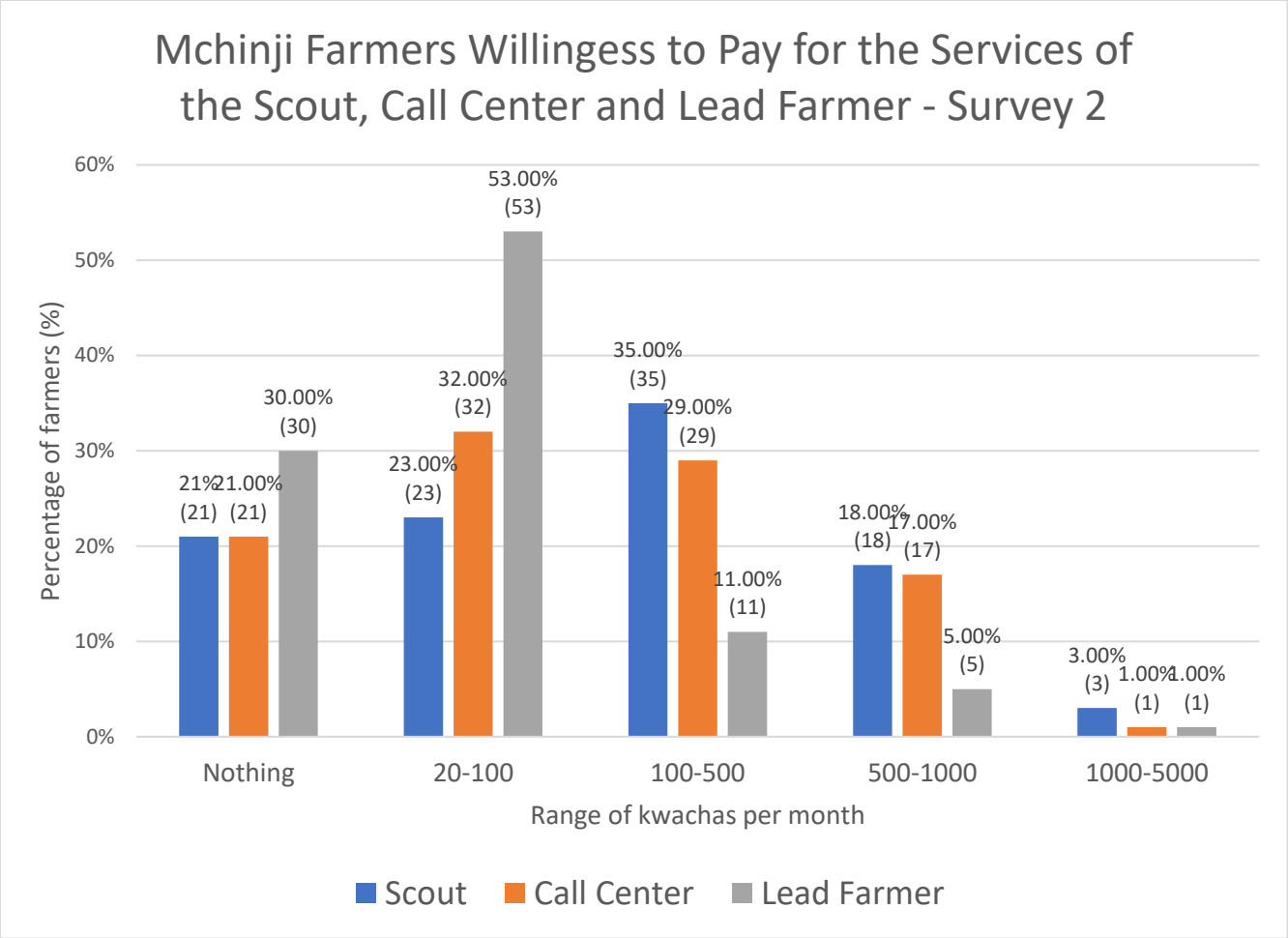

Figure #13: Willingness to Pay for the Services of the Scout, Call Center, and Lead Farmer in Mchinji as declared in Survey 2. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Mchinji, the farmers showed the least willingness to pay for the services of the lead farmer and the highest to pay for the services of the scout, consistent with their preferences as detailed in the table above.

Section 2 - Willingness to Pay Comparisons

As described in the Literature Review, a method to determine farmers' interest in monitoring their farm and receiving advice from the scout, call center and lead farmer can be their

willingness to pay for the aforementioned services. The question of the willingness to pay was part of the first survey, when most farmers had not yet used the services, and the second survey, when all farmers had already used the services of the scout, call center and/or lead farmer, at least once if not more times.

In the first survey, the farmers were asked if they were willing to pay for the aforementioned services and answered yes, no, or 'only if it's a small amount'. In the second survey, they were asked to choose between different ranges in kwachas (the local Malawian currency). For the purpose of the comparison between Survey 1 and Survey 2, the values in the ranges were converted to 'yes', 'no', or 'only if it's a small amount', as follows:

Range	**Category**
500-1000 kwachas, 1000-5000 kwachas, or 5000-10000 kwachas	Yes
0	No
20-100 kwachas, or 100-500 kwachas	Only if it's a small amount

The following comparisons only include farmers that were both part of the survey and the project.

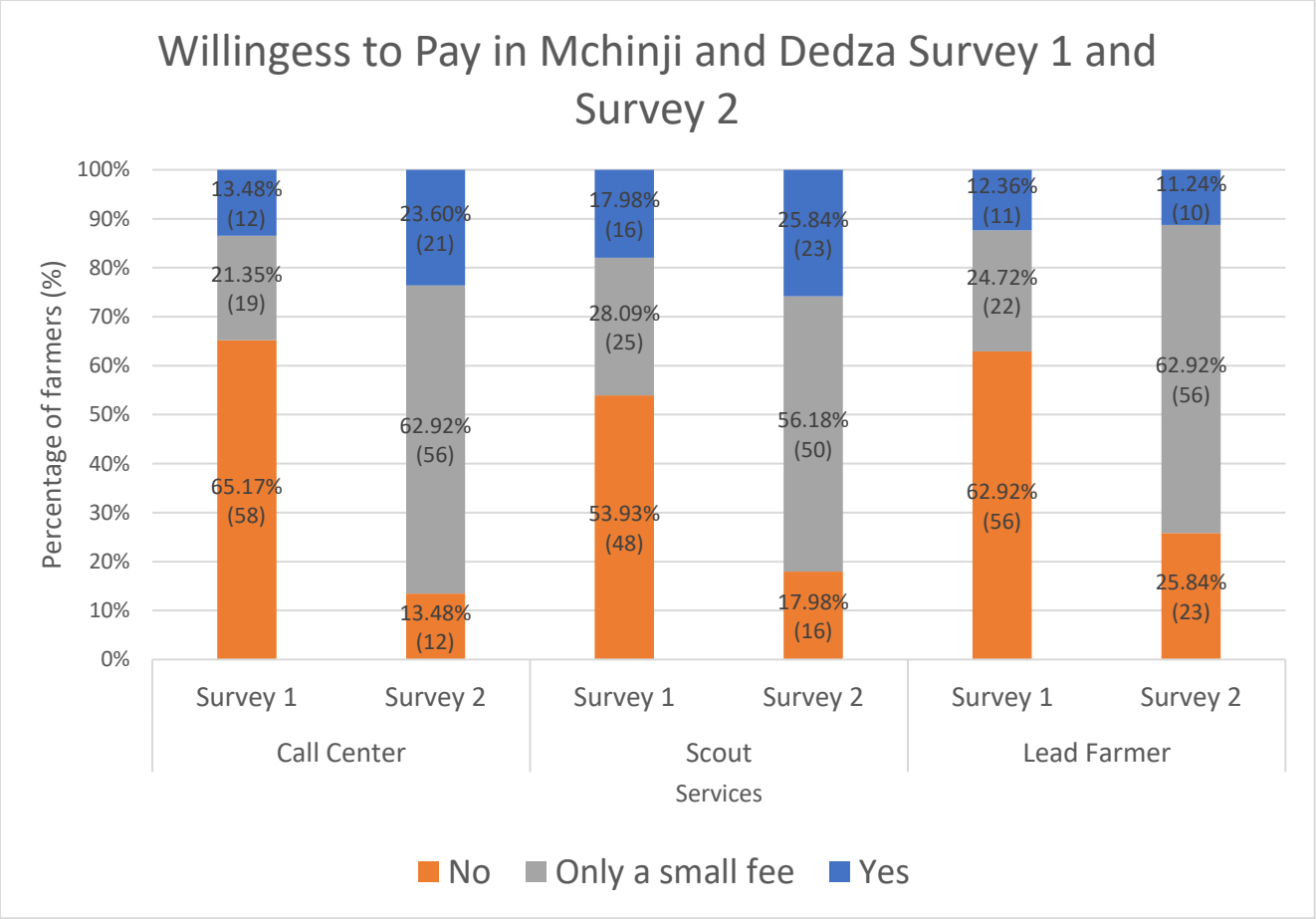

Figure #14: Willingness to Pay for the Services of the Scout, Call Center, and Lead Farmer in Dedza and Mchinji as declared by the farmers in Survey 1 and Survey 2. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Dedza and Mchinji, the number of farmers not willing to pay decreased in Survey 2 for all services (call center from 65.17% to 13.48%, scout from 59.93% to 17.98% and lead farmer from 62.92% to 25.84%). In most cases, farmers went from not being willing to pay for the services, to being willing to pay a small fee for the services. There was less variation (but still a slight increase between the surveys for all services except lead farmer) for the farmers who simply declared that they *would* be willing to pay (call center from 13.47% to 23.60%, scout from 17.98% % to 25.84% and lead farmer from 12.36% to 11.24%).

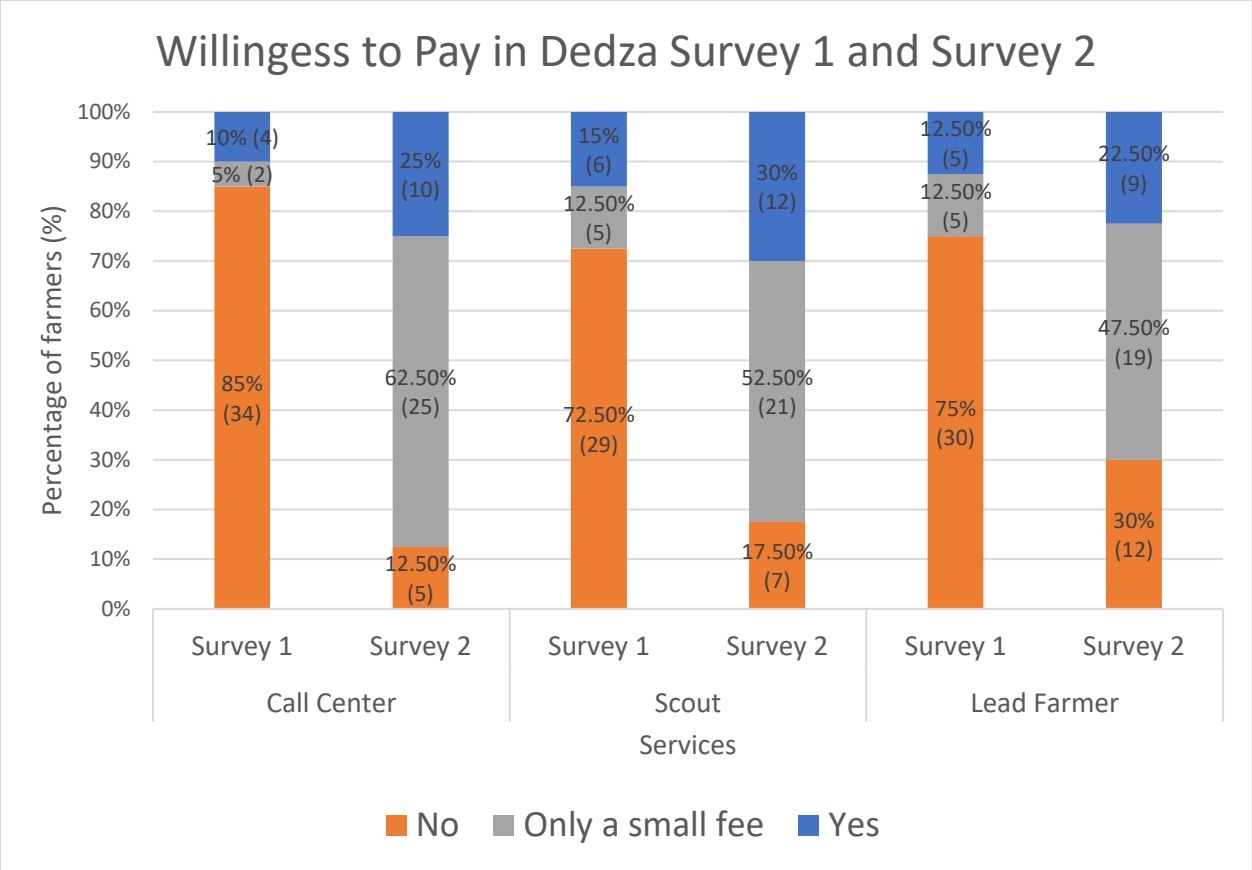

Figure #15: Willingness to Pay for the Services of the Scout, Call Center, and Lead Farmer in Dedza as declared by the farmers in Survey 1 and Survey 2. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Dedza, the number of farmers not willing to pay decreased in Survey 2 for all services (call center from 85% to 12.5%, scout from 72.5% to 17.5% and lead farmer from 75% to 30%). In most cases, farmers went from not being willing to pay for the services, to being willing to pay a small fee for the services. In survey 2, the highest willingness to pay number corresponds to the willingness to pay for the services of the scout (30% of respondents willing to pay between 500 and 10000 kwachas per month for the services).

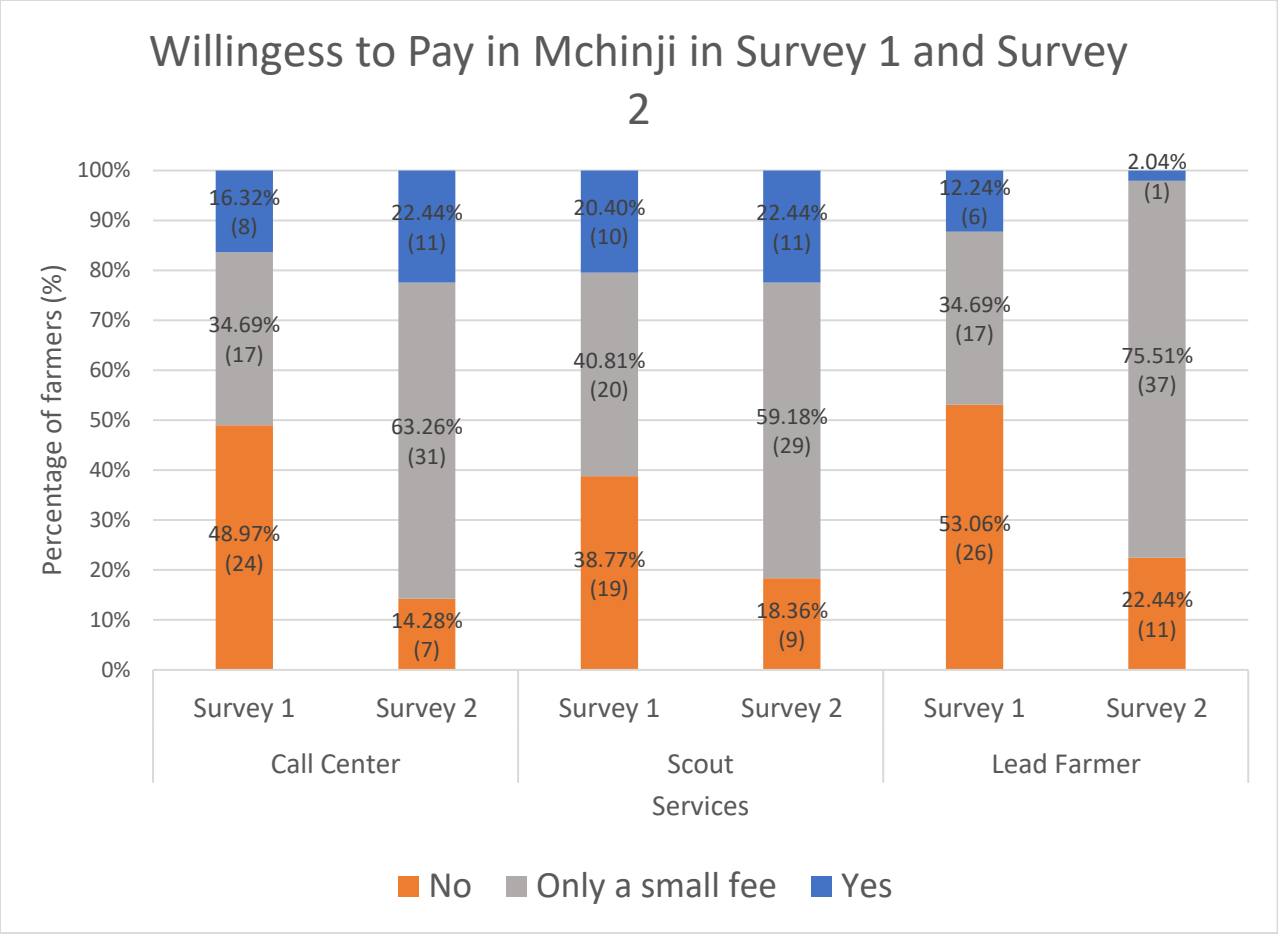

Figure #16: Willingness to Pay for the Services of the Scout, Call Center, and Lead Farmer in Mchinji as declared by the farmers in Survey 1 and Survey 2. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The number of farmers not willing to pay decreased in Survey 2 for all services (call center from 48.97% to 14.27%, scout from 38.77% to 18.37%, and lead farmer from 53.06% to 22.44%). In most cases, the farmers go from not willing to pay to being willing to pay a small fee for the services. In the second survey, the highest willingness to pay is for the services of the call center, with 22.44% willing to pay and 63.26% willing to only pay a small fee.

Section 3 - Factors affecting the farmers' interest in collecting field data and receiving advice from the call center, scout, and lead farmer

In order to determine the factors affecting farmers' interest in collecting farm data and receiving advice from the call center, scout and lead farmer, an analysis was performed between the farmers' interest (determined in their willingness to pay as declared in Survey 2), their actual interactions with the service providers (as determined by the Agritask records), and demographic factors (as declared by the farmers in Survey 1). The demographic factors included number of people in household, age, farm size, and education levels.

Section 3.1: Interactions

This section focuses on the relationship between farmers' interest (determined by their willingness to pay as declared in Survey 2) and their actual interactions with each service (before the date that they participated in Survey 2). For the purpose of this analysis, the number of interactions of each farmer with each service provider, and the date in which each of them participated in Survey 2, were considered. Furthermore, the following calculations are based on all farmers that participated in the project as well as both surveys or only Survey 2: 64 farmers in Mchinji and 42 in Dedza.

Table #6: Total interactions of all services providers with farmers before Survey 2

Total Interactions with farmers before the date of Survey 2

	Scout	**Call Center**	**Lead Farmer**	**Total**
Dedza	27	103	44	174

Mchinji	172	182	39	393
Total	199	285	83	567

The table above shows the significant differences in total interactions of the farmers with the scout, call center and lead farmer before their respective dates of participation in Survey 2. Mchinji farmers had a significantly higher number of interactions with the scout and call center than those in Dedza (especially in the case of the scout), while Dedza farmers had a slightly higher number of interactions with the lead farmer. However, the above data fails to take into account the differences in the number of farmers in each region, as the above data accounts for 42 Dedza farmers and 64 Mchinji farmers who participated in the project as well as both surveys or the second survey.

Table #7: Average number of interactions of all services providers with farmers before Survey 2

Average Interactions with farmers before the date of Survey 2

	Scout	Call Center	Lead Farmer
Dedza	0.6	2.45	1
Mchinji	2.68	2.84	0.6

The table above shows the significant differences in average interactions of the farmers with the scout, call center and lead farmer before their respective dates of participation in Survey 2. Mchinji farmers had a significantly higher average number of interactions with the scout and call center than those in Dedza, but the difference is especially high in the case of the scout (an

average of 2 more interactions). Dedza farmers had a slightly higher average number of interactions with the lead farmer (an average of about 0.4 more).

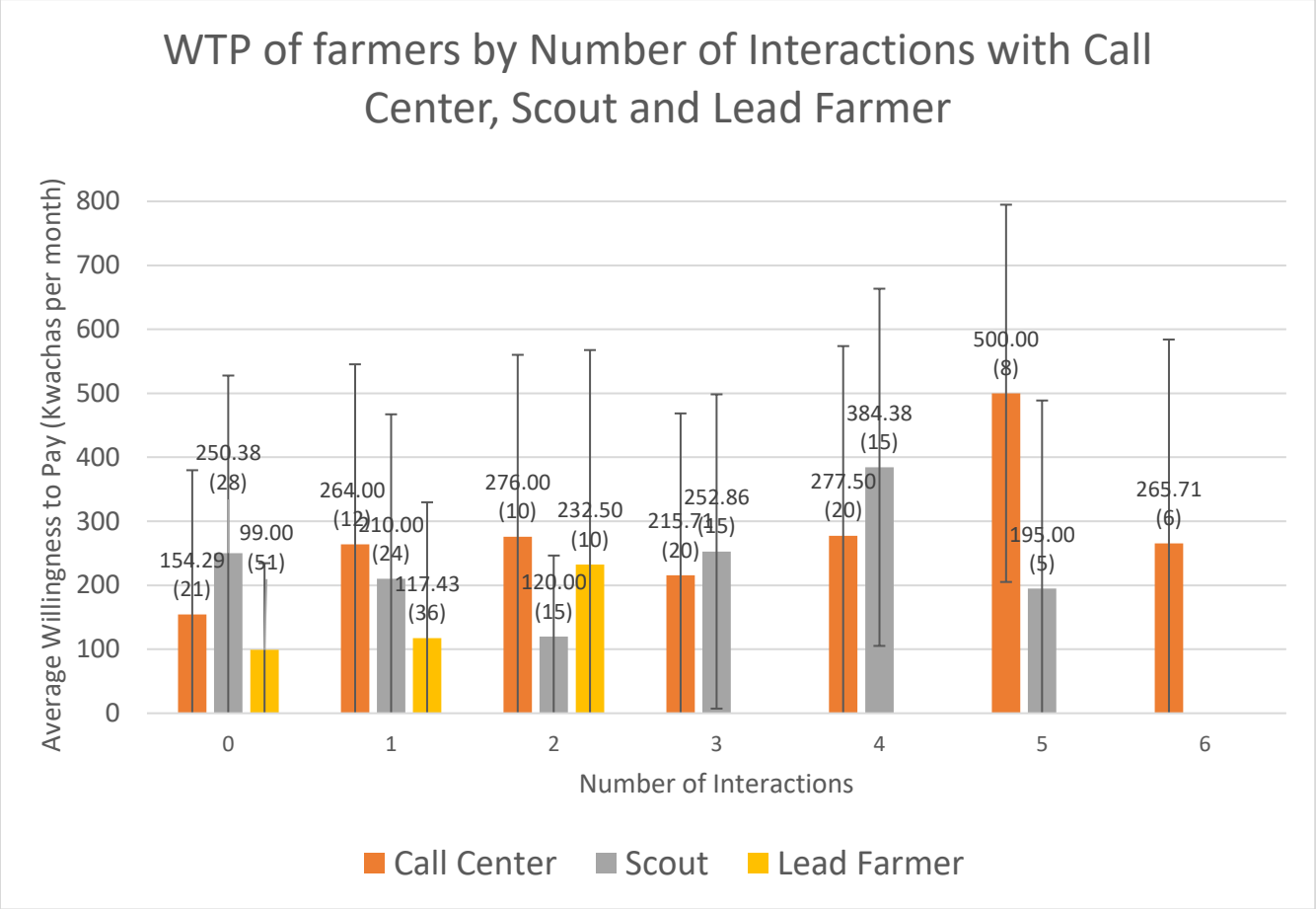

Figure #17: Dedza and Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and the number of their actual interactions with them. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The relationship between willingness to pay for the services and number of interactions shows an unclear relationship. When it comes to the call center, the WTP levels increase from 1 to 3 interactions, then decrease between 3 and 4, while finally increasing again from 4 to 5, then decreasing from 5 to 6 - showing an irregular trend yet overall increasing. In the case of the lead farmer, the numbers clearly increase, yet very slightly, with farmers with zero interaction being

willing to pay an average of 99 kwachas per month, and 1 interaction an average of 117 kwachas per month. Finally, in the case of the scout, the willingness to pay was very irregular, showing an increasing trend between 2 and 4 interactions and a decreasing trend between 4 and 5. Therefore, willingness to pay only increased with interaction in the case of the lead farmer.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (6.61% of farmers for the call center, 8% for the scout and 8.5% for the lead farmer).

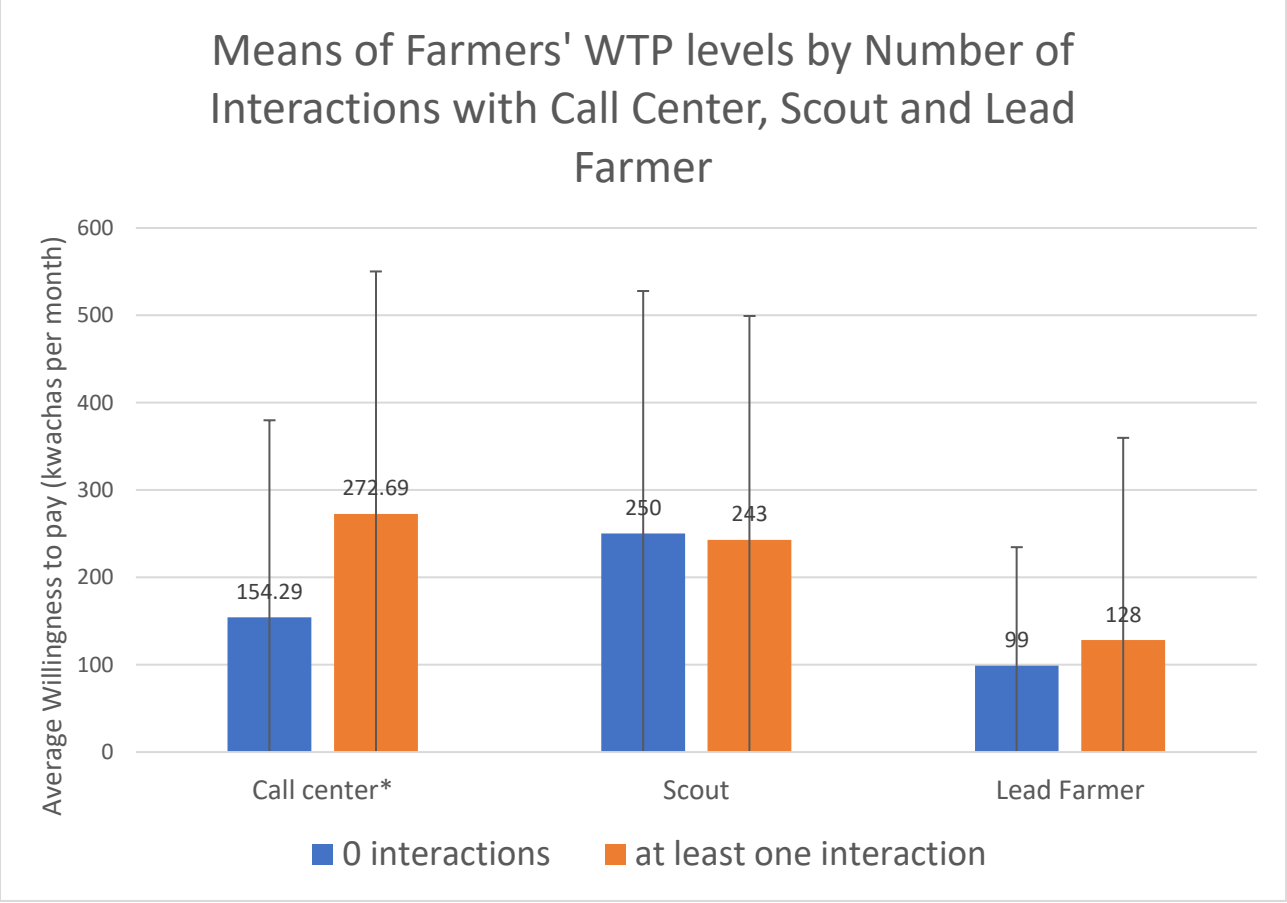

Figure #17a) :Average WTP levels of farmers in Dedza and Mchinji to the Call Center, Scout, and Lead Farmer by having interactions with them

According to the Figure above, the most significant difference in the means of the farmers who had not interacted with a service provider in comparison to those that had is in the case of the call center.

Table #8: Average WTP levels of farmers in Dedza and Mchinji to the Call Center, Scout, and Lead Farmer by having interactions with them

	Willingness to Pay (Average Kwachas per Month)		
	0 interactions	At least one interaction	P value
Call center*	154.29	272.69	0.0496
Scout	250.38	243.08	0.90
Lead Farmer	99	128.29	0.45

A T Test Analysis was performed to compare the samples of farmers in Dedza and Mchinji, combined, who had had 0 interactions with the service providers with those that had at least one interaction. The analysis was done at a significance threshold of 0.05. The results determined that only in the case of the call center was there a significant difference between the samples, with a P value of 0.049, below 0.05.

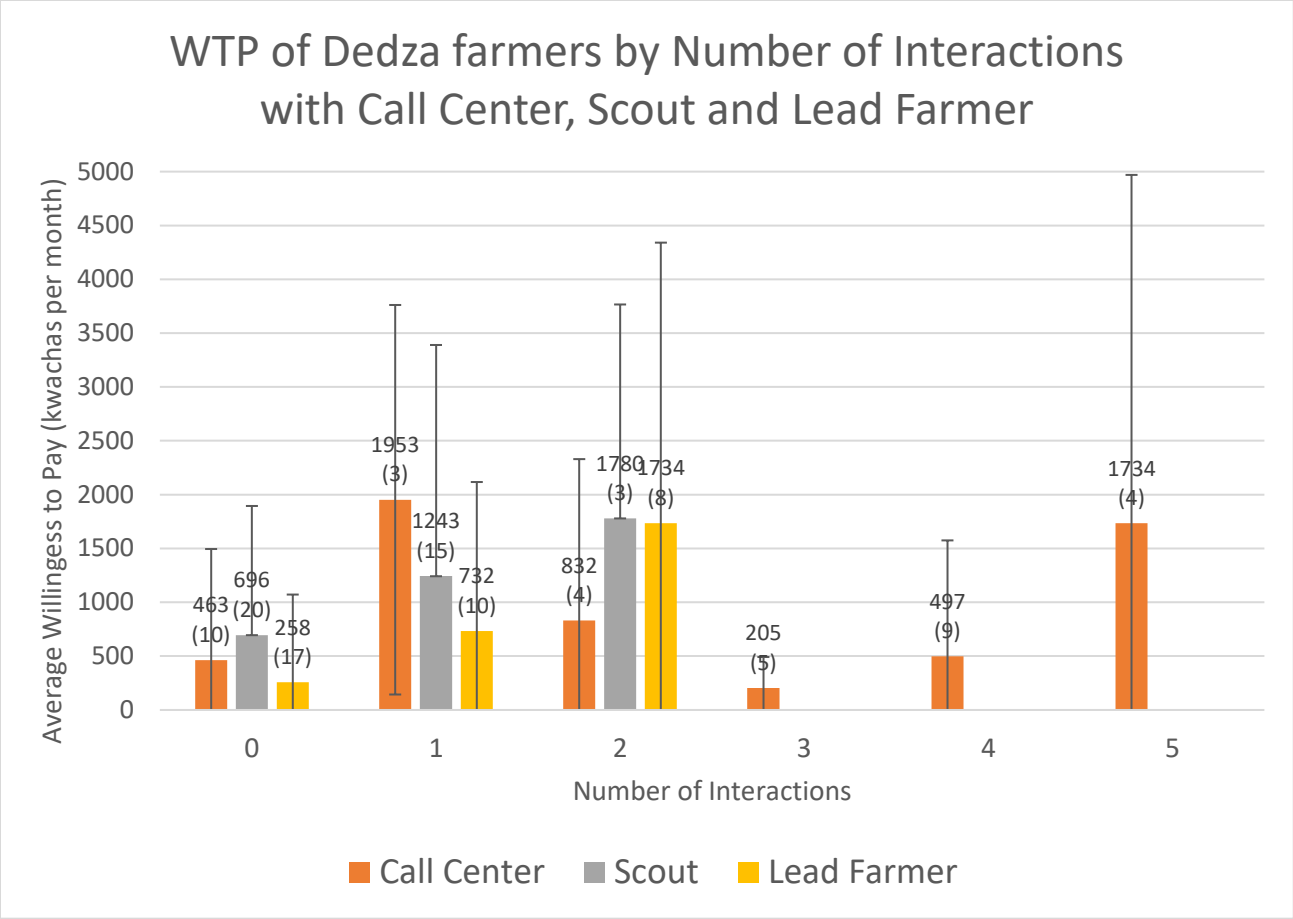

Figure #18: Dedza Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and the number of their actual interactions with them. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The average willingness to pay for the services of the scout and the lead farmer increased with the number of interactions each service provider had with the farmers in Dedza. For the services of the call center, the number varies, with a high willingness to pay for farmers who interacted with the call center once and five times, and low willingness to pay for those who interacted with the call center zero, two, three and four times.

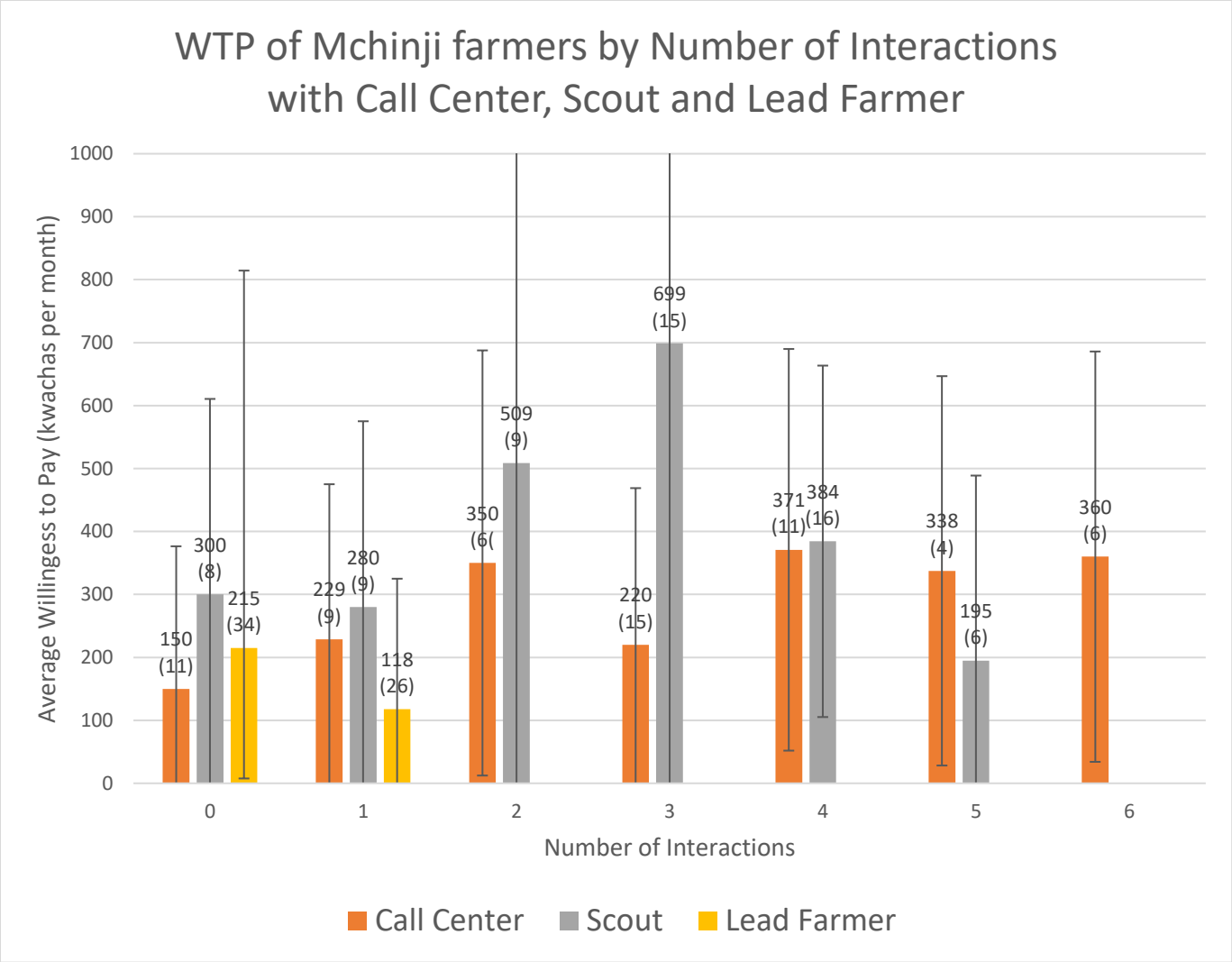

Figure #19: Mchinji Farmers number of their actual interactions with them and Willingness to Pay for the services of the call center, scout, and lead farmer. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In the case of Mchinji, the relationship between willingness to pay for the services and number of interactions shows an unclear relationship. In the case of the call center, the willingness to pay increased from farmers with 0 interactions to 2, then decreased for farmers with 3 interactions, then increasing for farmers with 3 to 4 interactions and showing similar levels for farmers with an average of 4, 5, and 6 interactions. In the case of the scout, the trend showed a

very clear increase of willingness to pay with interactions from farmers that had 0 interactions to those with 3 interactions, and then decreasing for those with an average of 4 and 5. Finally, in the case of the lead farmer, the willingness to pay decreased for farmers with 0 to 1 interaction. Therefore, in Mchinji there was somewhat of a positive relationship between the number of interactions and willingness to pay, in the case of the scout.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (1.56% of farmers for the call center).

Section 3.2: Number of people in household

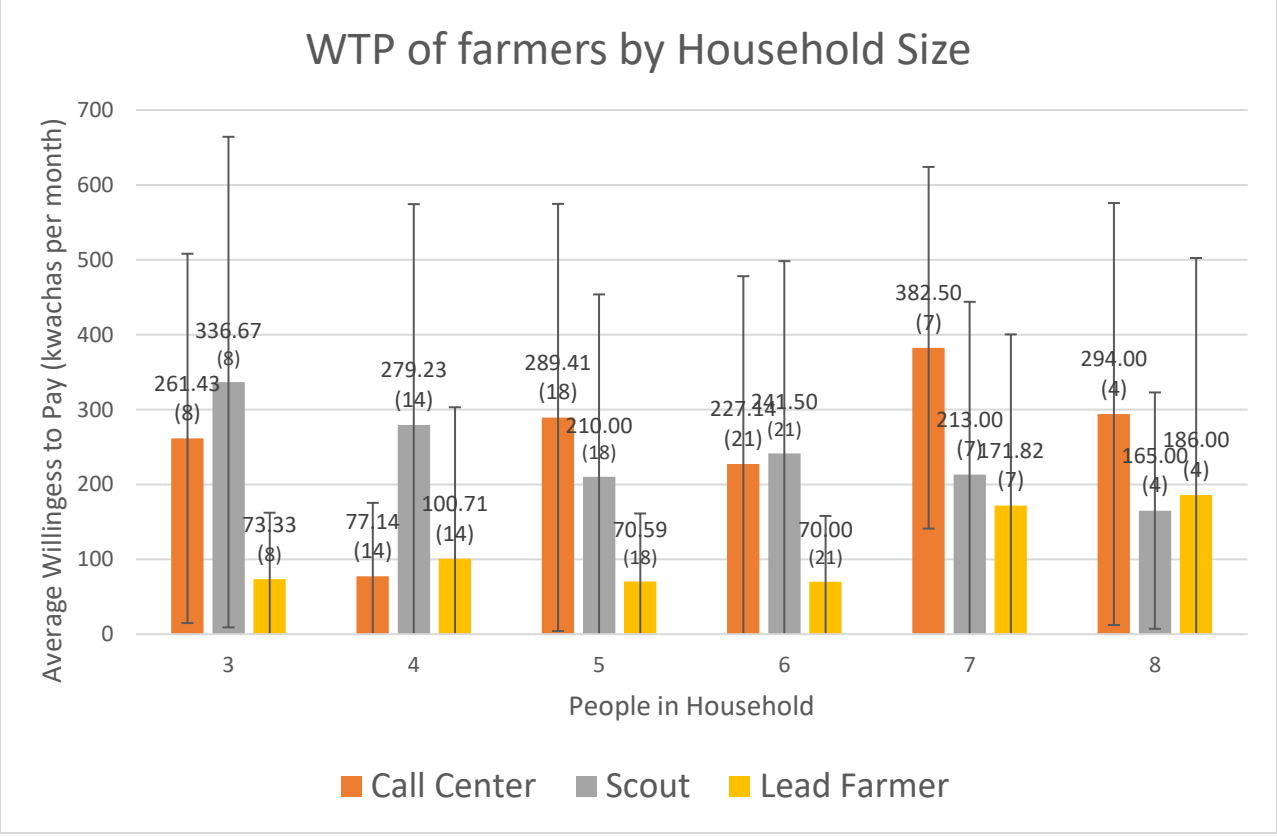

Figure #20: Dedza and Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and the average number of people in their households. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Dedza and Mchinji farmers' number of people in household in relation to their average willingness to pay for the services of the call center, scout, and lead farmer, shows a negative relationship between willingness to pay for the services and household size. In the case of the call center, the trend is slightly irregular but farmers with the largest households are willing to pay the most, notably those with 5, 7 and, 8 people in their households, but the differences are very small. Then, in the case of the scout, the trend seemed to be opposite, with farmers with smaller households showing a larger willingness to pay than those with smaller households. Finally, in the case of the lead farmer, the trend seems to be positive as well, with the WTP increasing for farmers with households of 7 and 8 members. Overall, the trend was generally a positive relationship between household size and willingness to pay, notably for the services of the lead farmer.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (6.74% for the call center, 10% for the scout and 7.86% for the lead farmer).

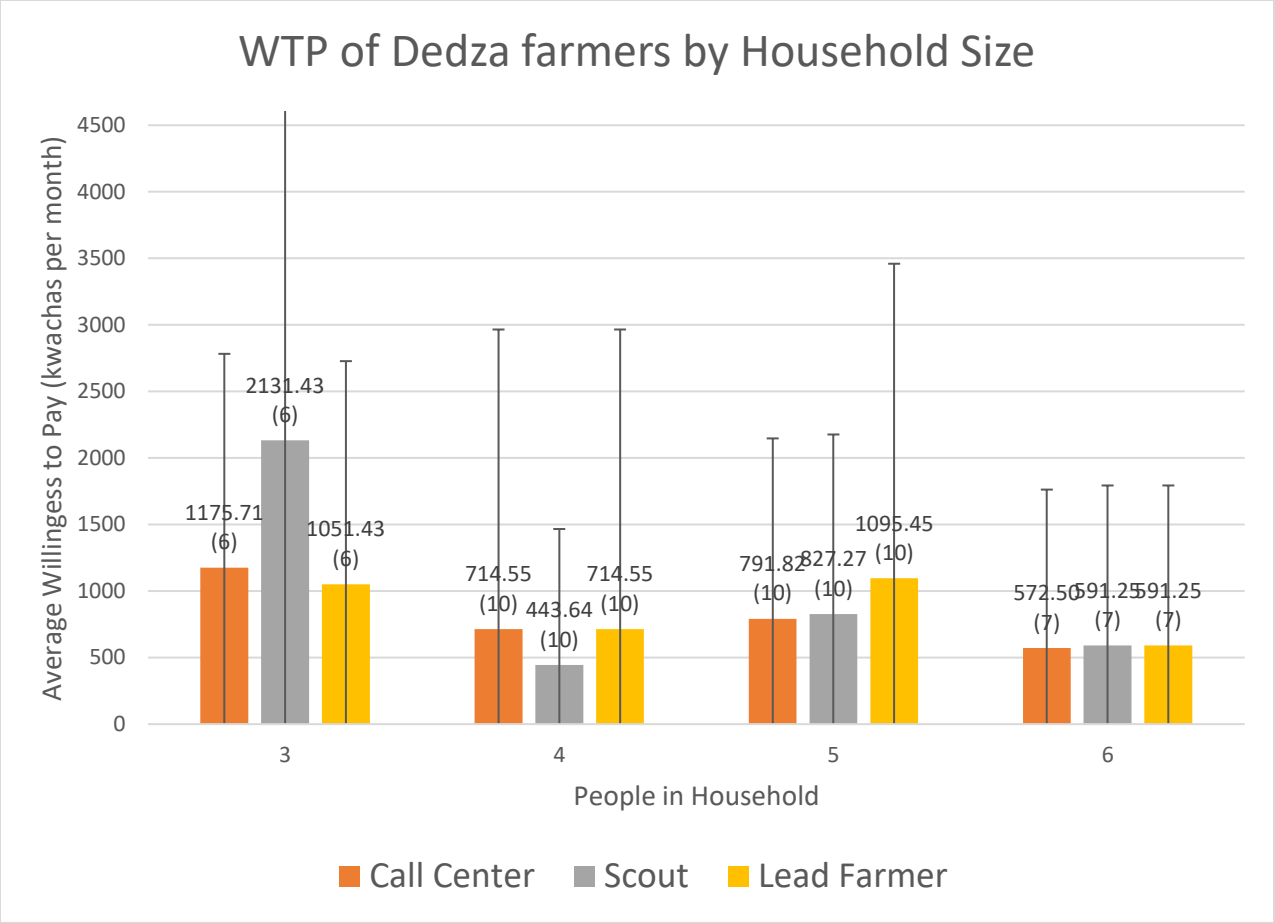

Figure #21: Dedza Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and the average number of people in their households. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Dedza farmers' number of people in household in relation to their average willingness to pay for the services of the call center, scout, and lead farmer, shows that in the case of the scout and call center, the farmers with less people in their household (3) are willing to pay the highest numbers for their services (an average of 1175.71 and 2131.43 kwachas per month respectively). In the case of the lead farmer, the willingness to pay is similar both for farmers with 3 and 5 people in their household and 4 and 5.

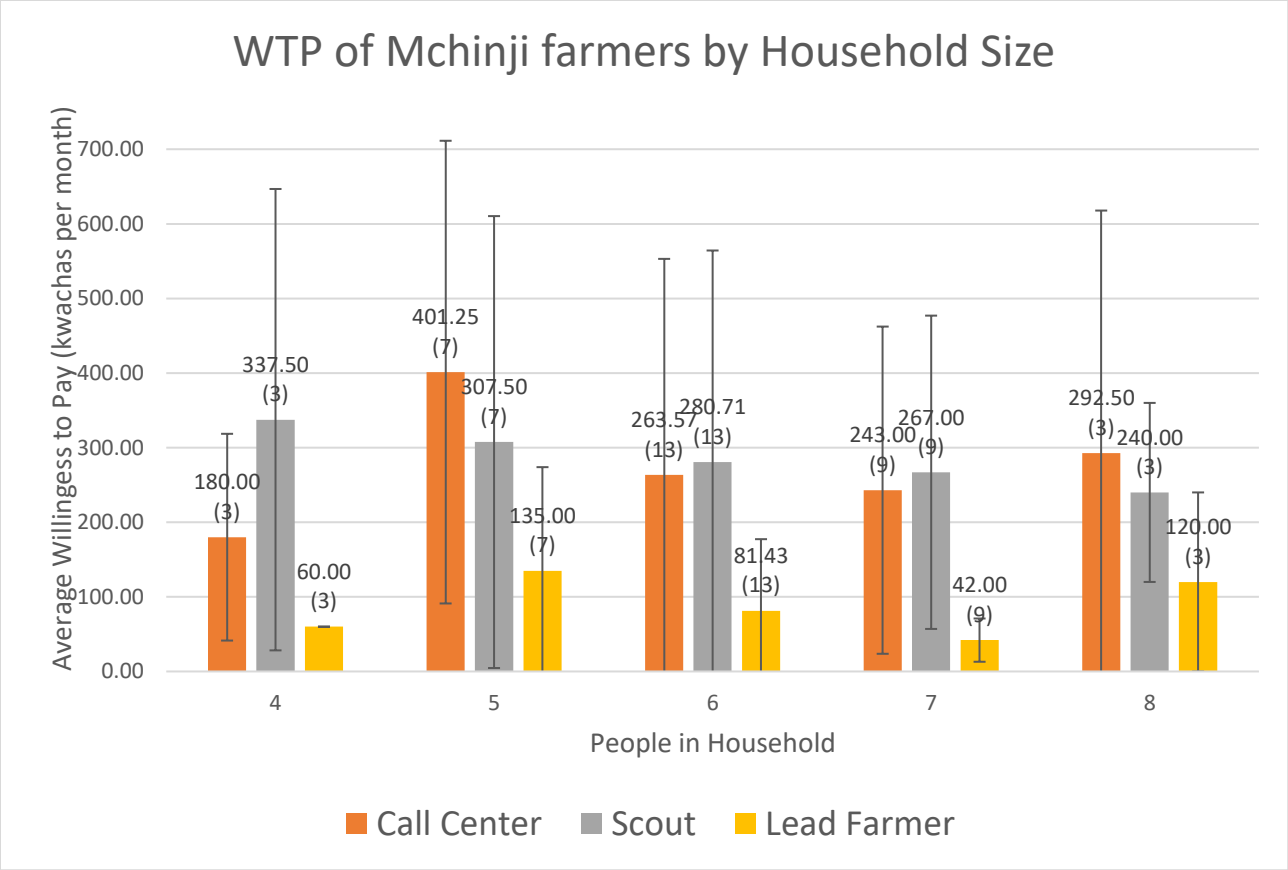

Figure #22: Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and the average number of people in their households. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Mchinji farmers' number of people in household in relation to their willingness to pay for the services of the call center, scout, and lead farmer, shows that in the case of call center and lead farmer the trend is quite irregular. Only in the case of the scout the farmers with a higher number of people in their household are willing to pay less for his services, as the number increases.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (1.56% of farmers for the scout).

Section 3.3: Age

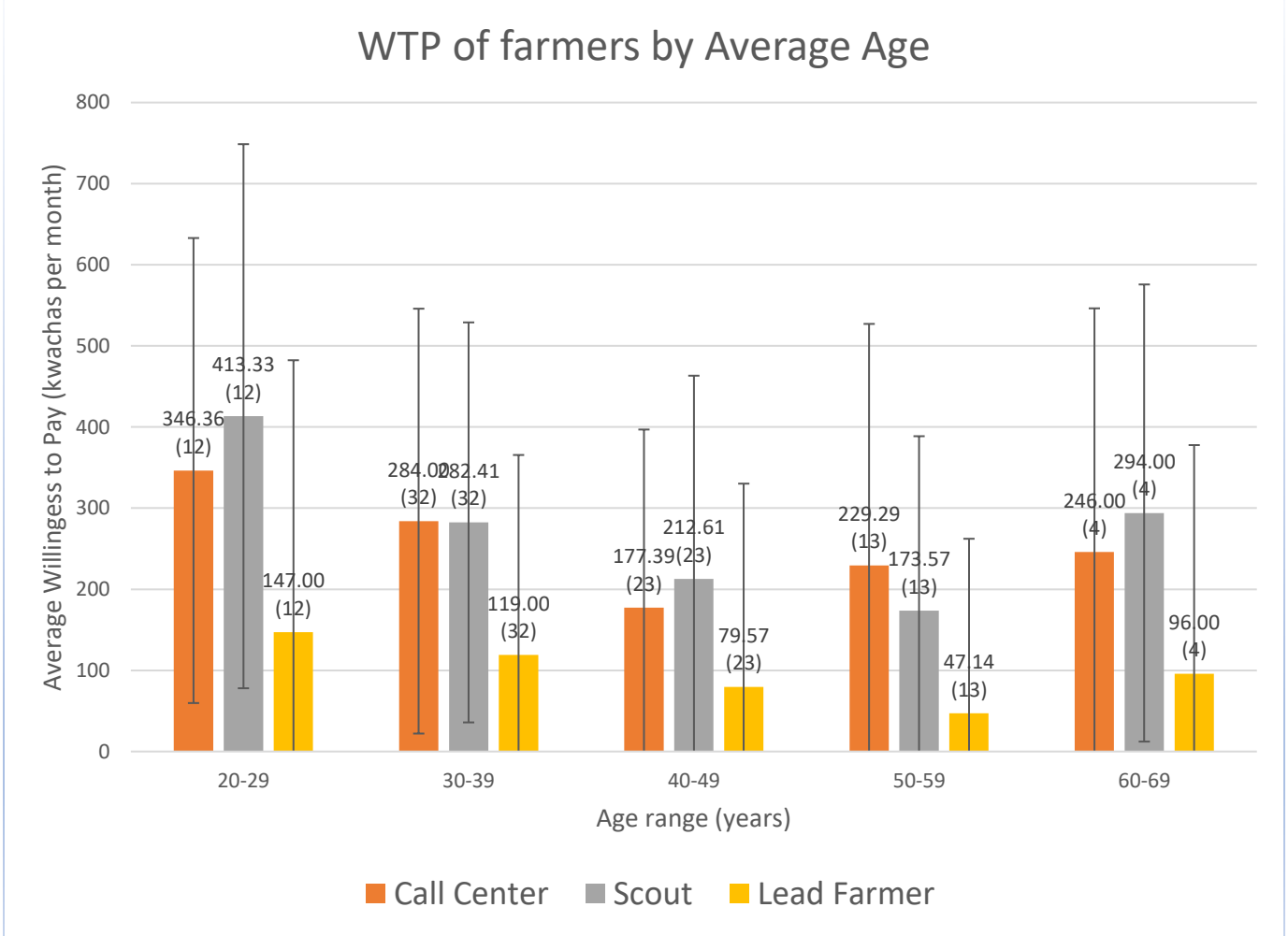

Figure #23: Dedza and Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their average age. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Dedza and Mchinji farmers' average age in relation to their willingness to pay for the services of the call center and scout shows a very clear negative relation where the willingness to pay decreases with age for all services providers. The most notable change is for the services of the scout, where farmers in the 20-29 age group are willing to pay an average of 413.33 kwachas per month, and this number decreases with every age group mostly regularly (282 for the 30-39

age group, 212 for the 40-49 age group, and 173 for the 50-59 age group). The same relation is evident for the services of the lead farmer and the cold center, although slightly less regular in the case of the call center where there is a slight increase in the last two age groups.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (6.74% for the call center, 10% for the scout and 7.86% for the lead farmer).

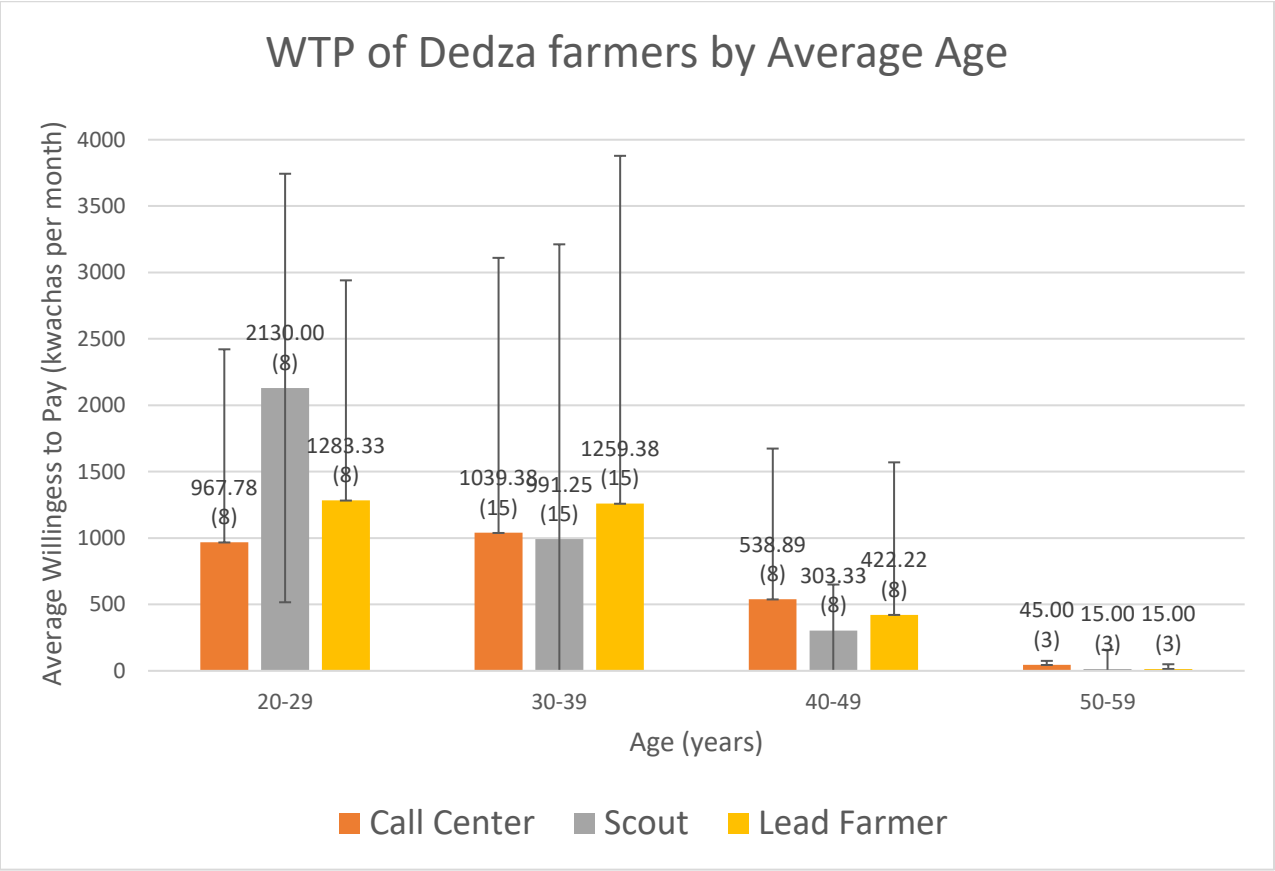

Figure #24: Dedza Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their average age. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Dedza farmers' average age in relation to their willingness to pay for the services of the call center and scout shows a relation. In all cases, the farmers' willingness to pay for the aforementioned services decreases with age. The farmers in the highest age groups are willing to pay the least for all services, and their willingness to pay decreases with age, especially for farmers over 30 years of age.

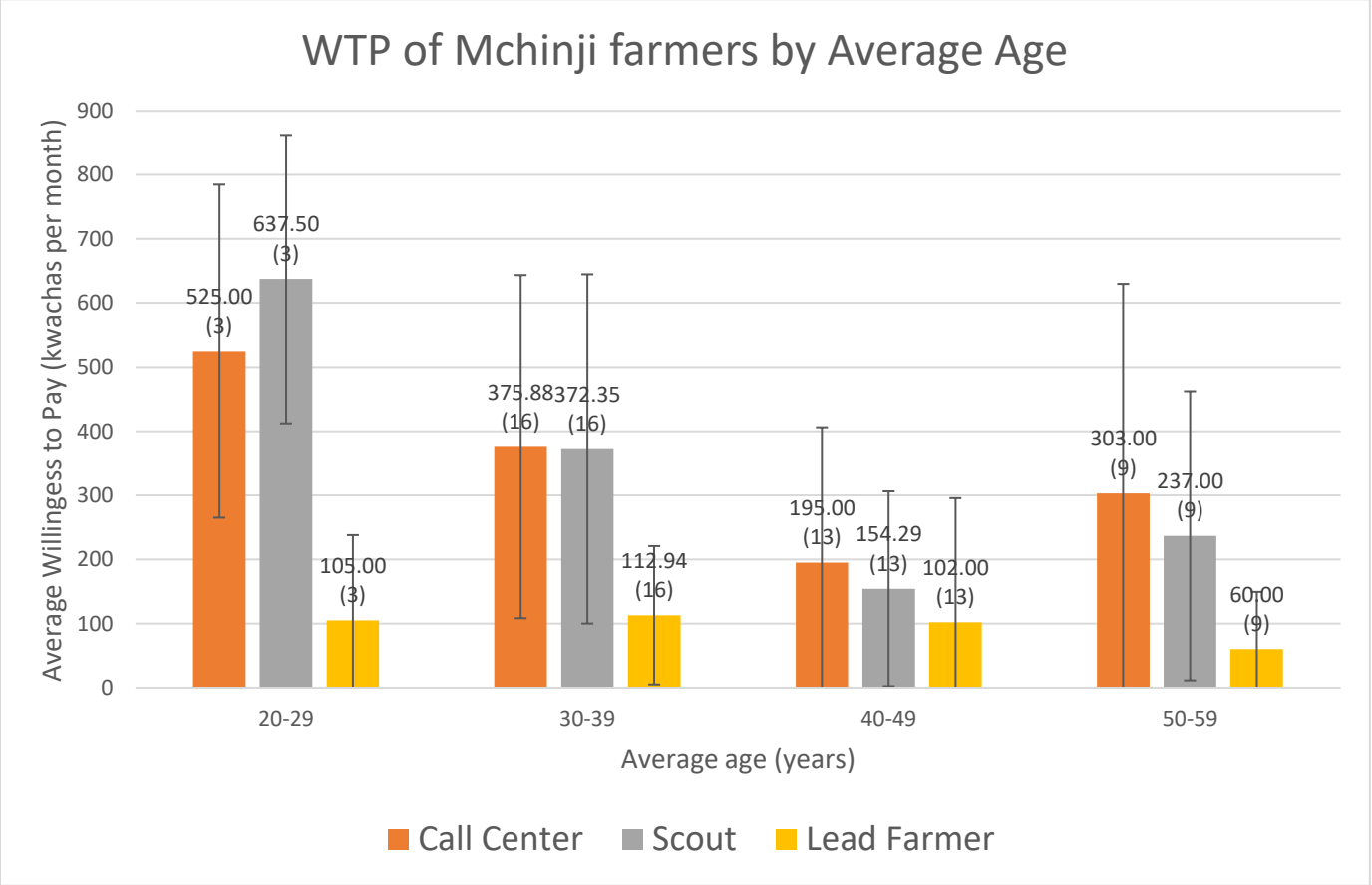

Figure #25: Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their average age. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Mchinji farmers' average age in relation to their willingness to pay for the services of the call center and scout shows somewhat of a relation. In the case of the scout, willingness to pay

for the service mostly decreases with age. The same is true for the case of the call center, except that the lowest willingness to pay is for the farmers between 40 and 49 years old, and then it increases for those between 50 and 59. In the case of the lead farmer, the willingness to pay is very similar for all age groups and slightly lower for the oldest farmers (50 to 59 years old).

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (1.56% of farmers for the scout).

Section 3.4: Farm Size

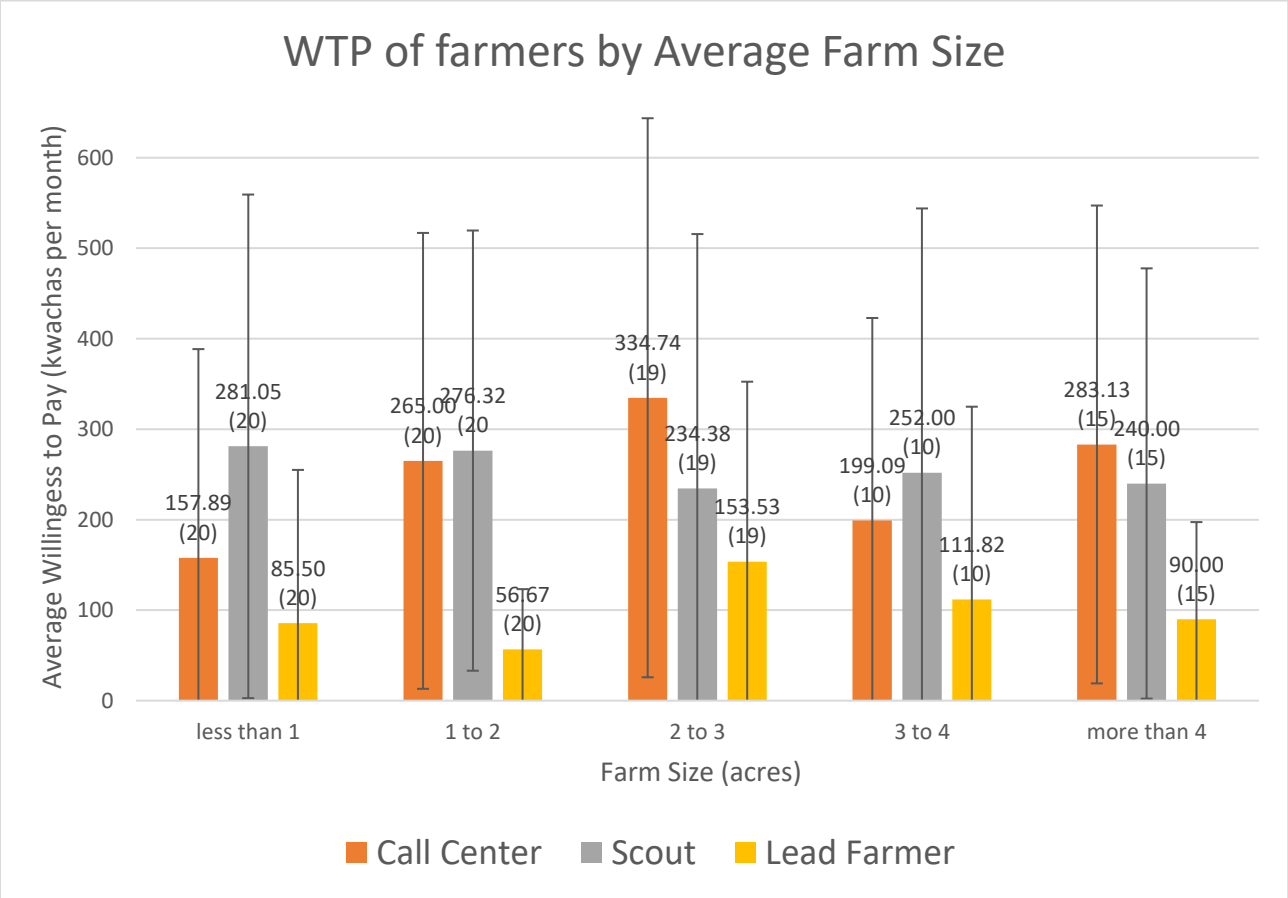

Figure #26: Dedza and Mchinji Farmers Willingness to Pay for the services of the call center, scout

and lead farmer, and their farm size (in acres). The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In the case of Dedza and Mchinji's farmers' farm size in relation to their average willingness to pay for the services of the call center, scout and lead farmer, the results vary. In the case of the call center, WTP increases with farm size up until farmers with a farm size of 2-3 acres. In the case of the scout, the WTP slightly decreases with increasing farm size but in very small numbers. Lastly, in terms of the lead farmer, the results are unclear.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (6.74% for the call center, 10% for the scout and 7.86% for the lead farmer).

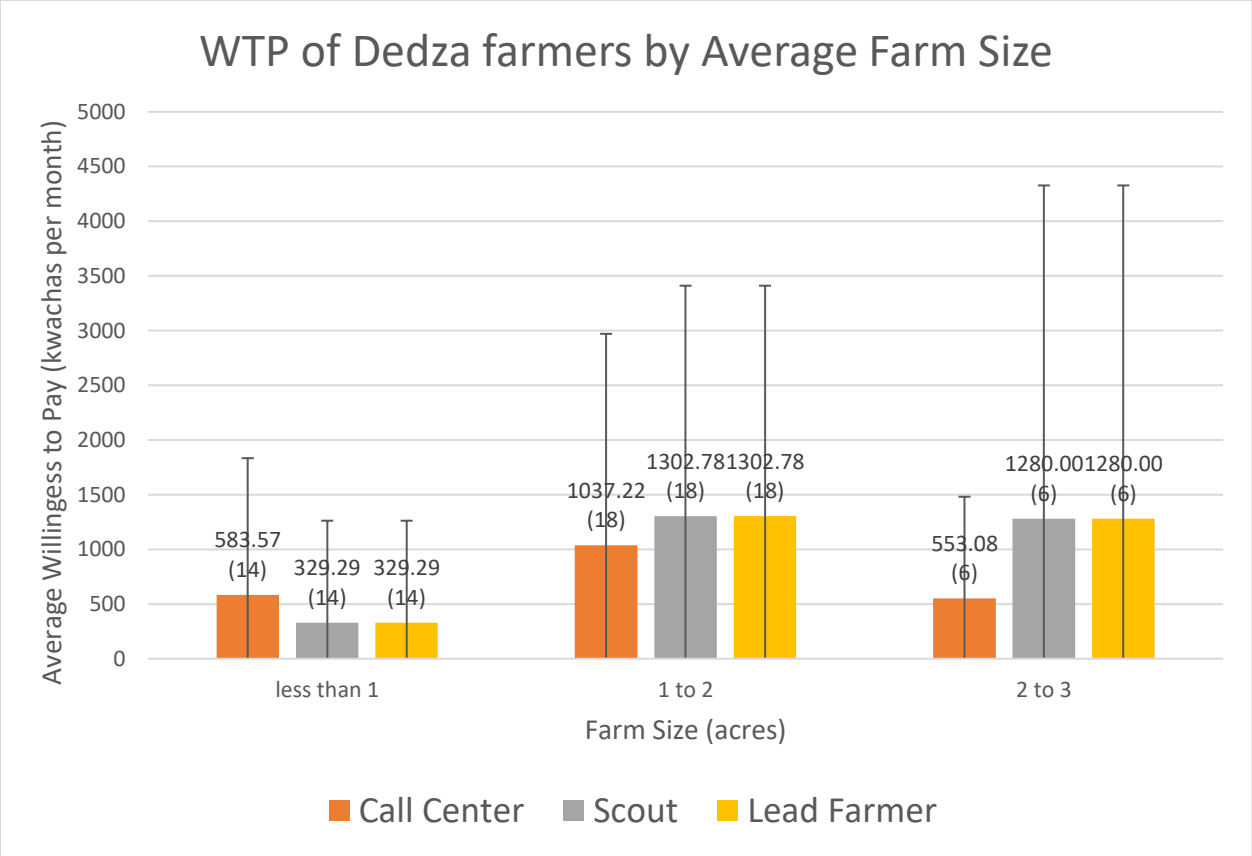

Figure #27: Dedza Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their farm size. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In the case of Dedza farmers' farm size in relation to their average willingness to pay for the services of the call center, scout and lead farmer, the results vary. In the cases of the scout and lead farmer, the farmers whose farm is less than 1 hectare are willing to pay the least (average of 329.29 kwachas per month) and the farmers with farms between 1-2 acres and 2-3 acres are willing to pay similarly (between 1200 and 1300 kwachas per month). In the case of the call center, the results vary, with the highest willingness to pay level from farmers whose farm is between 1 and 2 acres and similar willingness for farmers whose farm is less than 1 or 2-3 acres.

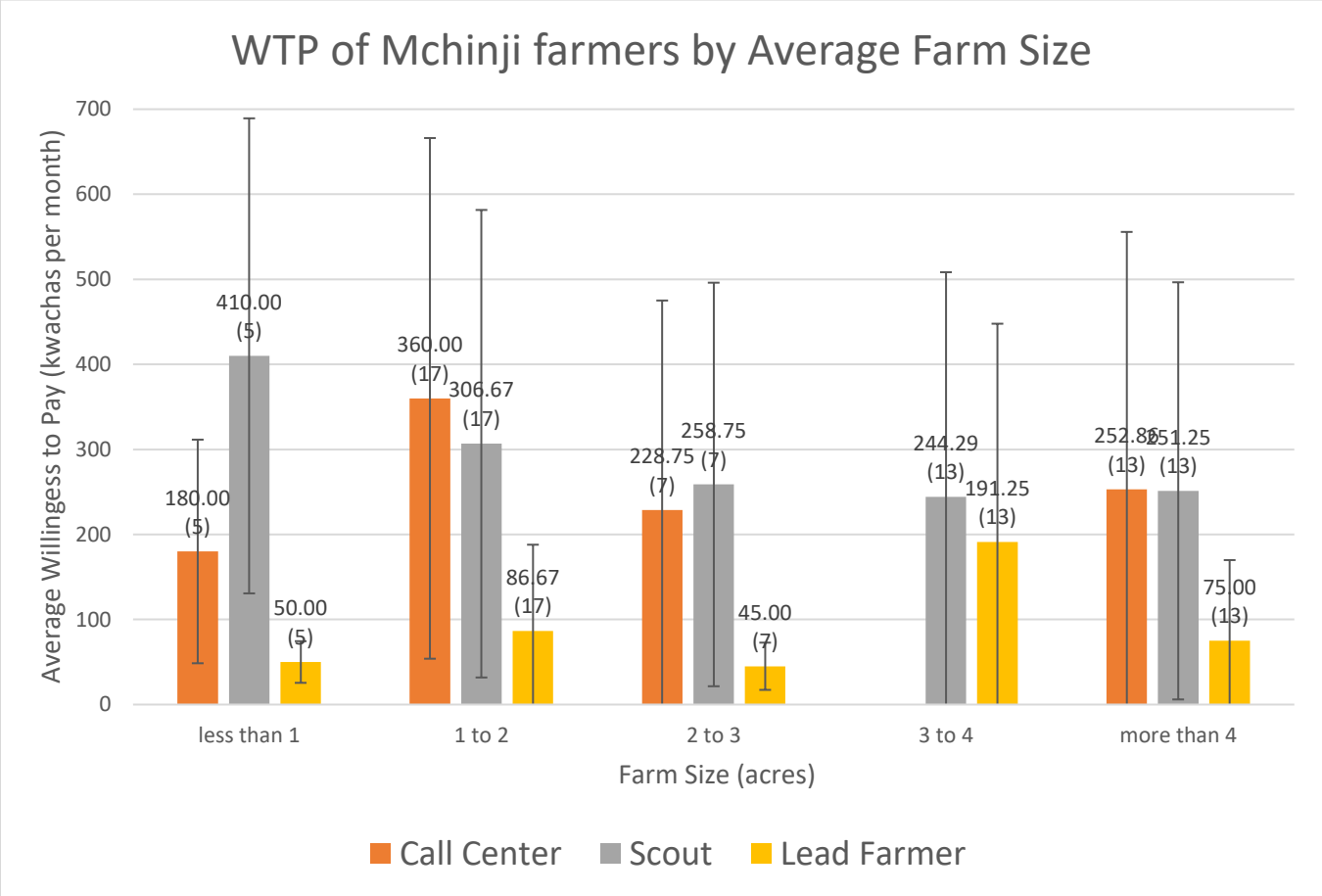

Figure #28: Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their farm size (in acres). The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

The Mchinji farmers' willingness to pay for the services of the call center and scout in relation to the average size of their farms shows an unclear relationship between both variables. In the case of the call center, there was an increase in willingness to pay levels between farmers with farm sizes of less than 1 hectare to those with 1-2 acres, then a decrease, and then a slight increase again between farmers with farms of 2-3 acres to those with farms larger than 4 acres. For the services of the scout the relationship seemed to be clearly negative, with WTP decreasing with farm size. In the case of the lead farmer, the results were unclear. Therefore, in Mchinji, it was unclear whether there was a relationship between farm size and farmers' willingness to pay.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (1.56% of farmers for the scout).

Section 3.5: Education Level

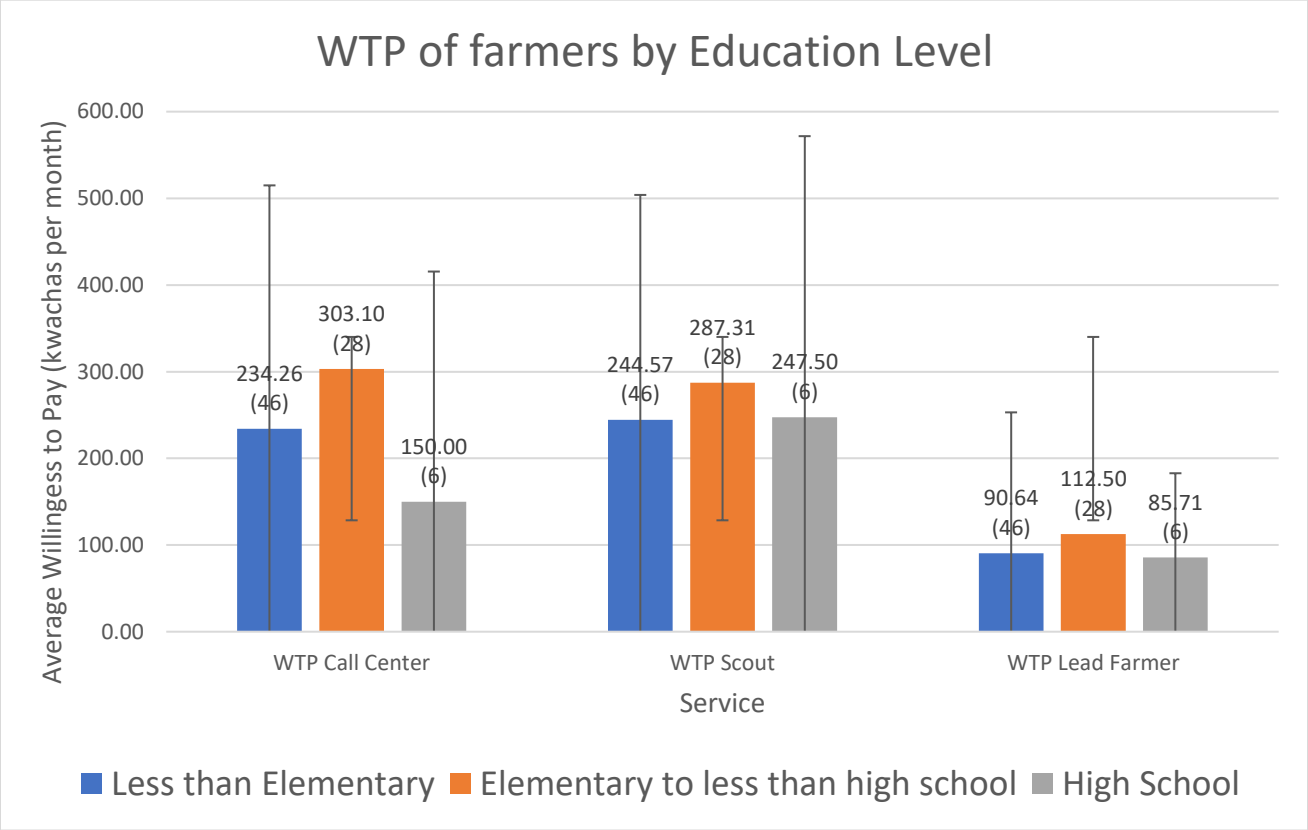

Figure #29: Dedza and Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their education level. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Dedza and Mchinji, farmers with the lowest educational level (less than elementary) had a lower WTP than those with an elementary to less than high school education. However, the most educated farmers (those with a high school education) had similar WTP levels than the least educated ones for the services of the call center and scout.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (6.74% for the call center, 10% for the scout and 7.86% for the lead farmer).

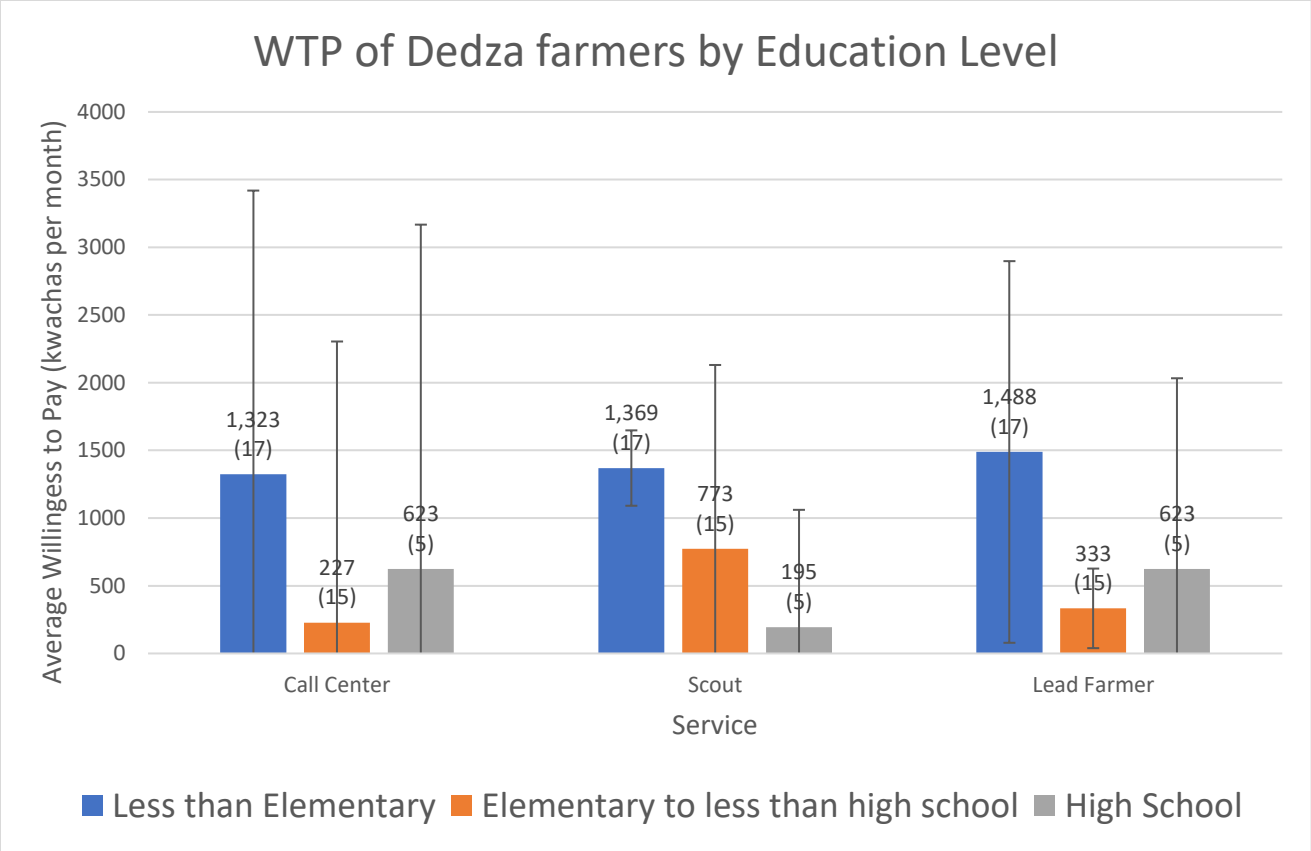

Figure #30: Dedza Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their education level. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Dedza, farmers with the lowest educational level (less than elementary) have the highest willingness to pay for all services. The willingness to pay for farmers with an elementary to less than high school education is the higher for the scout's services than for those of the call center or lead farmer. The willingness to pay for farmers with a high school education is just as high for the services of the call center and lead farmer and lower for the services of the scout.

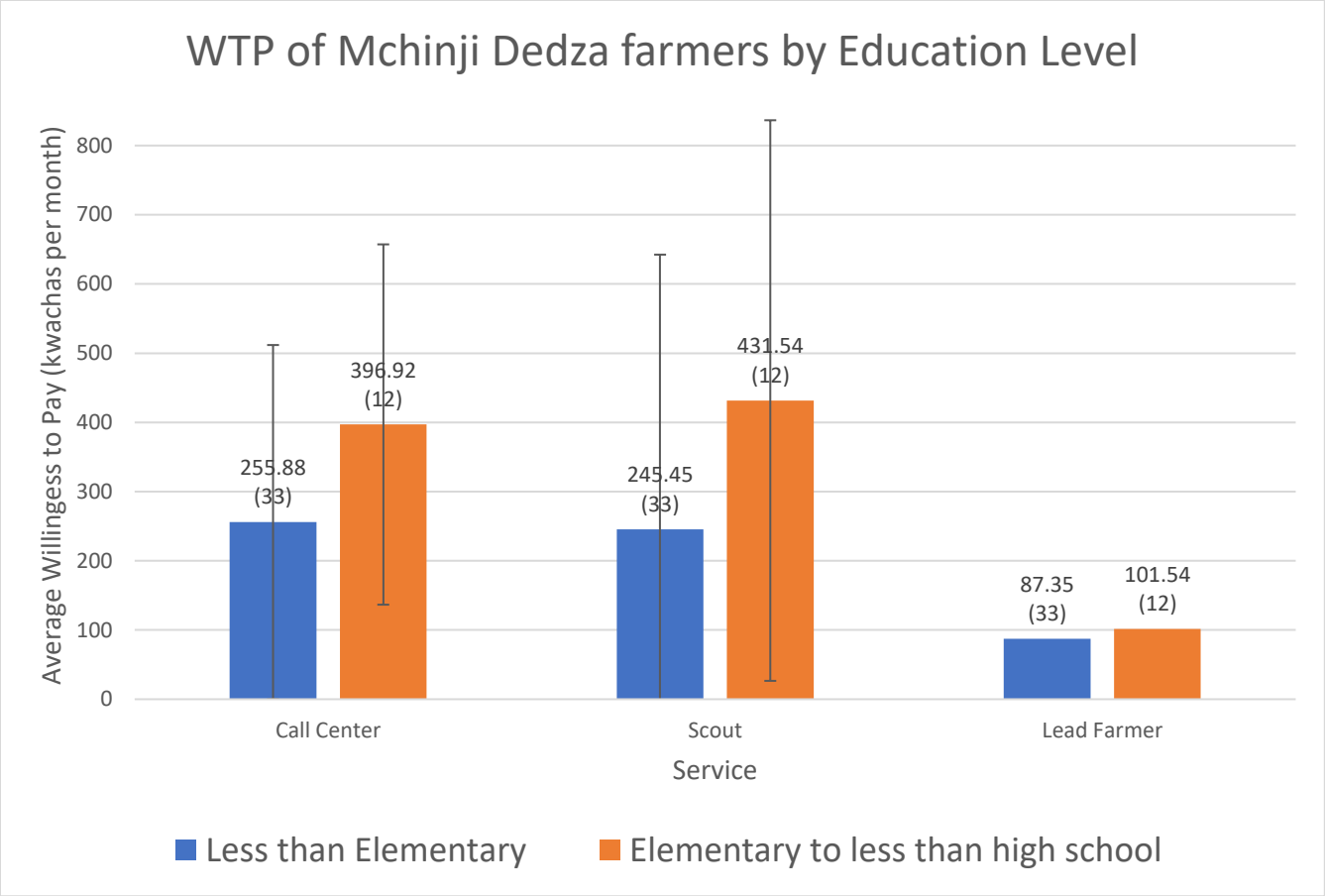

Figure #31: Mchinji Farmers Willingness to Pay for the services of the call center, scout and lead farmer, and their education level. The number in parenthesis under the percentage indicates the total number of farmers in the category (n).

In Mchinji, farmers with the highest-level education (elementary to less than high school) had the highest willingness to pay for all the services (call center, scout and lead farmer). The farmers with the lowest levels of education (less than elementary) have the lowest levels of willingness to pay for all services.

It is important to note that a minority of farmers declared WTP levels of over an average of 3500 kwachas. These numbers had to be removed for the purpose of analysis (1.56% of farmers for the scout).

Level of Pesticide Usage in Dedza and Mchinji

As stated in the Research Methodology section, on the 6th week of the project (corresponding to the 39th week of the year; the week of the 26th of September), the scouts were instructed to specifically recommend the farmers to spray their fields once every two weeks. While the Dedza scout refused to provide such an advice, the Mchinji scout did provide the advice as instructed.

As part of the routing weekly data collection by the scout, call center and lead farmer, they asked the farmers if they had sprayed their field in the last week, and recorded the information in the Agritask App.

The following analysis takes into account all farmers who participated in the project, including those that did not participate in one or both of the surveys.

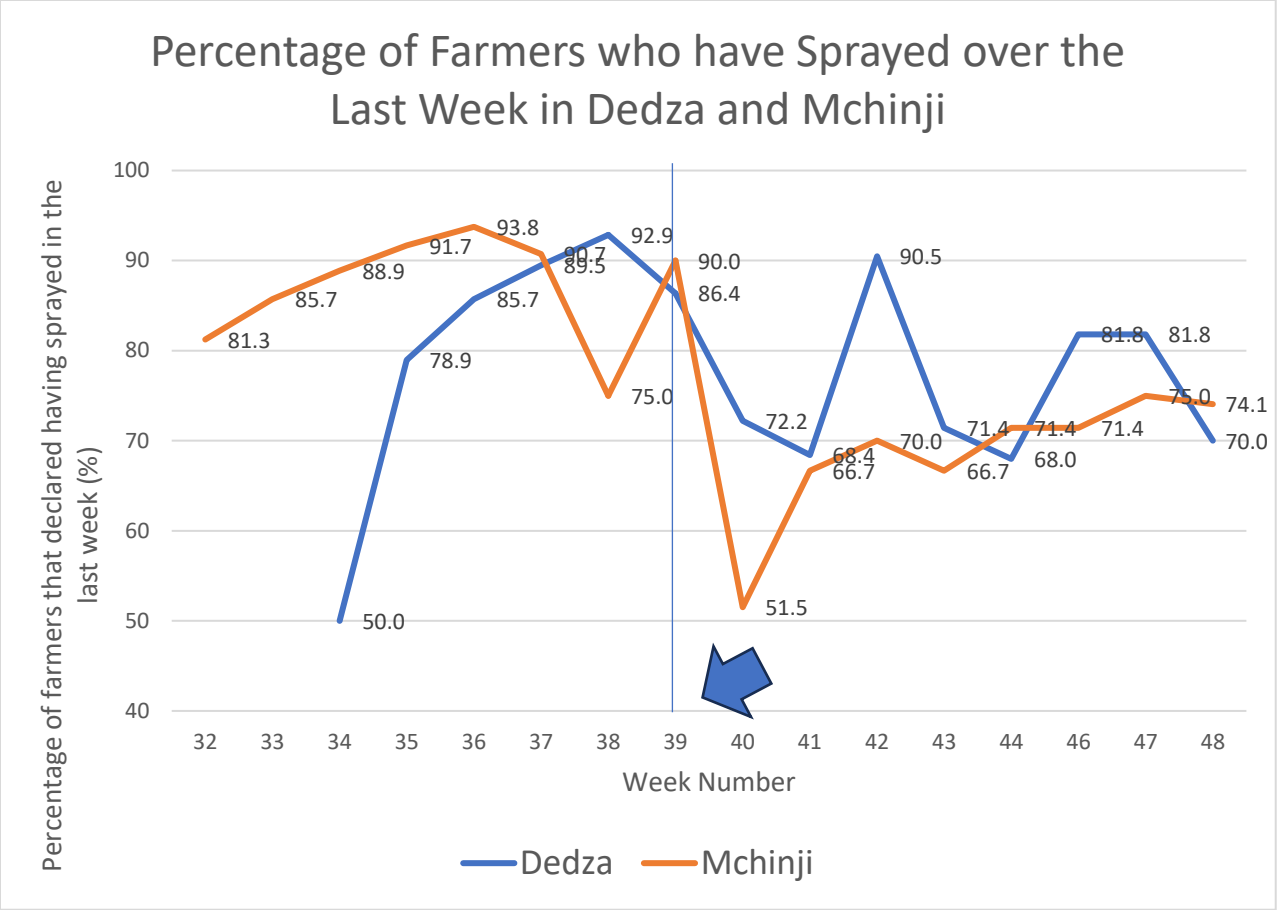

Figure #32: Dedza and Mchinji Farmers who declared to have sprayed their field over the last week throughout the project with an arrow on the week in which advice was provided in Mchinji

The Figure above shows a combined Figure of Dedza and Mchinji farmers showing the farmers that declared to have sprayed their field in the last two weeks. Week 39, signaled by an arrow, marks the week in which the advice to spray every two weeks was supposed to be given by the scout in the Dedza region, and actually given to the scout in the Mchinji region. Before week 39, in most weeks, more Mchinji farmers declared to have sprayed in the last week than those in Dedza (Except for weeks 32 and 33 where there is no data for Dedza and wee 38, where Mchinji had 17.9% less farmers declare to have sprayed the previous week than Dedza). In both cases, the number of farmers that declared to have sprayed in the last week generally decreased after week

39 with the exception of a higher percentage of farmers in Dedza in week 42. However, the difference is more dramatic in Mchinji, where every week before week 39 more farmers declared to have sprayed in the last week than those in Dedza, and almost every week after week 39 the opposite was true (except for week 44 and 48 where slightly more farmers in Mchinji declared to have sprayed last week than those in Dedza, 3.4% and 4.1% respectively).

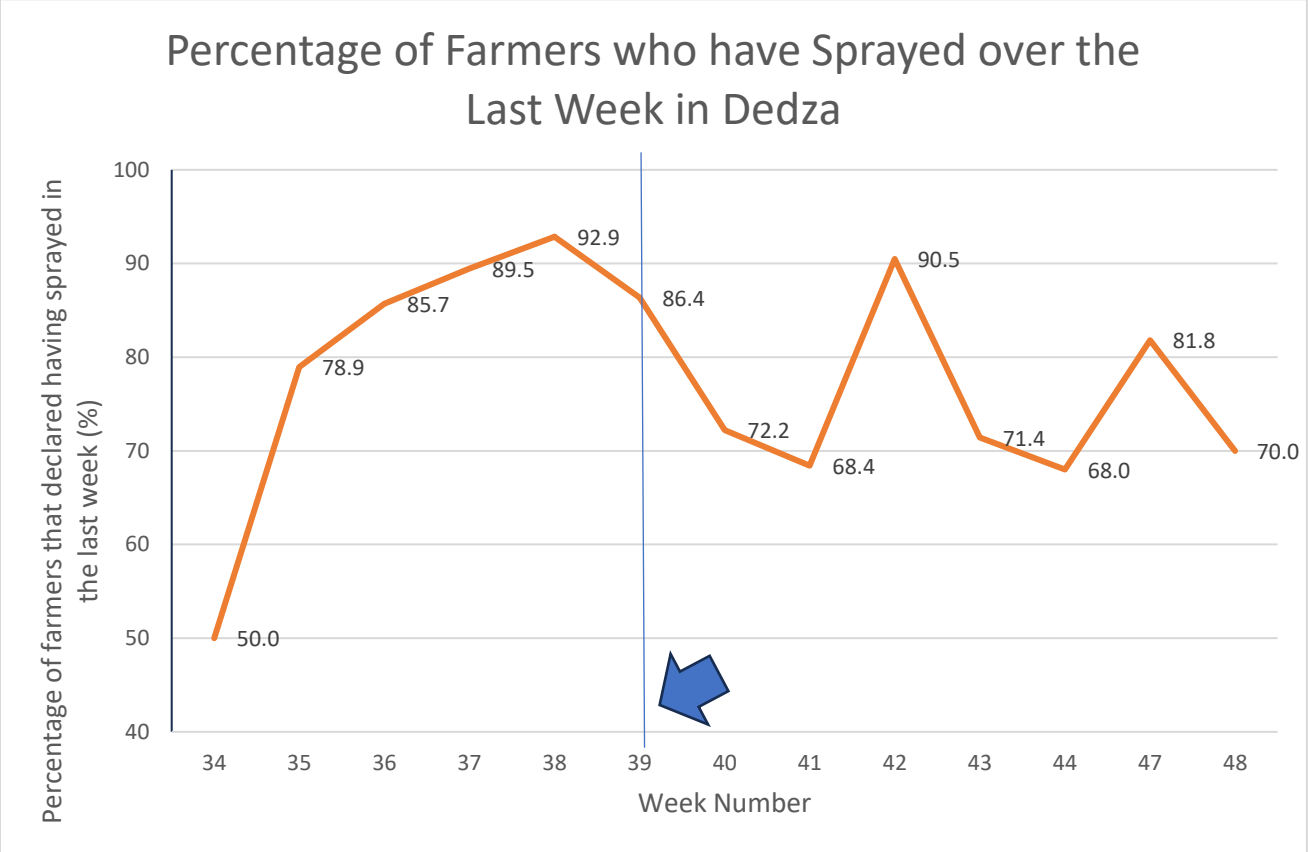

Figure #33: Dedza Farmers who declared to have sprayed their field over the last week throughout the project with an arrow on the week in which advice was provided in Mchinji

The number of farmers that declared having sprayed their fields over the last week varied throughout the project, starting at a low in the first week (week 34 of the year) with 50%, then increasing, and then decreasing again by the 6th week (week 39 of the year). After week 39 (which

corresponds to the week in which the advice to reduce spraying frequency should have been given and is signaled by an arrow) the number of farmers having sprayed their field in the last two weeks increased and decreased irregularly.

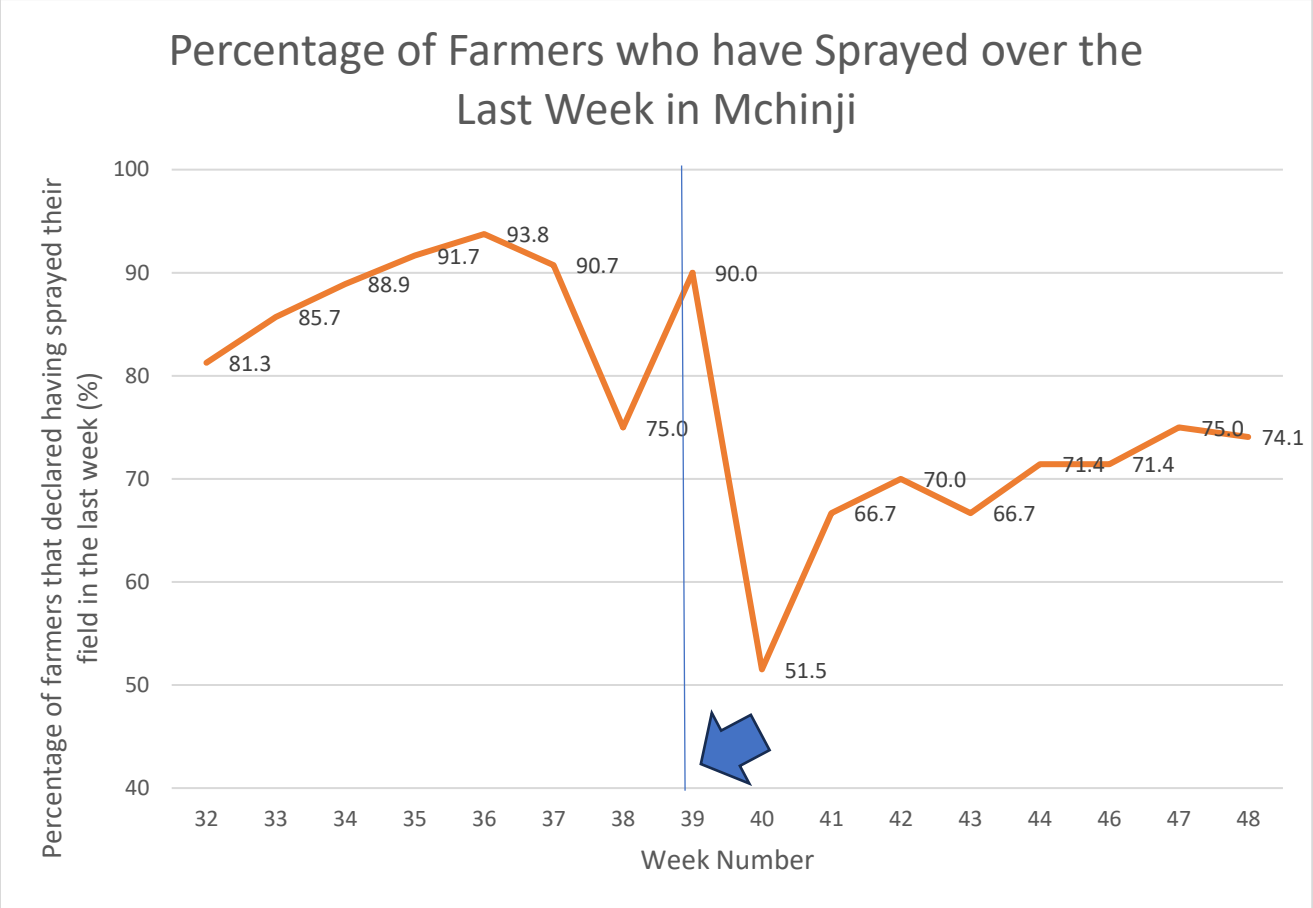

Figure #34: Mchinji Farmers who declared to have sprayed their field over the last week throughout the project with an arrow on the week in which advice was provided in Mchinji

The number of farmers that declared having sprayed their fields over the last week varied throughout the project, up until week 8 (week 39 of the year, signaled by an arrow in the above Figure) which corresponds to the week in which the scout started advising farmers to spray only every two weeks. The number of farmers who declared they had sprayed over last reached its lowest on week 9 (week 40 of the year) with a slightly over half of the farmers declaring that they

had, and then slightly increasing afterwards. Still, the numbers of farmers who didn't spray over last week was generally higher in all the weeks after the advice was provided than in the weeks before, with the exception of week 47 (after the advice) and week 38 (before the advice) which had equal percentages of farmers having sprayed over the last week.

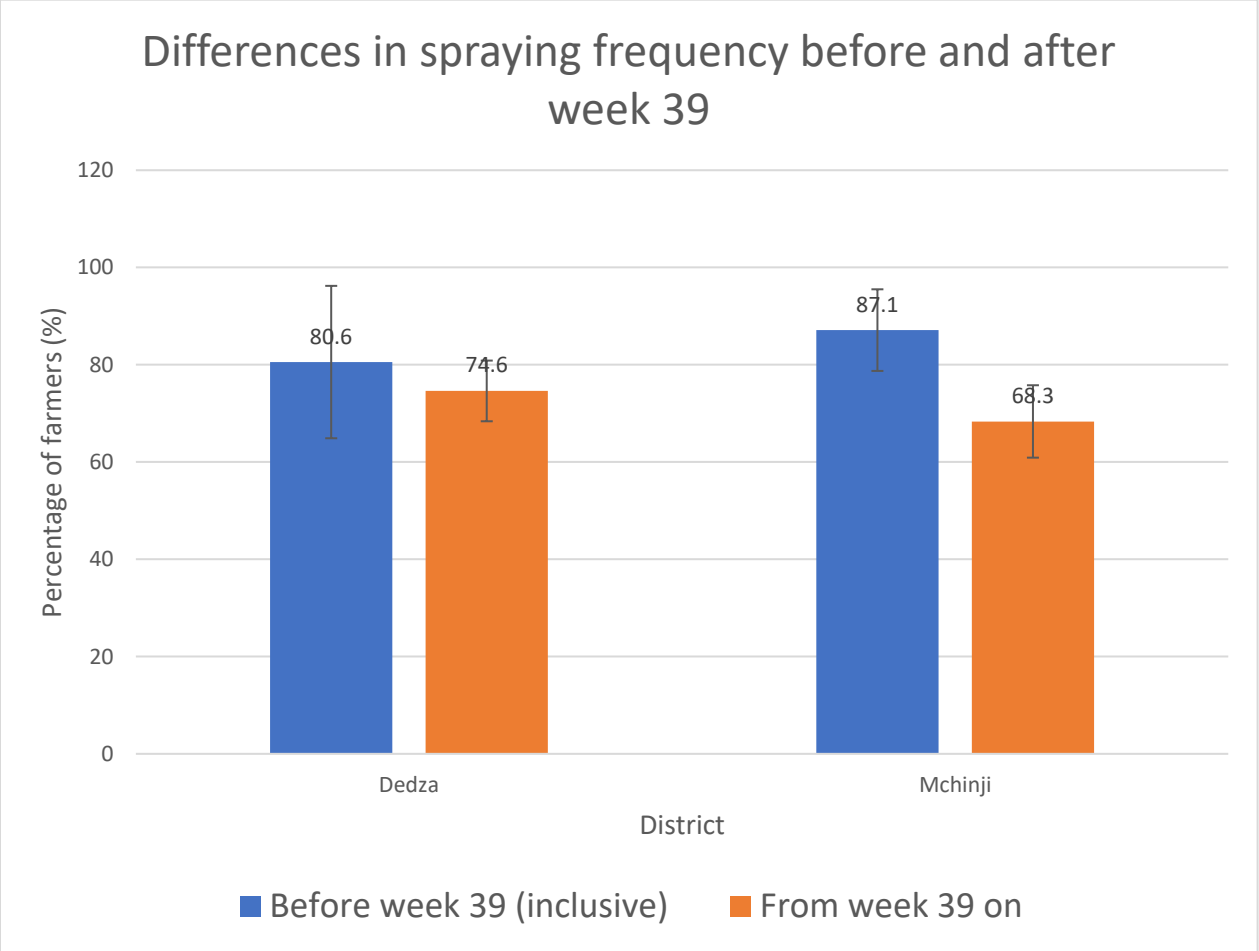

Figure #35: Difference in spraying frequency before and after week 39 in Dedza and Mchinji

The Figure above shows that both Dedza and Mchinji saw a decrease in percentage of farmers who declared to have sprayed in the last week before and after week 39. However, in Dedza, the difference was only 3.3%, while the difference in Mchinji was 15.95%.

Table #9: Difference in spraying frequency before and after week 39 in Dedza and Mchinji

Percentage of Farmers who Sprayed the previous week

	Before week 39 (inclusive)	After Week 39	P Value
Dedza	80.56	74.62	0.433
Mchinji*	87.13	68.35	0.00008

A T Test Analysis was performed to compare the spraying frequency of farmers in Dedza and Mchinji, combined. The analysis was done at a significance threshold of 0.05. The results determined an insignificant difference in the case of Dedza after week 39 (were no advise was provided) with a P Value of 0.433, above 0.05, and a significant difference in the case of Mchinji after week 39 (where advice was provided), with a P Value of 0. 0.00008, below 0.05.

Discussion

This study examined two different farmer populations: those from the Dedza district, and those from the Mchinji district. Within those farmers, they can be further categorized into two categories: all the farmers who participated in the surveys, and those who also participated in the project (meaning, had interactions with the scout, call center, and/or lead farmer).

The demographic data on section 1.1 of the results section was useful in understanding the demographic differences and similarities between the farmers from different districts and with different degrees of participation in the study. The data in such section showed that, for the most part, farmers from Dedza and Mchinji, and farmers participating in the survey and in the project, were generally demographically similar, as summarized in Table #1. Despite the clear similarities, the following was also true:

- Dedza had 16.1% more male farmers than Mchinji, and Mchinji had 8.19% more female farmers in the project than all those surveyed. These differences are small but should be considered in further analysis. As the literature review shows in the studies by Anugwa et. al. (2022), Olade O.I. (2008), and Fletschner et. al. (2010), male generally have a higher willingness to pay than women, it is possible that these differences affected willingness to pay levels.
- Farmers in Mchinji had an average of 5.9 people in their households while Dedza had an average of 4.8, a difference of an average of 1.1 more people per household in Mchinji than Dedza. This difference can be significant as the literature is conflicted as to the relationship between willingness to pay and household size, where Angwa et. al. (2020)'s research found a positive relationship, Onoh et. al. (2012) a negative one, and Mwaura et.al. (2010) no relationship. Therefore, if significant differences are found between smaller and larger

households, or between Dedza and Mchinji based on household size, it could bring more clarity as to the nature of the relationship between the two factors.

- Farmers in Mchinji were an average of 39.3 years old while Dedza were an average of 37, making Mchinji farmers an average of 1.7 years older than those in Dedza, and farmers in Mchinji participating in the project were an average of 2.93 years older in average than all those surveyed. These differences are small but should be considered in further analysis. As the literature review shows in the studies by Anugwa et. al. (2022), Mwaura et. al. (2010, and Umar et.a.l (2014), older farmers are usually less willing to pay than younger ones.
- Farmers in Dedza had a higher education level than those in Mchinji, and Mchinji farmers participating in the project were generally less educated than the total surveyed. These differences can be significant in that the literature, as concluded by Oladele (2008), Onoh et. al. (2012), Anugwa et.al. (2022), and Mwaura et. al. (2010), generally agrees on a positive relationship between a higher level of education and higher willingness to pay for agricultural technologies and extension services.

It is important to acknowledge the demographic differences between the districts as well as the farmers surveyed and the ones participating in the project for posterior comparisons between the groups.

The behavioral data in sections 1.2 and 1.3 examining responses to Survey 1 from Dedza and Mchinji farmers showed very different behaviors in relation to spraying and farm monitoring habits, as well as sources of information for farm management, farm management coordination habits, and willingness to provide information and trust recommendations from service providers. The farmers in Mchinji revealed to spray their fields less often, and to do so more when witnessing

a pest than out of routine. Mchinji farmers also disclosed spending less of their growing expenses in pesticide than those in Dedza. Furthermore, while most farmers in Dedza revealed not to track information at their farms and to believe it not to be important, about half of the farmers in Mchinji claimed to do so, and most said to believe it is important. Another fundamental difference was the source of information for farm management, where over half of Dedza farmers said that they obtain information from fellow farmers, while about three quarters of Mchinji farmers said that they do so from extension services. Consequently, farmers in Mchinji said to have a higher amount of contact with extension officers, where over half of them stated to be in contact, as opposed to Dedza , where most farmers said not to be in contact with extension officers at all. In a country with a ratio of one extension worker to between 2500 to 3000 farmers, the situation in Mchinji in this regard was very privileged. Therefore, while in Mchinji almost all farmers claimed to follow professional recommendations, over half of Dedza farmers said that they did not, simply because they were not in contact with information providers. In addition, while over three quarters of Mchinji farmers said that they coordinated farm management with others, only about half of Dedza farmers said to do so. In both districts, the main focuses of farm coordination with others were the same: pest and disease management, and input use. In both districts, virtually all farmers said that they were willing to provide information to a scout, call center operator or lead farmer, and almost all the farmers said that they would trust and follow recommendations from them. As per their willingness to pay for the different service providers, both farmers in Dedza and farmers in the Mchinji were, for the most part, not willing to pay for any of them. However, both in Dedza and Mchinji, the farmers were slightly more in favor of paying for the services of the scout as opposed to the call center and lead farmer.

The above data showed that, in terms of spraying habits, farm monitoring habits, sources of information for farm management, farm management coordination, the farmers in the Mchinji district were in a significantly better position than those in Dedza from the beginning of the study. Generally, the farmers in the Mchinji district declared to spray less often and more consciously, monitored their farms more, and understood the importance of doing so. Mchinji farmers' self-perception as spraying less often and more consciously contradicted the results of the scouts, call center and lead farmers' observations, as shown later in Figures #33, #32 and #35. Such Figures show the number of farmers in Dedza and Mchinji that declared to have sprayed in the last week, before and after calendar week 39 (when Mchinji scouts advised the farmers to reduce spraying). More farmers in Mchinji declared to have sprayed their field during the last week than those in Dedza (an average of 86.71% in Mchinji as opposed to an average of 79.39% in Dedza). This contradiction might be due to wrong self-perception, such as Mchinji farmers believing to be more cautious in their spraying than they were on practice. It could also be due to a desire to please surveyors during Survey 1 as opposed to being more honest with the scout, call center and lead farmers, since the scout and lead farmers actually visited the fields and saw for themselves. The exact reason for the contradiction might be unknown but is worth noting.

Returning to the topic of the behavioral data on sections 1.2 and 1.3 and the differences between Dedza and Mchinji, farmers in Mchinji could rely on professional information and reach out to extension officers way more than those in Dedza, who were limited to information from fellow farmers. Lastly, more farmers in Mchinji claimed to coordinate farm management with others than those in Dedza. Generally speaking, Dedza farmers sprayed more excessively, had less information resources, and managed their farms more independently than those in Mchinji.

It is important to take into account the relatively advantageous position of the Mchinji farmers from the outset and determine how much it could affect their behavior in the project. A study by Nagar et. al. (2021) exploring the "Determinants of Farmers' Access to Extension Services and Adoption of Technical Inputs" that took place in India, focused exactly on this issue. It determined that 'Access' to agricultural extension services does not guarantee 'Adoption' of the technologies or better farm practices, as all the variables emerging as significant in case of 'Access' do not emerge as significant for 'Adoption'" (Nagar et. al.' 2021). This means that Mchinji's preexisting higher access to extension services will not necessarily determine if their willingness to use the services of the scout, lead farmer and call center (as examples of choosing to adopt new technologies or better farm practices). However, Nagar's study did find a strong relationship between personal and household characteristics on both access to extension services and adoption of farming technologies. This highlights the importance of taking into account the differences in gender, household size, farm size, age and education levels between Dedza and Mchinji farmers in the posterior analysis.

Despite all the differences between the districts, Survey 1 did reveal some similarities, including the topics of focus of farm coordination activities (pest and disease management and input use), as well as their very high willingness to provide information and trust and follow recommendations from the scout, call center and lead farmer. Another similarity included the farmers in Dedza and Mchinji's general unwillingness to pay for the service providers, despite a slightly higher willingness to pay for the services of the scout.

The data in sections 1.4 and 1.5 examining responses to Survey 2 from Dedza and Mchinji farmers showed that, in both cases, over three quarters of respondents had received pest management advice over the last month. However, when asked about the specific content in the

advice, there was a fundamental difference: in Dedza, most farmers shared that the advice they received was, in fact, pest and disease management related. However, in Mchinji, the number was slightly above half. As shown in Figure #11, the farmers in Mchinji shared to have received advice in many other categories such as input use, water usage, soil quality, fertilizers application, and beyond. However, it is impossible to know if they received this advice in addition to actual pest management advice. Furthermore, the higher diversity in the topics of advice received in Mchinji than that of Dedza might be due to the higher number of actual interactions with the scout in Mchinji than Dedza. More interactions lead to more encounters and larger opportunities to discuss a wider variety of issues.

Both in Dedza and Mchinji most of the advice originated from the scout, followed by the call center, and the least came from the lead farmer. Still, even if in both districts most of the advice originated from the scout, there was still an important difference percentage wise. As detailed in Table #4, in Dedza 47.67% of advice originated from the scout, and in Mchinji, as detailed in Table #5, it was 69.53% of the scout. Still, it is fundamental to recognize that Mchinji farmers, in general, had a significantly higher number of interactions with the scout than those in Dedza before participating in Survey 2 (172 interactions in Mchinji and 27 in Dedza, as detailed in Table #6; and an average of 0.6 interactions in Dedza and 2.68 interactions in Mchinji, as detailed in Table #7). Both in Dedza and Mchinji, most of the advice generated from the Scout, but the topics of advice were way more varied in Mchinji than in Dedza (as detailed in Figures #8 and #11, describing 5 general topics of advice in Dedza and 13 in Mchinji).

In the case of the call center, the percentage of farmers that declared to have received advice from the call center in Dedza and Mchinji were very similar (as detailed in Table #4, 41.77% in Dedza and 45.24% in Mchinji). In this case, the number of interactions between the call center and

farmers before Survey 2 was still higher in Mchinji than in Dedza, but the difference is less extreme than in the case of the call center (103 interactions in Dedza and 182 in Mchinji; and an average of 2.45 in Dedza and 2.84 interactions in Mchinji as detailed in Table #7).

In both cases, most of the survey respondents said to have followed the advice. In Mchinji, however, more farmers coordinated applying the advice with others, which can be due to their already higher coordination with other farmers even before the beginning of the project as stated in Survey 1. As to the farmers' preferences, both farmers in Dedza and Mchinji mostly preferred the scout's service in monitoring their farms and receiving advice, followed by the call center, and much less so the lead farmer. In Dedza and Mchinji alike, farmers declared their highest willingness to pay for the services of the scout, followed by the call center, and lastly for the lead farmer, coinciding with the aforementioned declared preferences.

As stated in the literature review, farmers' willingness to pay for the services of the scout, call center and lead farmer, can be a good measure of their interest (as described in the literature by Stobierski, 2020) in monitoring their farms and receiving advice from the aforementioned service providers. Therefore, it is useful to discuss the comparison of the farmers' willingness to pay as declared in Survey 1, when they had not yet interacted with the service providers, and Survey 2, when all of them (who were taken into account in this analysis) had interacted with at least one of them. Furthermore, it is interesting to discuss if the willingness to pay increased with the specific number of interactions. This is the data shown in the Results Section 2 and Section 3.1 respectfully.

Section 2 of the results compared the farmers' willingness to pay for the services of the scout, call center and lead farmer as expressed in Survey 1 and Survey 2. In Survey 1, farmers from both districts (as shown in Figure # 14) overwhelmingly declared not to be willing to pay for

any of the services. This number changed very much in the results of Survey 2, where most farmers instead declared to be willing to pay a small fee for all services. In a country with such a high poverty rate, and among these farmers, who are among the lowest income population, this is not a given. The study by Akinnagbe and Adesina (2018), carried out in Nigeria, examined the issue of farmers' willingness to pay for extension services. It found that the majority of farmers, 57% of respondents were not willing to pay for such services "due to low income from farming" (Akinnagbe and Adesina, 2018).

A separate analysis of the differences in willingness to pay between surveys in Dedza and Mchinji as shown in Figures #15 and #16 contributes some insight to the differences between the districts. In Survey #1, more Dedza farmers declared not to be willing to pay than those in Mchinji, in regard to all services (36.03% more were not willing to pay for the services of the call center, 33.73% more for the scout and 21.94% more for the lead farmer). In the same survey, more Mchinji farmers declared to be willing to pay or be willing to pay for all services. This shows that, from the starting point, general willingness to pay was higher in Mchinji than in Dedza. In regard to the variations in willingness to pay levels between survey 1 and survey 2. In the case of the farmers not willing to pay, Dedza had a larger decrease between Survey 1 and 2 for all services than Mchinji. Then, in the case of farmers willing to pay only a small amount or declaring to pay, Dedza had a larger increase between Survey 1 and 2 for all services except those of the lead farmer. This may be due to the lower general starting point in willingness to pay for all services in Dedza, or other factors as discussed below.

It is interesting to then analyze if the variation in willingness to pay levels between Survey 1 and 2 has to do with the farmers' actual number of interactions with the service providers up until the date of survey 2, which is shown in Figures #17, #18 and #19. A joint analysis of both

districts on Figure #17 revealed an increase in willingness to pay levels for the services of the call center, while showing irregular trends for the other two services, especially those of the lead farmer. This was further emphasized by the analysis of the means of farmers' WTP levels before and after interacting with the call services, scout and lead farmer in Figure #17, showing that the largest increase in the average WTP between farmers before and after interacting with a service provider was for the call center.

This was clarified in the T test performed in Table #8, showing that indeed the only significant difference in average WTP levels before and after interactions was for the call center. This might be due to the fact that, at least in Mchinji (where the bulk of the farmers were from), farmers already had access to the public extension services before the project, as declared in the results from Sections 1.2 and 1.3. However, the call center was actually an innovation in the area, and the Mchinji farmers might have considered this service more worthy of their investment. Additionally, as described in Table #6, the farmers both in Mchinji and Dedza had the largest number of interactions with the call center (285 interactions in total). Therefore, the interactions with the call center could have been able to have more of an impact on the farmers and lead them to be willing to pay more for the services.

An individual analysis of the districts' willingness to pay in relation to interactions with the services brings further light to these points. In the case of Dedza in Figure #18, the willingness to pay increased with the number of interactions for the services of the scout and lead farmer and varied for the services of the call center. In Mchinji, as shown in Figure #19, the results for the scout and lead farmer were less clear, but the willingness to pay for the services of the call center clearly did increase with the number of interactions. As stated above, this difference might be due to Mchniji's farmers' high number of interactions with the services providers (as shown in Table

#16) or the fact that they had a higher exposure to extension services even before the project began (as describe in Sections 1.2 and 1.3). Since the Dedza farmers did not have such exposure from the outset, the sudden availability of these services might have caused more of an impact on their interest in them, as defined by their willingness to pay. To summarize, the results of Section 2 and Section 3.1 do show that time in the study, and number of interactions with the scout, call center and lead farmer, significantly impact the farmers' willingness to pay for their services, especially in the case of the call center.

Sections 3.2, 3.3, 3.4 and 3.5 examine the relationship between farmers' willingness to pay and demographic factors: number of people in household, age, farm size and education level.

In the case of the number of people in household, a joint analysis of both districts in Figure #20 showed a generally increasing willingness to pay for the services for larger households, and the trend is the clearest for the services of the lead farmer. The individual analysis of this relationship in Dedza in Figure #21 showed a mostly negative relationship between household size and WTP for the services for the scout and call center and an unclear relationship for the lead farmer. In Mchinji, as described by Figure #22, the same relationship was true for the services of the scout, with unclear results for the call center and lead farmer. Despite the general evidence being clearer in the combined Figure and for the Dedza rather than the Mchinji District, the data did generally show a positive relationship between willingness to pay and number of people in household. These results coincide with the contradicting literature described in the studies by Angwa et. al. (2020), determining a positive relationship between increasing household size and willingness to pay, Onoh. et. al. (2012) determining a negative one, and Mwaura et. al. (2010) determining that household size does not significantly influence willingness to pay. Since an increasing household simultaneously means more workers available, but also more mouths to feed,

it is difficult to determine the nature of the relationship between household size and willingness to pay. The findings in this research, along with the available literature, signal that the nature of the relationship, if any, is unclear.

As per age, a joint analysis of both districts in Figure #23 shows a very clear relationship between age and willingness to pay, where farmers belonging to the youngest age group (20-29) were willing to pay the most for all services, and the willingness to pay decreases with age. The only exception was a very slight increase in willingness to pay level for the oldest age group (60-69) This is mostly also true in the individual district level. As described by Figure #24, there was a clear relationship between decreasing willingness to pay for all services with increasing age in Dedza. The results for Mchinji shown in Figure #25 showed a similar trend, where the results for the scout and call center mostly showed the same relationship, and unclear results of the lead farmer. At a younger age, farmers might feel more open to taking risks and have less family members to take care of. Overall, age was a strong factor influencing willingness to pay for all services in both districts. This coincides with the literature as described by the studies of Augwa et. al. (2022), Mwaura et. al. (2010), and S.I. Umar et.a.l (2014), all agreeing that there is an inverse relationship between age and willingness to pay, where one increases when the other decreases and vice versa.

In regard to farm size, a joint analysis of both districts in Figure #26 showed large variation and unclear trends in the relationship between farm size and willingness to pay. As shown then in Figure #27, farmers in Dedza with the smallest farms were willing to pay the least for all services, and farmers with farms of 1-2 and 2-3 acres showed similar willingness to pay levels for all services. In the case of Mchinji, as shown in Figure #28, the opposite was true: farmers with larger farms mostly were willing to pay less for the services of the scout and call center, and the results

were unclear for the lead farmer. It is important to recall that farms were larger in Mchinji than in Dedza. A larger farm may be associated with more resources and income, but it also involves higher risks. Therefore, there is somewhat of a relationship between farm size and willingness to pay, but the exact type of relationship was not clear in the results. This contradicts the available literature, which states that that there is a positive relationship between increasing willingness to pay and farm size, as described by S.I. Umar et.a.l (2014), Oladele et.al. (2008), and Onoh. et.al. (2012). It is important to highlight that those three studies took place in Nigeria. It is possible, therefore, that one of the reasons for the contradiction between the literature and the results of this study is rooted in the differences between Malawi and Nigeria.

As per education, a joint analysis of both districts in Figure #29 showed that, generally, in both districts, the most educated farmers were willing to pay the lease for all services when including farmers with a high school education. However, when comparing only between farmers with less than an elementary high school and farmers with elementary to less than high school, the more educated farmers were willing to pay more for all services. Opposingly, at a district level, Figure #30 showed Dedza farmers with the lowest educational level (less than elementary) had the highest willingness to pay for all the services. However, in Mchinji and as shown in Figure #31, farmers with the highest-level education (elementary to less than high school) had the highest willingness to pay for all the services. It is important to recall here that Dedza farmers were generally more educated than those in Mchinji. A higher education might signify more awareness of the potential benefits of farm monitoring and provision of advice, but it might also signify more awareness of the potential risks of paying money. Therefore, there is somewhat of a relationship between education level and willingness to pay, but the exact type of relationship was not clear in the results. This, again, contradicts the literature that generally agrees on a positive relationship

between education and willingness to pay, as described in the studies by Oladele (2008) and Onoh et.al. (2012) and Anugwa et.al. (2022).

Finally, when it came to the actual effect of this project on spraying levels, it was interesting to compare the results in Dedza, where the scout refused to recommend the farmers to reduce spraying to once every few weeks instead of every week, to those in Mchinji, where the scout did provide this advice. The provision of advice was scheduled to begin on calendar week 39. Figures #32, #33, #34 and #35 showed that, during the project, spraying in both districts was reduced after week 39, but the reduction was much so in Mchinji than in Dedza (18.8% less in Mchinji as opposed to only 3.3% less in Dedza). This of course makes sense given the differences in the scouts' attitude in both districts. It can be said that the 18.8% of farmers who reduced spraying in Mchinji when receiving advice are, in some form, early adopters of the scouts' advice. Research about early adopters among farmers will be around a quarter, about 20%-25% of the individuals (Dielderen et. al.; 2003). Therefore, this study's results' percentage of 'early adopters' is close to the numbers in the literature. The reduction of spraying in Mchinji as opposed to Dedza shows some promise to the potential value of service providers giving advice to the farmers in order to change farmers' practices.

This was further emphasized by the T Test analysis described in Table #9 analyzing the difference in means of farmers' spraying the previous week up until week 39 (inclusive) and after week 39. The results showed no significant difference in Dedza, where no advice was provided in week 39. However, the results showed a significant difference in Mchinji, where advice was actually provided in week 39. These results corroborate the actual impact of advice on farmer behavior.

Conclusion

This study aimed to determine the extent to which farmers are interested in providing field data and receiving advice, and how such interest differs across different methods and populations. Through an extensive review of the available literature, and a case study among smallholder tomato farmers in Malawi involving two personal surveys with the farmers, field monitoring and advice provision via scout, call center and lead farmers, this study reached some interesting conclusions.

In theory, farmers are immensely interesting in providing field data and receiving advice, as in the surveys, close to 100% of the farmers from both participating districts claimed to be willing to provide information and receive advice via the scout, call center operator and lead farmers. However, interest in terms of willingness to pay tells a different and more complex story. Both in Dedza and Mchinji, farmers' willingness to pay increased over time and, in the case of the call center, there was a specific increase of willingness to pay levels with number of interactions with the service providers. The same was not true for the scout and lead farmer, which might be due to the fact that Mchinji farmers already had access to extension services before the project, or to the generally very low levels of interactions with the scout in both districts. This shows that one of the important factors influencing farmers' interest in providing farm data and receiving advice (the services of the scout, call center and lead farmer) is the actual exposure and interactions they have with them in practice, especially in regards to a 'new' service such as the call center, (due to the innovative approach of the call center actively calling the farmers.)

In regards to demographic factors, this study showed conflicting results regarding the relationship between farmers' willingness to pay and number of people in households, coinciding with the contradictory literature available in the topic. More research is required to find if

household size is a determinant factor. Similarly, this study was unable to determine the nature of the relationship between farm size and willingness to pay, contrarily to the literature stating that there is a positive correlation between both factors. Again, more research is required in the topic, specifically in the Malawian context. Contrarily, when it came to age, this study supported the available literature indicating an inverse relationship where the younger farmers' willingness to pay levels are higher than the older farmers. In the topic of education, where the literature usually agrees that more educated farmers' willingness to pay would be higher, this was only true for Mchinji's farmers and not Dedza's. In conclusion, this study supports literature that determines that younger farmers are the most interested in investing in extension services, while encouraging further research in regards to the other factors. Efforts to promote extension services and new technologies should then focus on the younger farmers, empowering them to expand awareness on the importance of monitoring smallholder farms and reaching out for advice. Younger farmers could lead the efforts for different smallholder farmer groups and cooperatives to become organized and employ scouts or other service providers for this purpose.

When comparing farmers' level of interest between the scout, call center and lead farmer, this study showed that farmers overly preferred the scout. This was true in the information from the farmers' surveys indicating their preferences, the high levels of interactions that the scout was able to achieve in relation to its counterparts, and the farmers' generally high willingness to pay for its services across different ages, household and farm sizes and education levels. The opposite was true, for the most part, in the case of the lead farmer. There is, therefore, great promise in the role of scouts in farm monitoring and advice provision, and more resources should be invested in training and compensating scouts for their services.

Finally, it is important to note the actual tangible effect of providing advice to smallholder farmers, as was done by the scouts in the Mchinji region. The fact that the Dedza scouts refused to provide the advice actually created the ground to check the actual effect of providing advice as opposed to not providing advice in regards to farmers' spraying frequency. The actual difference in spraying frequency in Mchinji before and after advice was received shows the value and potential of providing advice to farmers.

Beyond the tangible effects of providing farmers with advice, farmers in the study provided large praise to this study (both anecdotally and in a question on Survey #2, see Appendix A).

In conclusion, this study determined that farmers are generally greatly interested in monitoring their farms and receiving advice. In regards to the differences between methods, farmers' interest was greater in the case of the scouts' services than the call center or lead farmer. When it came to a newer type of extension service, such as the call center, there was great value in the actual number of interactions that the farmers had with the service in order to increase their interest. In regards to demographics, the clearest determinant of interest was age, with great promise for the potential of younger farmers to invest in extension services. Further research is required to determine the role of other demographic factors.

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Appendix

Appendix A: Testimonies from the farmers

On the second survey, the farmers were asked about the major benefits of the project, and these were some of their answers:

Question: What have been the major benefits of this project to you?

Answers [excerpt]

- "It is encouraging to know that we have access to professional advice at all times."
- "Now, extension services are only a phone call away!"
- "They come to the farm to advise us!"
- "Now we have someone to talk to when we have a problem in the farm."
- "Gaining knowledge on beneficial agricultural practices for higher income."
- "We receive advice easily because extension services are available now."
- "Very easy access to extension services."
- "Empowerment through knowledge acquisition."
- "Now I know the importance of monitoring my farm and keeping records."
- "Now I have access to advice when I need it."
- "Now we are learning the proper ways of growing tomatoes and have easy access to agricultural information."