# TIYENI ANNUAL SURVEY FOR BASELINE/IMPACT STUDY REPORT 2018

BY

*(Promoting sustainable farming methods in Malawi)*

MR. FRANCE M. GONDWE,

P.O. Box 429, Mzuzu, Malawi.

Email: fmtgondwe@yahoo.com;

Phone: +265-888-875-374

# ABSTRACT

Tiyeni Organisation is a Malawian NGO aimed at combating hunger and poverty in Malawi an innovative Climate Smart Agriculture (CSA) method known as the Deep Bed Farming (DBF) method. The DBF doubles maize yields of smallholders in the first year of adoption, stops surface runoff, stops soil erosion, builds soil fertility and retains soil moisture.

In 2018 Tiyeni conducted an annual multipurpose survey for baseline indicators in new areas as well as project impact evaluation where Tiyeni had been conducting its intervention for some time. The survey was conducted in 8 Extension Planning Areas (Bolero, Bwengu, Chikangawa, Chikwina, Emsizini, Madisi, Mhuju and Zombwe EPAs) where Tiyeni is carrying it DBF activities. Systematic sampling was used to select sites in both old and new areas and proportionate random sampling was used to selected farmers practicing DBF. A total of 560 farmers were interviewed. A structured questionnaire was used to collect socio-economic data. Data was analysed using STATA, SPSS and Excel Programmes. The 'Food Insecurity Experience Scale' (FIES) was analyzed using the Rasch Model. The FIES is a metric of severity of food insecurity at the individual farmer household level that relies on people's direct responses to eight brief questions regarding their access to adequate food.

The survey found that there are more female (53%) than male farmers in DBF. These farmers are distributed normal between the ages of 20 to 80 years with the average age at 49.7 years. The average household size was 6 members. They have an average land holding of 1.3ha and they put aside 0.73ha for maize. The average DBF land size is 0.24ha with the largest mean land size (0.3ha) recorded in Emsizini and Madisi EPAs while the smallest was in Bolero and Mhuju (0.1ha) where DBF was new. The survey shows that a great many farmers have recently started using BDF, with those just registered for DBF constituting 33%, those that have used it for only one year constituting 32% but the rest are distributed in descending order up to 9 years where there were very few. On DBF farming trends, 64% of farmers perceive that DBF is increasing. Rate of adoption of DBF is estimated at 370%. About 13.6% of the farmers are willing to convert their land to DBF up to 100%. DBF also increased the use of manure (from 0.5tons to more than 2.5tons per household) the longer period that the farmers practice it. The use of inorganic fertilizers is decreased. DBF farming increases the yields of almost all crops that the farmers have tried including: maize, common beans, soya beans, ground nuts, and sweet potato. It also increases mean annual income from MK500,000 to more than MK800,000. It eradicates severe food insecurity by $6^{th}$ year.

It can therefore be concluded that DBF is one of the best Climate Smart Agricultural technologies at the current amount of benefits to the farmers and at the rate of adoption of technology.

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# 1 INTRODUCTION:

Tiyeni Organization is a Malawian agricultural non-governmental organisation, headquartered in Mzuzu. It was registered with CONGOMA as a not-for-profit organisation as Tiyeni Limited, an NGO in 2015 with the aim of combating hunger and poverty in Malawi through sustainable farming. Tiyeni promotes an innovative Climate Smart Agriculture (CSA) farming technique known as the Deep Bed Farming (DBF) method. The Deep Bed Farming method stops surface runoff, stops soil erosion, builds soil fertility and retains soil moisture. These benefits also translate to other benefits including recharging of aquifers and reducing flooding. The climate smart Deep Bed Farming method is a blend of several recommended technologies, which are not being sufficiently adopted by farmers on piece meal approach. The Deep Bed Farming method has been received by the smallholder farmers with much enthusiasm. It gives maximum soil productivity to small scale farmers. It generally doubles maize yields of smallholders in the first year of adoption (up to 8 tons of maize per hectare from 1.7 tons with far lower costly inputs). Therefore, with the said benefits of reduced input costs and more than doubling yields it eradicates hunger and poverty through surplus crop yields which are sold for income. It has a history of continued use by farmers that have adopted the technology for close to ten years and it is now widely spreading.

In 2018 Tiyeni started conducting an annual multipurpose survey for establishing indicators (Baseline indicators in new areas) as well as for project impact evaluation (to follow up how much Tiyeni activities have impacted the lives of farmers). Since Tiyeni projects are mostly short-term (one to two year) without a component of evaluation, the annual surveys are designed in such way that they can easily incorporate impact studies at end of the project. The 2018 survey was extensive reaching every site where Tiyeni was conducting its intervention.

## 2 PROBLEM STATEMENT

Tiyeni has a large number of farmers that are practicing DBF estimated well above 10,000 farmers. More farmers are requesting to be trained in the technology. However, Tiyeni has not conducted a scientific study which can characterize its farmers. This means that until now, Tiyeni does not fully understand its farmers. It also means that previously Tiyeni did not have sufficient knowledge of the socio-economic parameters associated with adoption of deep bed technology.

Without a good study to characterise its farmers, and studies to follow-up any changes in farmers characteristics, Tiyeni does not know how long and by how much DBF adoption affects its farmers. This therefore means that in the past Tiyeni could not substantially or scientifically claim to what extent the impacts resulting from its interventions are directly related.

## 3 RATIONALE

Tiyeni has been conducting its activities for close to ten years without a systematic or scientific way of evaluating the impacts of its activities. Tiyeni however has many farmers practicing the innovative deep bed farming. Tiyeni also has several claims on the impacts of its project activities such as increasing adoption, increased demand for training from new farmers, increased crop yields, reduced input costs, soil erosion control and many good claims which need systematic assessment methods. Tiyeni uses several of these important parameters in its proposals and project documents without much documented evidence. It is worthy to establish the baseline status of these parameters and use them in following up how the interventions change livelihood of the farmers. Without a scientific way of measuring and documenting the successes in these parameters, Tiyeni risks meeting limitations in continued promotion of its innovations and in accessing finances.

Tiyeni has been receiving steady support to promote its DBF technologies and has several projects on the ground. Tiyeni is also trying to source more funding to reach out to more farmers. Tiyeni has received funding from Fore Foundation to conduct monitoring and evaluation activities from 2018 to 2021. Every source of project funding would be happy to see a well-defined impact that their funding produces. This study seeks to correct the lack of information about DBF famers and to analyse the result.

# 4 SURVEY OBJECTIVES

1) To establish the level of some socio economic parameters that can be used as indicators for project impact.
2) To obtain farmers' perceptions on Deep Bed Farming
3) To make comparative analyses between new farmers and those who have already adopted Deep Bed Farming and also,
4) To assess impact by time.

# 5 MATERIALS AND METHODS

The survey was conducted in Extension Planning Areas (EPAs) where Tiyeni is carrying it DBF activities. Sampling was conducted using stratified random sampling. Sections/sites where Tiyeni activities are carried were categorised (stratified) by year when they started participating in DBF (age of site). Systematic sampling was used to select sites which are old and new areas in any given EPA and in each site that was selected sampling was carried out using proportional random sampling to randomly selected farmers based on its population size in proportion to the total population of farmers practicing deep beds farming method. This baseline survey was conducted using a structured questionnaire developed to collect socio-economic data. Data collected could be used to compare new farmers against older farmers hence can show if there are any significant differences in social economic parameters between the old and new farmers (impact assessment). Data was first processed and cleaned for outliers and mistakes. The data was analysed using STATA, SPSS and Excel Programmes.

**The Rasch Model to Measure 'Food Insecurity Experience Scale' (FIES)**

Tiyeni Annual Household Survey of 2018 collected information on access to food applying the Food Insecurity Experience Scale (FIES) module. The FIES is a metric of severity of food insecurity at the individual farmer household level that relies on people's direct responses to eight brief questions regarding their access to adequate food. It is a statistical scale similar to other widely accepted statistical scales designed to measure unobservable traits (Ballard, et al., 2013) such as intelligence, personality, and a broad range of social, psychological and health-related conditions.

The approach used to analyse FIES data comes from 'Item Response Theory', a branch of statistics that permits the measurement of unobservable traits through analysis of responses to surveys. Since food security itself is an inherently unobservable trait it can be measured only by examining its observable indicators. The specific model used to analyse the FIES data collected is the one parameter logistic model, otherwise known as the Rasch Model.

The foundation of the modern 'Item Response' is the assumption that a quantitative measure of an underlying, unobservable construct (i.e. a latent trait) can be inferred from a set of dichotomous variables (1/0, yes/no, positive/negative, correct/incorrect). The fundamental assumption of this theory is that the probability of responding correctly, or affirming an item associated with a certain level of difficulty or severity depends on the unobservable true ability, or condition of the respondent (FIES technical paper).

**The Rasch Model:**

In the Rasch model, the probability that a respondent with ability $b_h$ will report a given experience characterized by difficulty level $a_i$ is a logistic function of the distance $b_h$ and $a_i$

$$Prob(x_{h,i} = 1 \mid b_h, a_i) = F(b_h - a_i) = \frac{e^{b_h - a_i}}{1 + e^{b_h - a_i}}$$

To measure food insecurity the $a$ parameters is interpretation as indicating the severity associated with the experience captured by different questions, and $b$ parameters as the measure of insecurity experienced by the respondents (Ballard, et al., 2013).

The relative severity associated with each of the experiences($a_i$) can be inferred from the frequency with which they are reported by a large sample of respondents, assuming that, all things being equal, more severe experiences are reported by fewer respondents. Once the severity of each experience is estimated, the severity of a respondent's condition ($b_h$) can be computed by noting how many of the items have been affirmed. The justification for this is that, on average, it is expected that a respondent will answer positively to all questions that refer to experiences that are less severe to their food insecurity situation, and negatively to questions that refer to situations more severe. The mathematics of the model imply that a proper statistical measure of the respondent's food insecurity level can be based only on the Raw Score (number of affirmative answers), irrespective of which specific experiences were affirmed (Ballard, et al., 2013).

The model analyzes the following FIES question:

*"During the last 12 months, was there a time when, **because of lack of money or other resources**:*

*FIES_1. You were **worried** you would not have enough food to eat?*

*FIES_2. You were unable to eat **healthy and nutritious** food?*

*FIES_3. You ate only a **few kinds** of foods?*

*FIES_4. You had to **skip a meal**?*

*FIES_5. You **ate less** than you thought you should?*

*FIES_6. Your household **ran out** of food?*

*FIES_7. You were **hungry** but did not eat?*

*FIES_8. You went **without eating for a whole day?”***

The data was analyzed using STATA, SPSS and Excel computer packages.

## 6 RESULTS AND DISCUSSION

### 6.1 Study Areas and Sample Size

The study used multistage sampling method. The first stage constituted sampling areas where DBF is practiced and systematic sampling was used to select sites which are old and new in any given EPA. Project activities were carried out mainly in 4 districts including Dowa, Mzimba, Nkhata Bay and Rumphi.

Table 1: The districts and the number of farmers involved in the study.

```
. tabulate district
```

| District | Freq. | Percent | Cum. |
|---|---|---|---|
| Dowa | 136 | 24.29 | 24.29 |
| Mzimba | 301 | 53.75 | 78.04 |
| Nkhatabay | 92 | 16.43 | 94.46 |
| Rumphi | 31 | 5.54 | 100.00 |
| Total | 560 | 100.00 | |

From district level the study was carried out in 8 EPAs where Tiyeni is currently working. The study EPAs included: Bolero, Bwengu (Embombeni), Chikangawa, Chikwina, Emsizini (also included is Chimbongondo), Madisi, Mhuju and Zombwe. Secondly, proportional random sampling to randomly selected farmers from each area community based on its population size in proportion to the total population of farmers practicing deep beds farming method.

Table 2: EPAs and the number of farmers involved

```
. tabulate EPA
```

| Extension Planning Area | Freq. | Percent | Cum. |
|---|---|---|---|
| Bolero | 17 | 3.04 | 3.04 |
| Bwengu | 43 | 7.68 | 10.71 |
| Chikangawa | 27 | 4.82 | 15.54 |
| Chikwina | 92 | 16.43 | 31.96 |
| Emsizini | 129 | 23.04 | 55.00 |
| Madisi | 136 | 24.29 | 79.29 |
| Mhuju | 14 | 2.50 | 81.79 |
| Zombwe | 102 | 18.21 | 100.00 |
| Total | 560 | 100.00 | |

## 6.2 Household Heads

The survey according to Table 3 shows that 85% of the household were male headed and 15% of the household heads were female. The household head was described as the breadwinner in the household and more household were male headed.

Table 3: Sex of the Household Head

```
. tabulate sexhh

     sex of |
  household |
       head |      Freq.     Percent        Cum.
------------+-----------------------------------
     Female |         82       14.70       14.70
       Male |        476       85.30      100.00
------------+-----------------------------------
      Total |        558      100.00
```

## 6.3 Gender of DBF Farmers

Table 4 reveal that there are more female DBF farmers (53%) than men (47%). The fact that more female farmers are using DBF farming in the male headed households means that women have equal opportunities with their male counterparts on DBF. This is also true with the fact that in Malawi women carry more farming activities than male farmers hence they are more likely to be exposed and subsequently use DBF than their male counterparts. Women like DBF farming because it provides the farmers with a good harvest assuredly regardless of the common agricultural shocks of droughts, water logging from high intensity rainfalls and unavailability of adequate inorganic fertilizers by either high prices or lack of access. These usually are the main causes of poor harvest among most smallholder farmers.

Table 4: Gender of the Farmers

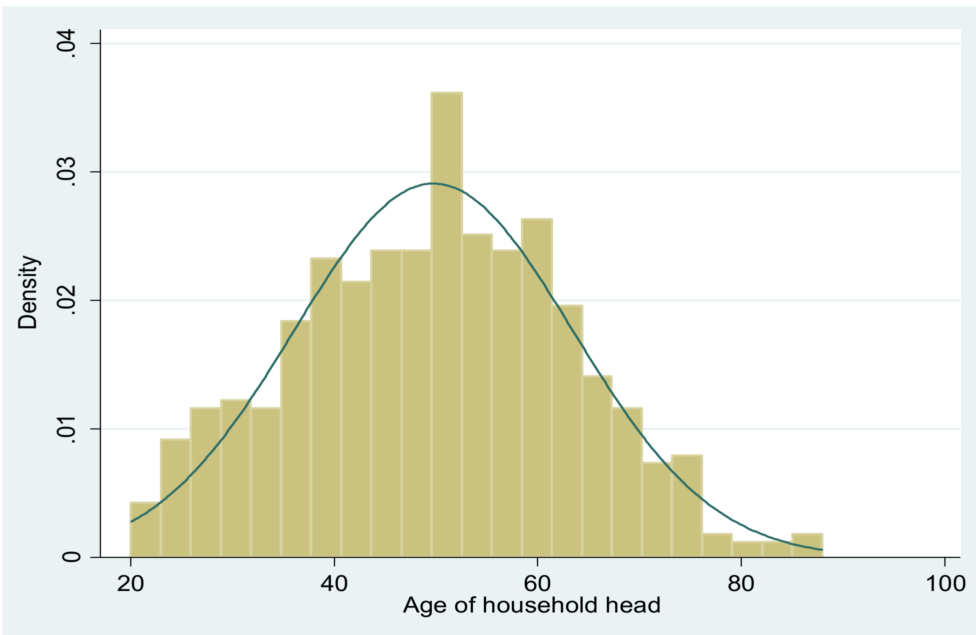
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FEMALE | 295 | 52.7 | 52.7 | 52.7 |
| | MALE | 265 | 47.3 | 47.3 | 100.0 |
| | Total | 560 | 100.0 | 100.0 | |

Most farmers are also attracted to BDF because of its labour saving characteristics through: using the principles of minimum tillage before the land can again be tilled; and it also reduces amount of labor required for weeding because it encourages light weeding. Only light weeding is necessary because the weeds are suppressed or out-competed by the crops given that DBF encourages early planting (planting with first rains).

### 6.4 Age of the Famer

Figure 1 shows the age distribution of the household heads. It shows that age ranged from 20 years old to 88 years old with the average at 49.7 years. It shows an almost equal distribution between youthful and elderly farmers with a slight skew towards youthful farmers.

Figure 1: Age of the Household Head




### 6.5 Size of the Household

Table 5: Size of the Households

. summarize sizehh

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| sizehh | 560 | 5.6875 | 1.853446 | 1 | 13 |

The sizes of the households of these farmers range from one member household to 13 members. The average household size is 6 members. The sizes of the households reflect to the amount of labor in households and it also affects food and income utilisation. However, the amount of labor cannot be construed directly to DBF labor unless it is known which members participate in DBF farming and to what extent. For example it is common practice to see members from same household having separate DBF fields which means they carry out activities separately.

## 6.6 Average Total Land Under Cultivation

The farmers cultivate land areas ranging from 0.1ha to 7ha. The average size is 1.3ha. This shows that some farmers cultivate very small amounts of land.

Table 6: Total Land Area under cultivation

```
. summarize tland_a if tland_a<17
```

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| tland_a | 525 | 1.300316 | .9021764 | .01 | 7 |

Figure 2: A Graph of Land Size Distribution (ha)

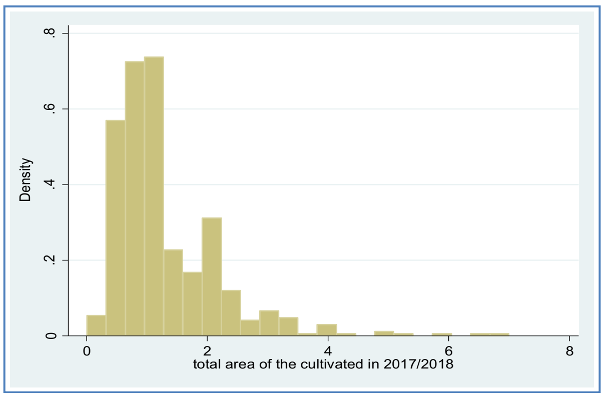



Figure 3: A Graph of Land Under Maize (ha)

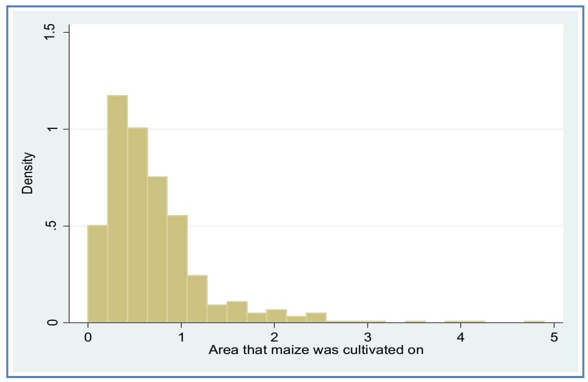



Figure 2 shows that many farmers have land sizes below one hectare and that those who have more than two hectares are few, less than half of the farmers. This is the land that the farmers used to plant with different types of crops and practice intercropping and crop rotation. Figure 3 shows that maize occupies a large proportion (about half) of the land that is under cultivation. This is confirmed with the average land area under maize. Table 7 shows that maize occupies an average of 0.73ha.

Table 7: Total Land for Maize

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| TOTAL MAIZE LAND | 560 | 0 | 5 | .73 | .560 |
| Valid N (listwise) | 560 | | | | |

### 6.6.1 Land Area under Deep Bed Farming

The land sizes for DBF ranged from 0.003ha to 2.0ha. A lot of farmers had between 0.2ha to 0.4ha (Table 8). Most farmers start using DBF with about 0.2ha. It however is interesting to note that about 20% of the farmers have increased their land under DBF above 0.4ha. Some farmers have expanded their fields to more than 1.8ha. These results correspond to the number of years the farmers have practiced DBF. Since half of those interviewed had cultivated on DBF for first time, it is expected that their land size will be small since they start DBF farming by tilling small pieces of land to try it out and increase their DBF land in subsequent years after proving its worthiness.

Table 8: Land That Was Tilled and Used far DBF Farming

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 0.0-0.2 Ha | 391 | 69.8 | 80.3 | 80.3 |
| | 0.21-0.4 Ha | 65 | 11.6 | 13.3 | 93.6 |
| | 0.41-0.6 Ha | 15 | 2.7 | 3.1 | 96.7 |
| | 0.61-0.8 Ha | 6 | 1.1 | 1.2 | 97.9 |
| | 0.81-1.0 Ha | 6 | 1.1 | 1.2 | 99.2 |
| | 1.01-1.2 Ha | 1 | 0.2 | 0.2 | 99.4 |
| | 1.21-1.4 Ha | 1 | 0.2 | 0.2 | 99.6 |
| | 1.61-1.8 Ha | 1 | 0.2 | 0.2 | 99.8 |
| | 1.81-2.0 Ha | 1 | 0.2 | 0.2 | 100 |
| | Total | 487 | 87 | 100 | |
| Missing | System | 73 | 13 | | |
| Total | | 560 | 100 | | |

The results show that on average the farmers have about 0.24ha of their land on DBF (Table 9). This means that there is a shift from the minimum and farmers are increasing their land.

Table 9: Average Land Used for DBF Farming

```
. summarize dbfland_a if dbfland_a > 0

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
   dbfland_a |       367    .2438322    .2161637       .003          2
```

### 6.6.2 Means DBF Land Size Per EPAs

If we compare the various EPAs we see that Emsizini has the largest mean land size of 0.29ha followed by Madisi with a mean of 0.28ha. It can also be noted that the EPAs where the mean land areas are smallest are very new Bolero and Mhuju. This shows that typically in the first year most farmers start with land size of less 0.2ha. The smallest land size in the survey was 0.003ha (three deep beds of ten meters each). This clearly indicates that farmers increase DBF land with time.

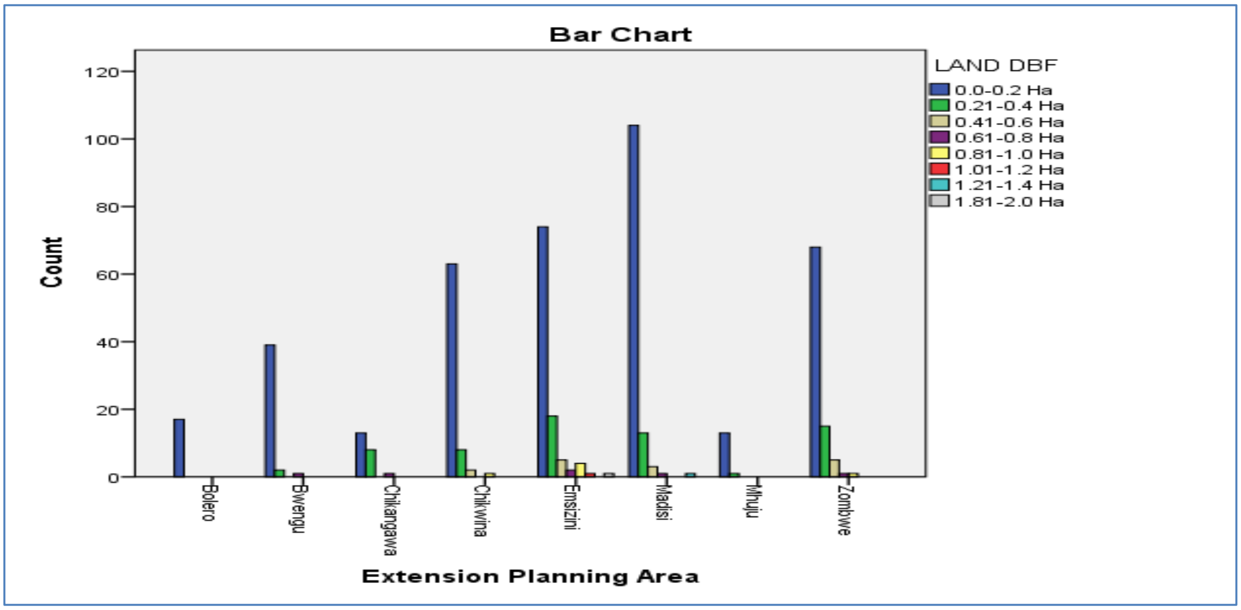
Table 10: Cross-tabulation of Mean DBF Land in the growing Season of 2017/18 and Names of the EPAs

| Extension Planning Area | Mean DBF Land in 2017/18 (ha) | Bootstrap[a] | | | |
|---|---|---|---|---|---|
| | | Bias | Std. Error | 95% Confidence Interval | |
| | | | | Lower | Upper |
| Bolero | .100000 | .000000[b] | .000000[b] | .100000[b] | .100000[b] |
| Bwengu | .251389 | -.002877[c] | .052741[c] | .160000[c] | .364000[c] |
| Chikangawa | .226798 | -.000061 | .030696 | .170568 | .292360 |
| Chikwina | .216290 | -.001070 | .018509 | .180513 | .254608 |
| Emsizini | .294448 | -.001831 | .029115 | .238824 | .353293 |
| Madisi | .281375 | .000410 | .025077 | .236102 | .339158 |
| Mhuju | .130000 | .001134[d] | .045804[d] | .066667[d] | .233333[d] |
| Zombwe | .201642 | .000181 | .015536 | .172158 | .233037 |
| a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples | | | | | |
| b. Based on 979 samples | | | | | |
| c. Based on 999 samples | | | | | |
| d. Based on 996 samples | | | | | |

### 6.6.3 DBF Land Size Distribution in an Extension Planning Area (EPA)

Looking at Figure 4 below we see that land distribution diversifies according to the years the EPA has adopted the DBF. In Bolero and Mhuju we have the least diverse land distribution compared to older EPAs (see Table 11). Emsizini and Madisi have land size ranging from 0-0.2ha, 0.21-0.4ha, 0.41-0.6ha, 0.61ha-0.8, 0.81-1.0, 1.01-1.2ha, 1.21-1.4ha up to 1.8ha. The more the years DBF is promoted the more the new comers adopt it starting with land areas of below 0.2ha but as time pass-by they increase their land sizes and attract even more farmers to join in DBF farming. The figure shows that farmers all over the EPAs that have adopted DBF are increasing their DBF adopted land area. It shows land size distribution in all ranges up to just above 1.8ha as seen in Emsizini EPA.

**Figure 4: Distribution of Land sizes by Hectares in Various EPAs**




## 6.7 Length of Time the Farmers have Practiced DBF

Table 11 shows how the farmers were distributed according to number of years they had used DBF. About 33% of the farmers had just registered but not used DBF while another 33% have used deep bed farming for one year. Of the farmers that had used DBF farming, half of them had used DBF for a single year while the other half had practiced it for a few years (1-3years). Only a few had used DBF for many years (4-9 years constituting about 10% of the total sample). This also indicates the exponential growth of adoption of DBF by farmers.

Table 11: Number of years that the farmers have practiced DBF

. tabulate yrdbf

| number of years the farmer has practiced DBF | Freq. | Percent | Cum. |
|---|---|---|---|
| 0 | 185 | 33.04 | 33.04 |
| 1 | 183 | 32.68 | 65.71 |
| 2 | 76 | 13.57 | 79.29 |
| 3 | 61 | 10.89 | 90.18 |
| 4 | 32 | 5.71 | 95.89 |
| 5 | 9 | 1.61 | 97.50 |
| 6 | 8 | 1.43 | 98.93 |
| 7 | 2 | 0.36 | 99.29 |
| 8 | 1 | 0.18 | 99.46 |
| 9 | 3 | 0.54 | 100.00 |
| Total | 560 | 100.00 | |

Table 12 shows the average number of years a farmer has been practicing DBF. From this sample where other farmers had been using DBF for 9 years, the average number of years of cultivation using DBF by 2018 is 1.4 years. This average includes those farmers that had just registered but not yet cultivated in their fields (see Table 11). Again, this low figure is an indication of the exponential rise in adoption of DBF particularly in the last 2 years.

Table 12: The Average Number of Years a Farmer has Been Practicing DBF

. summarize yrdbf

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| yrdbf | 560 | 1.407143 | 1.558158 | 0 | 9 |

## 6.8 The Trends of DBF Farming in Malawi

When farmers were individually asked to give their perception on whether DBF is increasing, decreasing or static (Table 13), it was found that the majority (64%) said DBF is increasing and about 33% said it neither increasing nor decreasing. Only 3% were pessimistic saying DBF is decreasing. This means that a majority of farmers are actively adopting DBF and 64% are increasing their land area of DBF. It also means that a few farmers are maintaining the same size of land for several years that is why others say it is static but very few are coming out of DBF. Disadoption is very minimal with DBF technology.

Table 13 Trend of DBF

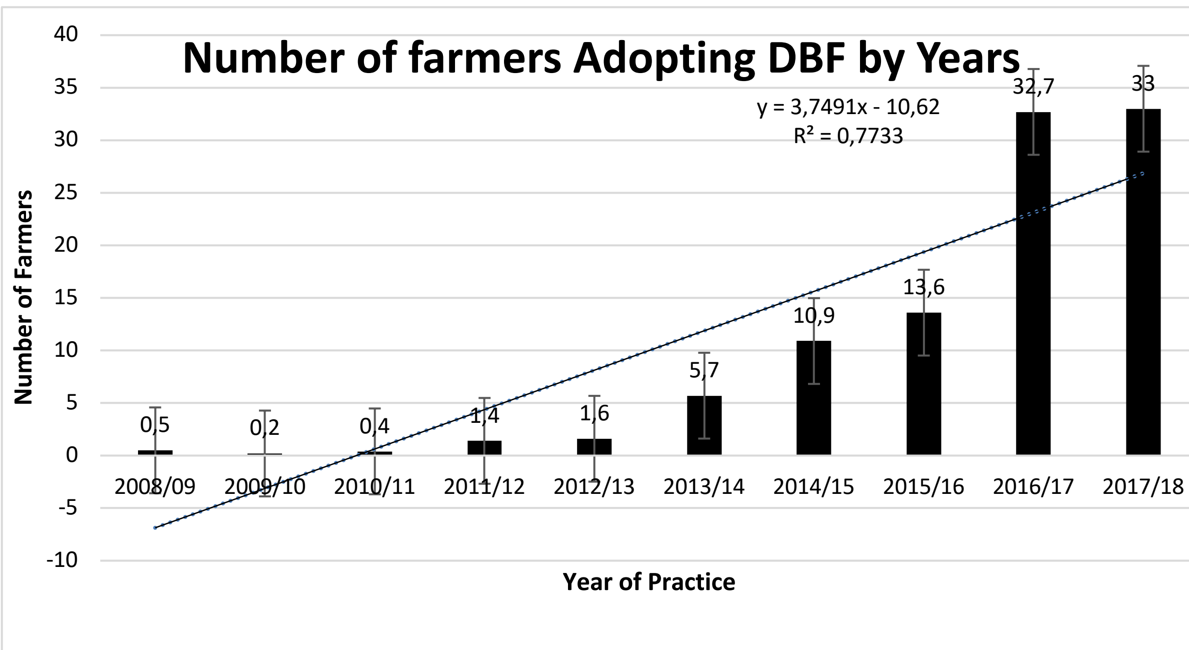
. tabulate trend

| trend of use of DBF in terms of land | Freq. | Percent | Cum. |
|---|---|---|---|
| Decreasing | 9 | 2.91 | 2.91 |
| Increasing | 199 | 64.40 | 67.31 |
| Static | 101 | 32.69 | 100.00 |
| Total | 309 | 100.00 | |

## 6.9 Rate Adoption of DBF Use Since 2009 to 2017

Figure 5 below is depicting the rate of increase of the farmers that are adopting DBF since 2009 to 2017 growing seasons. This figure depicts the actual level of adoption through a histogram but also a smooth line to show a trend line of adoption. The trend line shows that the adoption rate is very high. It has a slope, dy/dx of the equation y=3.7x-10.6, of 3.7 times (coefficient of X). This is a very good indicator of high adoption since adoption rates of this magnitude (3.7 times i.e. 370%) are very hard to come by. Technologies are deemed adoptable at rates of 0.2 times (20%). DBF has good and transitive result on the ground so no wonder that the adoption rate is so high among farmers once they see their neighbours who have adopted and then get in touch with technical expertise from Tiyeni and partners. DBF is displaying its invincible capacity as an instrument to end hunger in Malawi through this very high adoption which cannot be found in any other land management and Climate Smart Agricultural (CSA) technologies being currently promoted in Malawi.

*Fig. 5: Rate of Adopting of DBF from 2009 to 2018*




Deep Bed Farming method is a Climate Smart Agriculture (CSA) farming methodology that has a clear and overwhelming impact on the ground on food security among smallholder farmers. Apart from the sustainable way of improving the soil health, it fulfills all good husbandry requirements and can be called the best method in its capacity to impact climate change effects like prolonged dry spells, droughts and uneven distribution of rainfall. Farmers adopting this technology continually acknowledge that during dry spells, crops on DBF have rarely experienced the wilting point as the moisture is conserved in the Deep Beds continuously.

## 6.10 Percent of Land to be Converted to DBF

Farmers were asked to estimate the amount of land that they are ready to convert from conventional farming to DBF. It is interesting to note that 13.6% said they are willing convert 100% of their land to DBF. An aggregate of 48.7% said they would convert over 25% of their land to DBF. This means that DBF would be a significant farming practice once the farmers adopt it.

Table 14: Percent of land to be converted to DBF

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 0.01-0.10 | 110 | 19.6 | 21.7 | 21.7 |
| | 0.11-0.25 | 150 | 26.8 | 29.6 | 51.3 |
| | 0.26-0.50 | 134 | 23.9 | 26.4 | 77.7 |
| | 0.51-0.75 | 44 | 7.9 | 8.7 | 86.4 |
| | 0.76-1.00 | 69 | 12.3 | 13.6 | 100.0 |
| | Total | 507 | 90.5 | 100.0 | |
| Missing | .00 | 46 | 8.2 | | |
| | System | 7 | 1.3 | | |
| | Total | 53 | 9.5 | | |
| Total | | 560 | 100.0 | | |

## 6.11 Total Maize Production

Table 15 shows that the average total maize production of the survey farmers was 939kg. The survey covered all 560 farmers some of whom reported zero (0.0kg) production because they had been away in that growing season and highest yield was 14,180kg. In this survey 33% of the farmers had not yet started harvesting from DBF and another 33% had DBF land sizes of not more than 0.2ha (inferred from Table 11).

Table 15: Average (Mean) Total Maize production (kg).

. summarize maizeprod

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| maizeprod | 560 | 939.5179 | 1130.159 | 0 | 14180 |

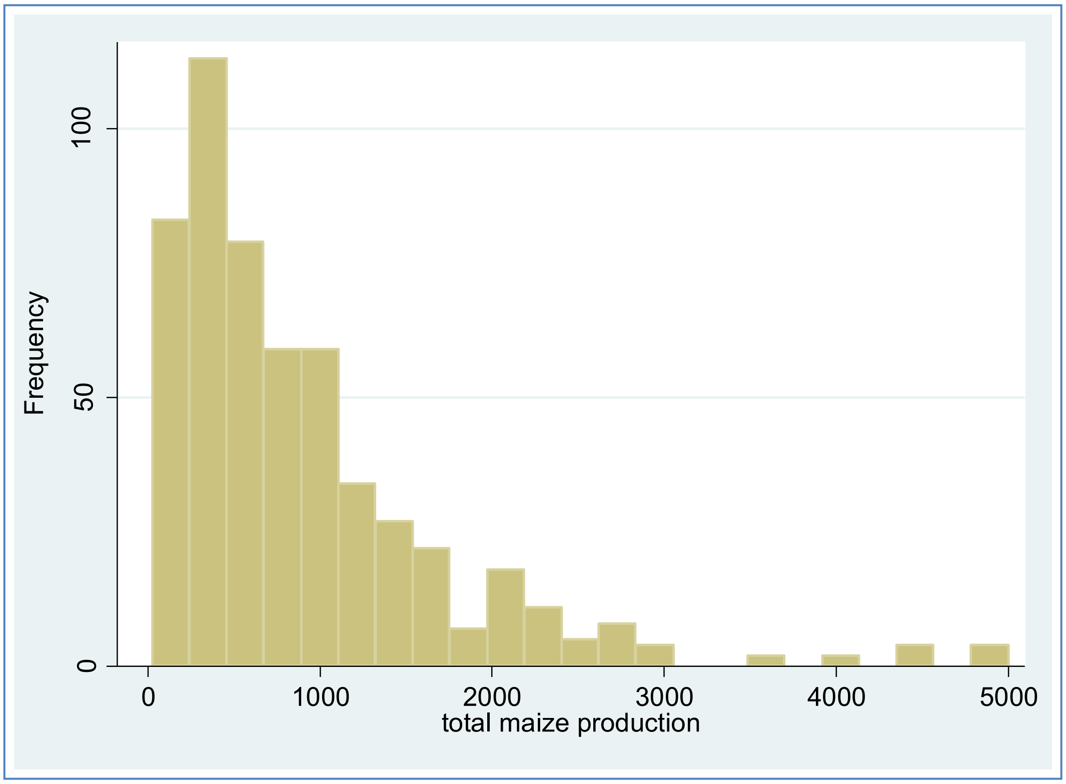



*Figure 6: Histogram Showing Distribution of Maize Yield*

Figure 6 shows that the yields have been skewed/tipped towards less than one ton per farmer. However, we also see that we have a good number of farmers that are getting better yields even of 4 tons or 5 tons each. Most farmers are adopting DBF after seeing that their fellow farmers are moving out of the low yields (the hunger zone) and transiting to the surplus zone. Maize yield typically shows what is happening on the ground showing a trend of improvements in yields.

## 6.12 Soil Fertility Improvement

Most soils in Malawi are over used and so eroded and depleted that they cannot support a healthy crop. Farmers generally use chemical fertilisers to support crop production. For the majority of smallholder farmers in the country, chemical fertilisers are too expensive to purchase for appropriate levels of production. DBF farming promotes the reduction in the use of chemical fertilisers by advocating increased use of organic manure. To substitute the chemical fertiliser usage, Tiyeni equips the farmers with the technical expertise to make and use organic manures such as Mbeya, Bokash, Changu, Farmyard Manure and Pit Manure. Tiyeni also trains and advocates the use of animal manure using livestock pass on program to help farmers produce good quality manure.

### 6.12.1 Use of Manure

DBF advocates soil fertility improvement and manure is one of its main components. Table 16 shows that in the Year 0, when farmers had not yet started using DBF, about 43% of them did not use manure while 57% of them used manure. However, as the farmers used DBF for many years they all learnt and used manure. The percent of farmers that didn't use manure started to decline drastically from the 1st year to 5th year such that by the end of the fourth year all DBF farmers used Manure.

Table 16: Tabulation of Use of Manure

**Was manure used? * number of years the farmer has practiced DBF**

| | | Number of years the farmer has practiced DBF | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| **NO** | # | 79 | 32 | 10 | 4 | 3 | 0 | 0 | 1 | 0 | 0 | 129 |
| | % | 42.7% | 17.5% | 13.2% | 6.6% | 9.4% | 0.0% | 0.0% | 50.0% | 0.0% | 0.0% | 23.0% |
| **YES** | # | 106 | 151 | 66 | 57 | 29 | 9 | 8 | 1 | 1 | 3 | 431 |
| | % | 57.3% | 82.5% | 86.8% | 93.4% | 90.6% | 100.0% | 100.0% | 50.0% | 100.0% | 100.0% | 77.0% |
| **Total** | # | 185 | 183 | 76 | 61 | 32 | 9 | 8 | 2 | 1 | 3 | 560 |
| | % | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Figure 7 shows how much of different kinds of manure farmers apply. The main kinds of manure used include Pit Manure, Bokashi, Chimato and Mbeya. Most farmers rely on Pit Manure complementing it with Mbeya, Bokashi and other manure.

Figure 7 and Table 17 show how much of the different kinds of manure are used by farmers in the different stages of adoption. It shows that farmers are using manure between 600kg and 2,500kg per season. It is interesting to note that the extra labour incurred in making manure is well balanced with the reduction in labour by avoiding any tillage after the first year. This may also explain why farmers do not feel the need to purchase as much artificial fertiliser, particularly in subsequent years – see section 7.11.2.

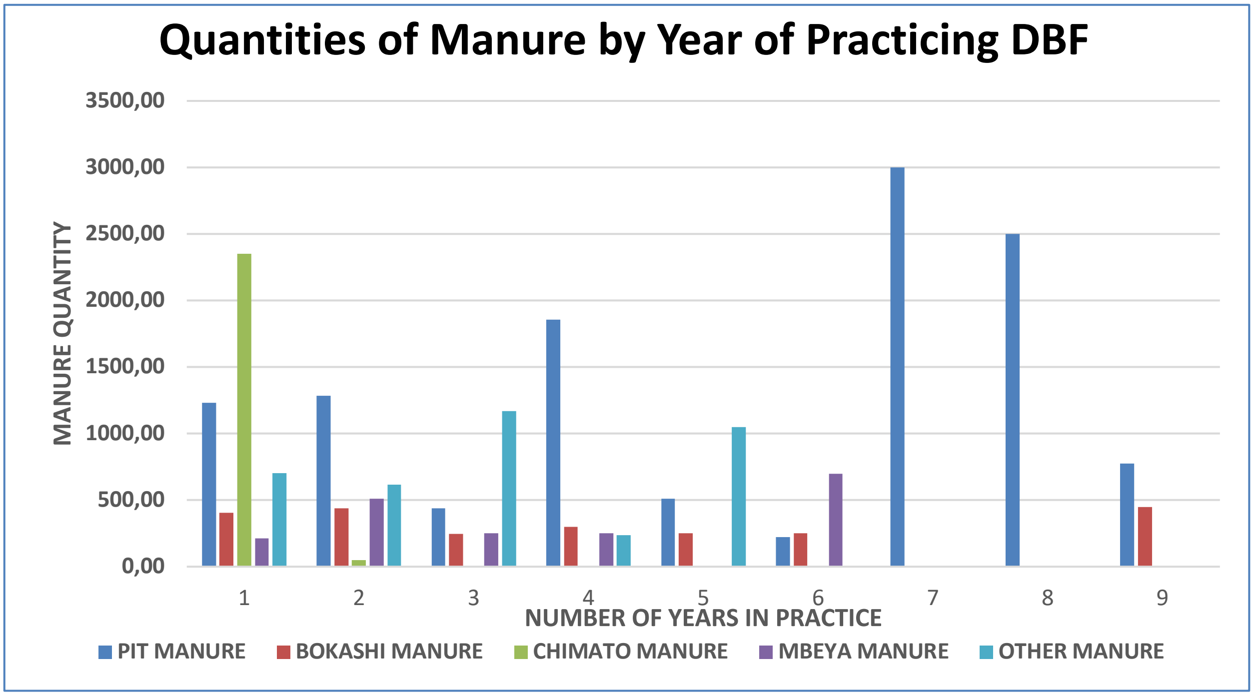



*Figure 7: Quantities of Manure by Year of Practicing DBF*

Those that are practicing DBF are using more manure than those that have not yet started using DBF. Pit Manure is the main type of manure that farmers use in all stages of DBF. Chimato was used mostly by farmers who had just started practicing DBF. Mbeya manure was used by many farmers but in small quantities. Mbeya manure is made with an input of inorganic fertilizer at 1:5 ratio of one part fertilizer to five parts organic matter for composting. It is used as a substitute of basal dressing fertilizer and top-dressing fertilizers depending of the fertilizer ingredient used. The last category of manure, 'Other manure', is a category of all the different types of manure that were not directly captured. Animal dung is an important input in making the different types of manure but when it is composted alone and applied alone it is called animal manure and it was captured together with other manure.

Table 17: Mean Amount of Manure Used (kg) by The Year of DBF Practice

| Year of_DBF | PIT MANURE | BOKASHI MANURE | CHIMATO MANURE | MBEYA MANURE | OTHER MANURE | TOTAL |
|---|---|---|---|---|---|---|
| 0 | 323.15 | 41.89 | 0.00 | 23.11 | 266.42 | 654.57 |
| 1 | 565.17 | 62.22 | 38.52 | 26.67 | 123.06 | 815.65 |
| 2 | 828.55 | 109.57 | .66 | 26.97 | 72.89 | 1038.64 |
| 3 | 294.44 | 96.08 | 0.00 | 16.39 | 153.02 | 559.93 |
| 4 | 1160.16 | 103.13 | 0.00 | 15.63 | 22.34 | 1301.25 |
| 5 | 341.67 | 27.78 | 0.00 | 0.00 | 233.33 | 602.78 |
| 6 | 192.63 | 94.50 | 0.00 | 87.50 | 0.00 | 374.63 |
| 7 | 1500.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1500.00 |
| 8 | 2500.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2500.00 |
| 9 | 516.67 | 150.00 | 0.00 | 0.00 | 0.00 | 666.67 |

The general trend which is coming out of manure use from the survey is that farmers are increasing the amount of manure which they use each year. The more the years they have practiced DBF the more the manure. This corresponds to the amount of land under DBF which is also increased with time (as described on Figure 4 and Table 13). Figure 8 below shows that the amount of manure used is steadily increased by farmers who are continuing to use the DBF. The stronger $R^2$=0.8 means that there is a stronger relationship between quantity of manure used and the number of years the farmers has practiced DBF. A few years were skipped to get a better relationship of quantity of manure (y variable) and the year of DBF practice (x variable).

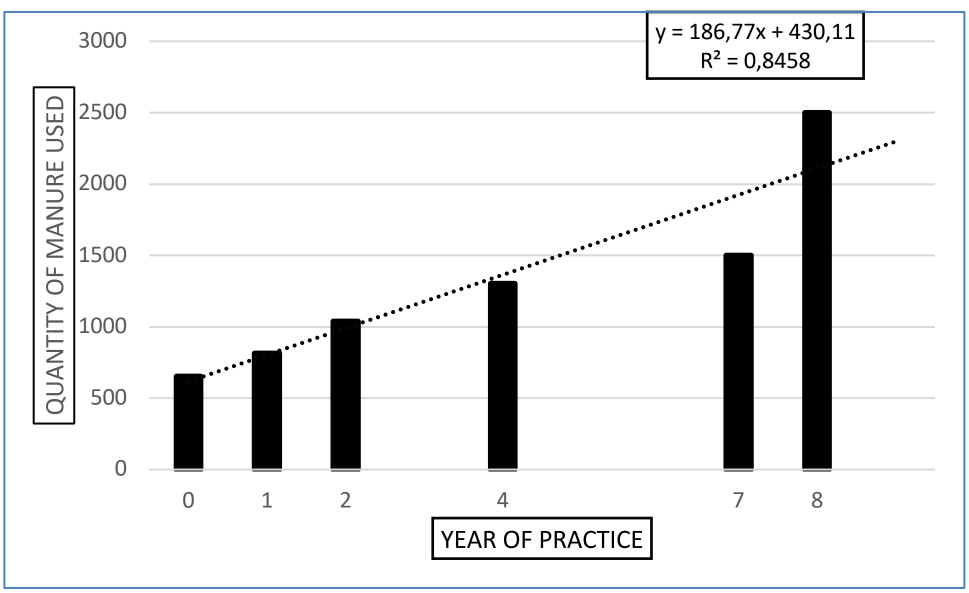



*Figure 8: Total Amount of Manure of Use by Year of Adoption*

### 6.12.2 Effects of DBF on Fertilizer Use

Chemical fertiliser is one of the most promoted technologies to provide nutrients to crops as a soil fertility technology. To find the effect of DBF on amounts of chemical fertiliser used, farmers were asked whether DBF helps the farmer reduce or increase the amount of fertilizer used, or there is no difference in amounts of fertiliser use. The frequencies of the responses results were converted to percentages and plotted according to the years the farmers have been using DBF. Figure 9 below is showing the effect of DBF on the fertilizer use among farmers adopting this practice.

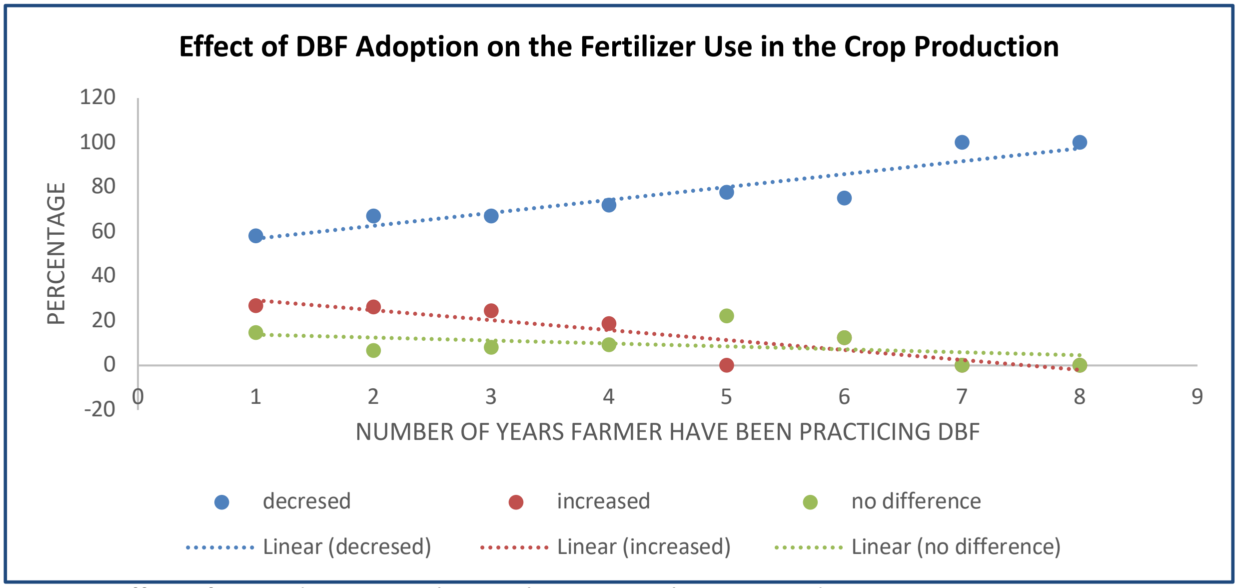



*Figure 9: Effect of DBF Adoption on the Fertilizer Use in the Crop Production*

In the figure above, there are three graphs: i.e. fertiliser use decreased (top line); fertiliser use increased (middle line); and fertilizer used did not change (bottom line). The graphs that show that fertilizer use decreases as its graph has the largest proportion of farmers and it keeps on rising with years in DBF. The other lines showing that there is no difference in fertilizer use or that DBF increased the use of chemical fertiliser drop to zero the more years the farmers practice DBF technology which means only one graph that fertilizer reduce remain. The means that fertiliser use decreases as years of DBF go by**.** When farmers start using the DBF system, they may use chemical fertilisers only in basal and top dressing. However, as time elapses they learn to make adequate manure to add to fertilisers at a rate of 1:5 (1 part fertiliser to 5 parts of manure).

## 6.13 Effect of DBF Farming on the Yield Crops

DBF farming increases the yields of maize, beans, Soya Beans, ground beans, ground nuts and sweet potato. It was found that almost all the crops that farmers tried to grow on DBF increased in yields compared to the current practice whether grains, legumes or root crops. In general the farmers reported that DBF increases the yields of various crops bcause only a few farmers said that DBF decreases yield or that there was no difference with other technologies.

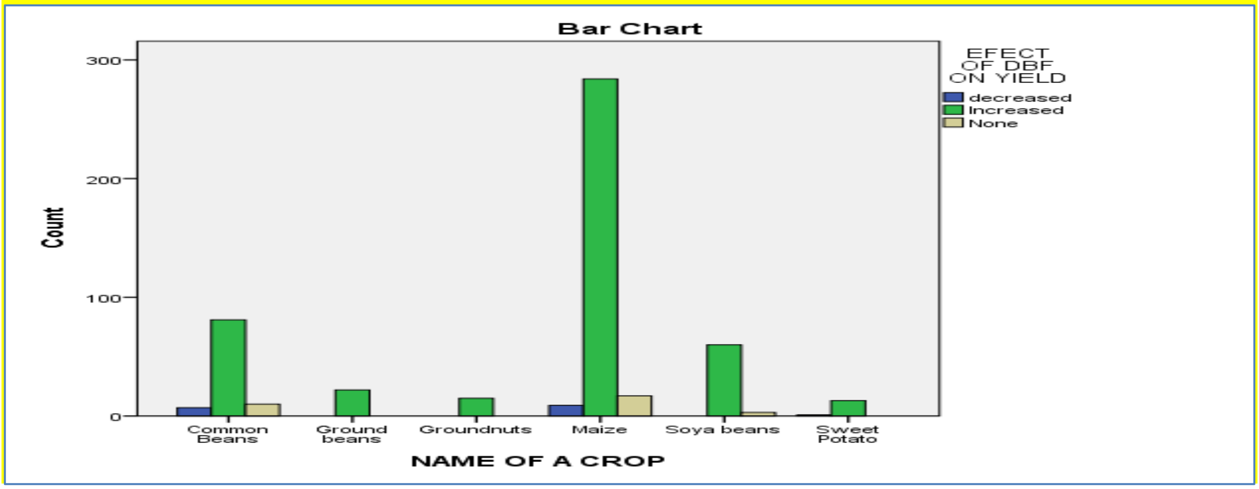



*Figure 10: Effect of DBF on Crop Yields*

In Table 18 it can be seen that 94% of the farmers said that DBF increases yield, 3% said it decreases yield and another 3% said it does not change anything. When asked by how much does the DBF farming increase yield: 1.5% said it increases yield by 150%, 28% said it gives 100% increase and 70% of those that said that DBF increases yield projected a 50% increase or more.

Table 18: Percent Change in Yield Due to the Effect of DBF Farming

| | | | PERCENT CHANGE IN YIELD BY DBF | | | | Total |
|---|---|---|---|---|---|---|---|
| | | | 0 % | 50 % | 100 % | 150 % | |
| EFECT OF DBF ON YIELD | decreased | Count | 0 | 11 | 3 | 1 | 15 |
| | | % within Effect | 0.0% | 73.3% | 20.0% | 6.7% | 100.0% |
| | | % of Total | 0.0% | 2.2% | .6% | .2% | 3.0% |
| | Increased | Count | 0 | 332 | 134 | 7 | 473 |
| | | % within Effect | 0.0% | 70.2% | 28.3% | 1.5% | 100.0% |
| | | % of Total | 0.0% | 66.0% | 26.6% | 1.4% | 94.0% |
| | None | Count | 15 | 0 | 0 | 0 | 15 |
| | | % within Effect | 100.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| | | % of Total | 3.0% | 0.0% | 0.0% | 0.0% | 3.0% |
| Total | | Count | 15 | 343 | 137 | 8 | 503 |
| | | % within Effect | 3.0% | 68.2% | 27.2% | 1.6% | 100.0% |
| | | % of Total | 3.0% | 68.2% | 27.2% | 1.6% | 100.0% |

Table 19 shows the effect of DBF on individual crops: 82.7% said DBF increase common beans; 91.6% reported yield increase on maize; 92.9% reported yield increases on Soya Beans; 100% of respondents reported yield increases ground beans and ground nuts; and 92.9% said DBF farming increases yield of sweet potato. It however should be noted that the number of farmers that responded on ground beans ground nuts and sweet potato were less than 30.

Table 19: Effect of DBF Farming on Crop Yields

| | | | EFECT OF DBF ON YIELD | | | Total |
|---|---|---|---|---|---|---|
| | | | Decreased | Increased | None | |
| NAME OF A CROP | Common Beans | Count | 7 | 81 | 10 | 98 |
| | | % % within A CROP | 7.1% | 82.7% | 10.2% | 100.0% |
| | Ground beans | Count | 0 | 22 | 0 | 22 |
| | | % % within A CROP | 0.0% | 100.0% | 0.0% | 100.0% |
| | Groundnuts | Count | 0 | 15 | 0 | 15 |
| | | % within A CROP | 0.0% | 100.0% | 0.0% | 100.0% |
| | Maize | Count | 9 | 284 | 17 | 310 |
| | | % within A CROP | 2.9% | 91.6% | 5.5% | 100.0% |
| | Soya beans | Count | 0 | 60 | 3 | 63 |
| | | % within A CROP | 0.0% | 95.2% | 4.8% | 100.0% |
| | Sweet Potato | Count | 1 | 13 | 0 | 14 |
| | | % within A CROP | 7.1% | 92.9% | 0.0% | 100.0% |
| Total | | Count | 17 | 475 | 30 | 522 |
| | | % within A CROP | 3.3% | 91.0% | 5.7% | 100.0% |

## 6.14 Total Income Contribution by the Various Sources to Farmers Practicing DBF

Apart from improving the food security of farmers in the country, Tiyeni also considers yearly income of their clients as a priority. By the end of the growing season, what really matters, apart from the food, is the yield that can be converted from their production into cash. Figure 11 below shows the 2017 annual total income from the various sources. This income was calculated by summing up all the income according to the various sources. It is shown that crops as a category contribute the largest amount of cash to the income of the communities followed by livestock but the category of other income sources such business and employment contribute very little into the communities. The five main sources of income in decreasing order are tobacco, common beans, cattle, pigs and maize. Tiyeni provides support in three of these main income sources namely common beans, pig production and maize show that the impact of Tiyeni can be appreciated.

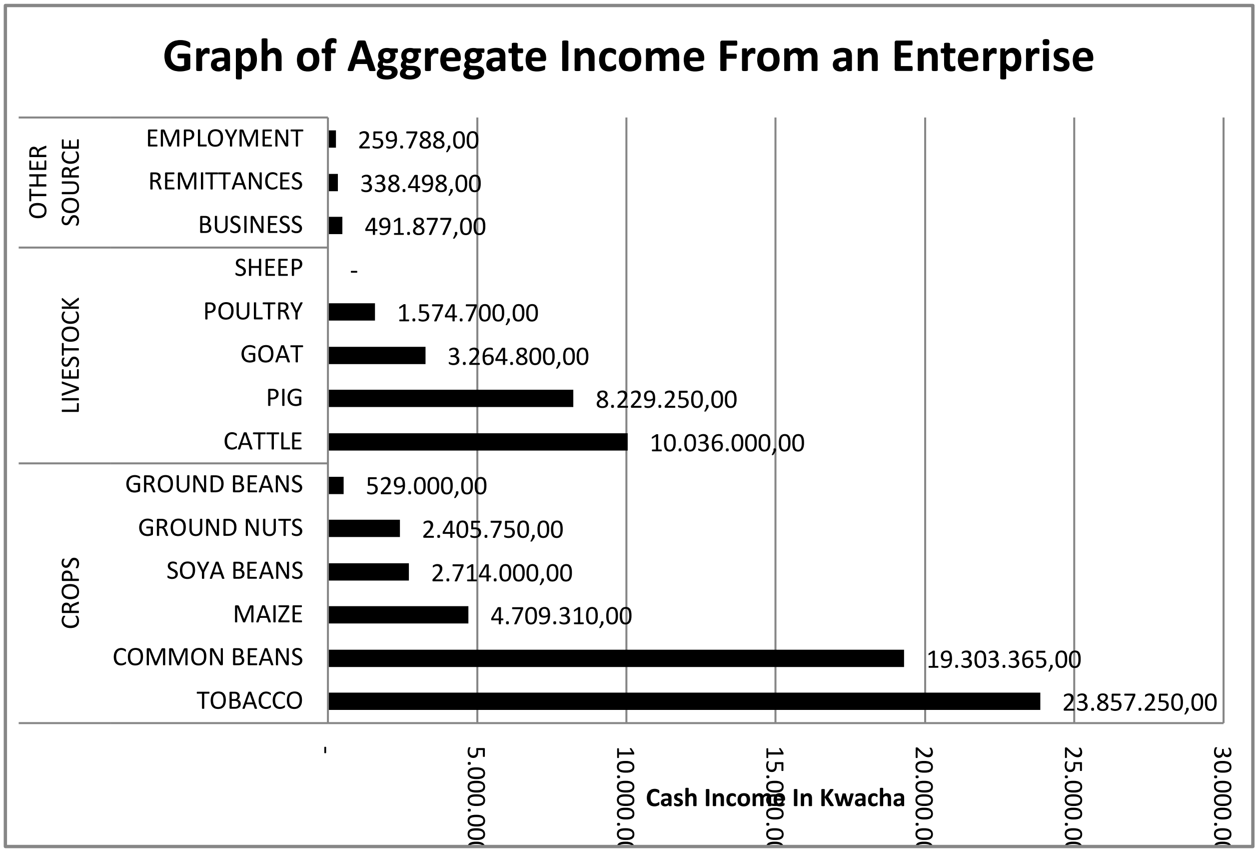



*Figure 11: Total Income Contribution by the Various Sources to Farmers Practicing DBF*

### 6.14.1 Annual Income Receive From Various Enterprises by Farmers Practicing DBF

The annual income from an enterprise is the mean of total cash incomes farmers received from that enterprise. When a graph of the mean of total incomes was plotted it was noted that individual farmers get very high income from tobacco (MK1,200,000), followed by income from businesses (MK500,000, remittances (MK400,000), employment (MK305,000), cattle (MK313,000) and pigs (MK146,000). However crops like common beans and maize contribute in small amounts to per capita income. The flattening of the mean of income from common beans and maize shows the importance of such crops to many farmers shown by the very high income as aggregates.

The average income contribution of below K100,000 per year the farmers basket is just above the cost of variable costs (MK23,000 per bag for two bags fertilizer an acre and MK15,000 for hybrid seeds). This shows that farmers are operating in losses in many crops when labor for cultivation, application of inputs, transportation and harvesting are factored in.

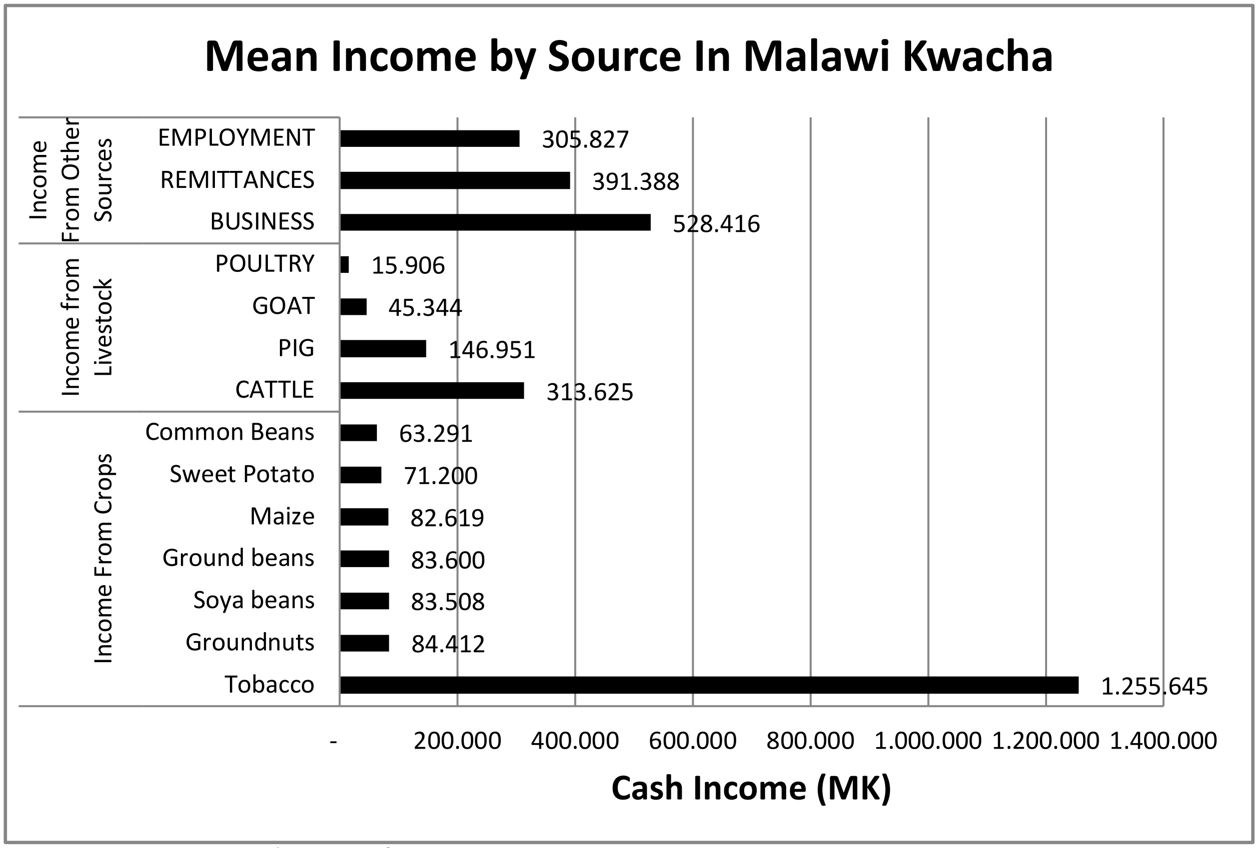



*Figure 12 Mean Annual Income from Various Enterprises Various Sources*

### 6.14.2 Aggregate House Income of DBF Farmers in Malawi Kwacha

To assess the impact of DBF on household income, data from the various enterprises were aggregated for each farmer and the means of these aggregated household incomes have been plotted in a graph as shown in Figure 13. The graph shows that there is an income increase starting with the first year of DBF farming. The graph shows a trend-line which increases with the years the farmers have practiced DBF. Using this trend-line, it can be shown that annual household income increases from MK500,000 to more than MK800,000.

This increase in annual income value is due to the increasing annual yields since DBF doubled their gross yield from the conventional way of establishing their crops. Tiyeni also promotes pig production which has a very significant contribution to house income. Since DBF farming promotes substitution of purchased inorganic fertilizers with manure at the ratio of 1 parts fertilizer to 5 parts manure, house income is expected to increase further due to reduced input expenditure. DBF also promotes minimum tillage starting with the second year after making beds hence reduced labor cost in subsequent years are another addition to income. Also DBF promotes early planting and such farming promotes cultivation where crops out grow weed and this reduces weeding expenses.

The bar graph however also shows a deep for the farmers that have practiced DBF 4 years to 7 years. This can be explained with further focused studies.

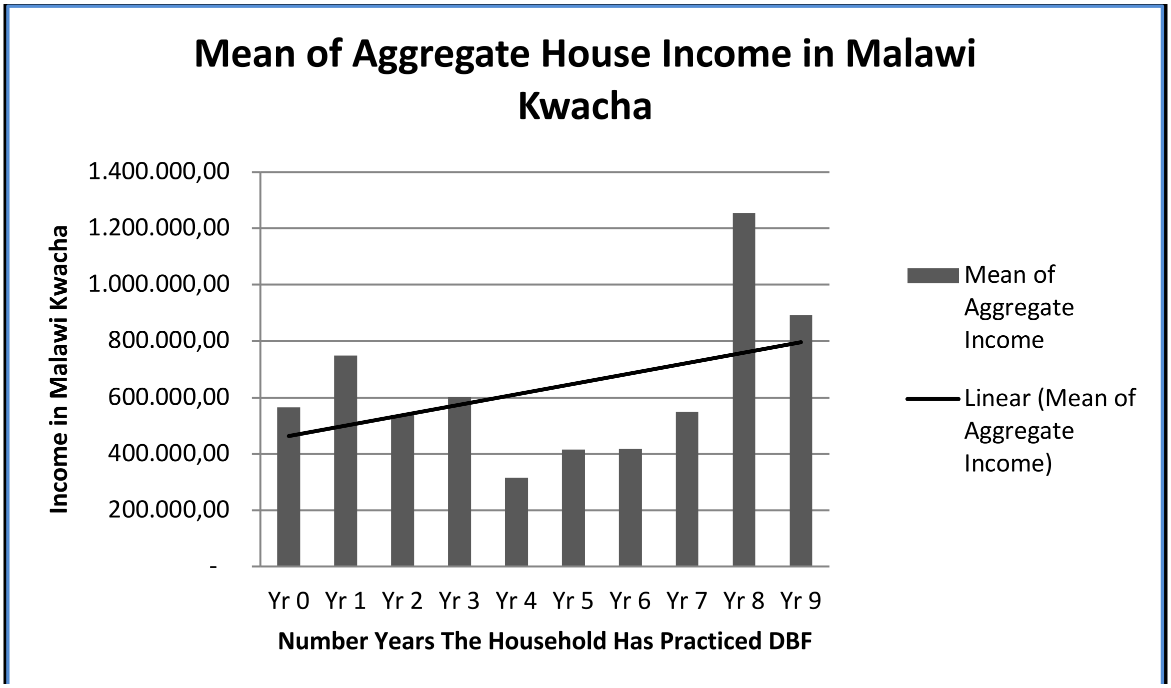



Figure *13: Mean Aggregate House Income in Malawi Kwacha*

## 6.15 Food Security

Food Security, '*exists when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life'* (FAO, 2009 http://www.fao.org/cfs/en/). There are multiple dimensions to food security as the definition suggests, one of them being food access. Food insecurity is one of major problems facing smallholder farmers in Malawi that Tiyeni is also addressing. Therefore a change in the indicators of food security/insecurity is an important way to show the improvement/change of farmers' livelihood.

### 6.15.1 The Number of Months that Maize Take to Last

The Figure 14 below shows that how long it takes for the maize that the farmers harvested to finish. It shows that farmers that are practicing DBF have a better outlook of maize availabliy as there graph is above those on conventional ridge after 12 months. The depressed pick of the DBF graph shows that food availability in the communities is being redefined by DBF farming which is pushing forward households that used to run out of maize by 8-10 months. This meaning DBF is extending food availability however each group has about 25% of farmers still running out of maize within 7 month of harvest.

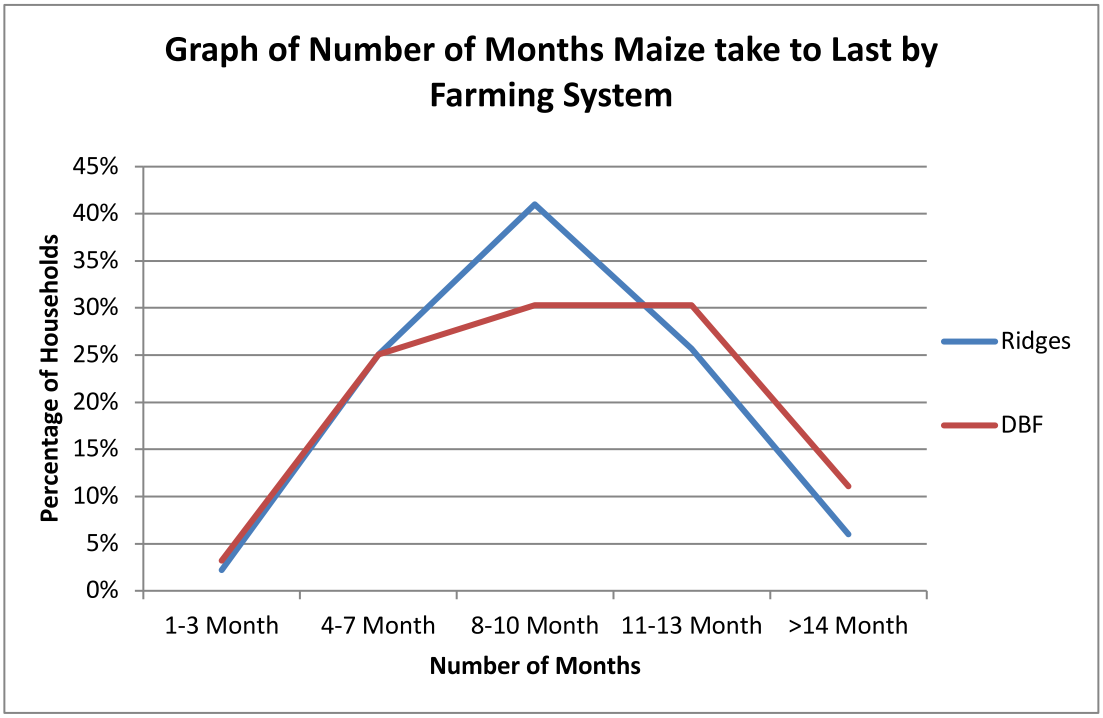



*Figure 14: Number of Months the Maize Last*

### 6.15.2 Meals The Farmers Eat Per Day:

One of the questions that were asked as a proxy to food security was how many meals the farmers eat per day.

**Table 20: Meal in The Lean Period**

| number of meals taken during lean periods | Freq. | Percent | Cum. |
|---|---|---|---|
| 1 | 95 | 17.63 | 17.63 |
| 2 | 299 | 55.47 | 73.10 |
| 3 | 145 | 26.90 | 100.00 |
| Total | 539 | 100.00 | |

**Table 21: Meal in The Period of Plenty**

| number of meals taken during periods of plenty | Freq. | Percent | Cum. |
|---|---|---|---|
| 1 | 2 | 0.36 | 0.36 |
| 2 | 138 | 24.69 | 25.04 |
| 3 | 411 | 73.52 | 98.57 |
| 4 | 6 | 1.07 | 99.64 |
| 5 | 2 | 0.36 | 100.00 |
| Total | 559 | 100.00 | |

It was found that farmers change the frequency of meals depending on the season. They eat many meals during the period of plenty but fewer meals per day during the thin/lean periods (Tables 19 and 20). During the period of plenty they eat at least 3 meals per day (75% of the farmers) while 73% of the farmers said that during the lean period eat they less than 3 meals per day and worse still 17% of the farmers eat only one meal per day.

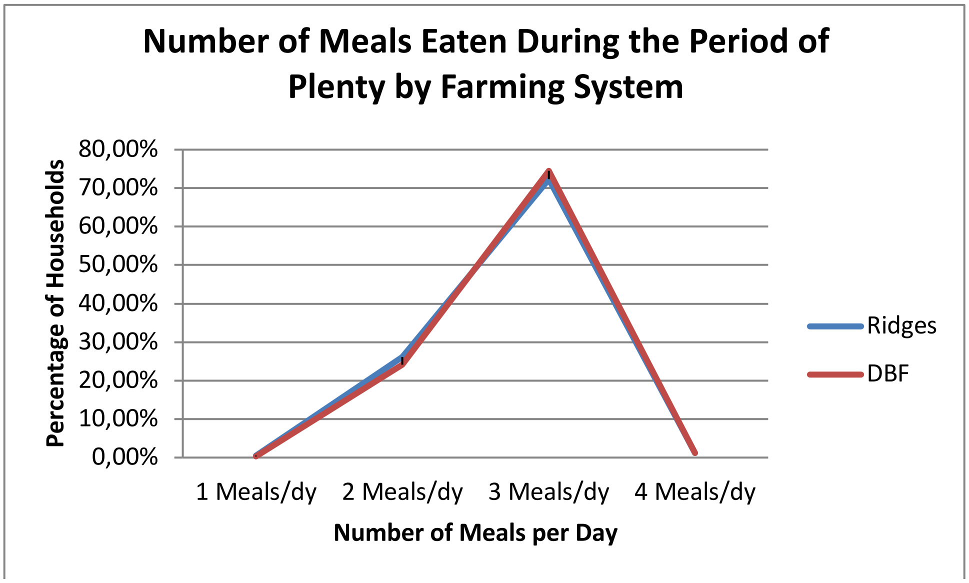



*Figure 15: Graph of Number of Meals Eaten During the Period of Plenty by Farming System*

Figure 15 show that during the period of plenty the households eat almost the same way whether in DBF or conventional ridges. But during the lean period Figure 16 more houses in the conventional ridge eat two meals per day while more farmers in the DBF farming eat 3 meals (more) per day. Figure 16 shows that DBF farmers have better food security than conventional ridges farmers.

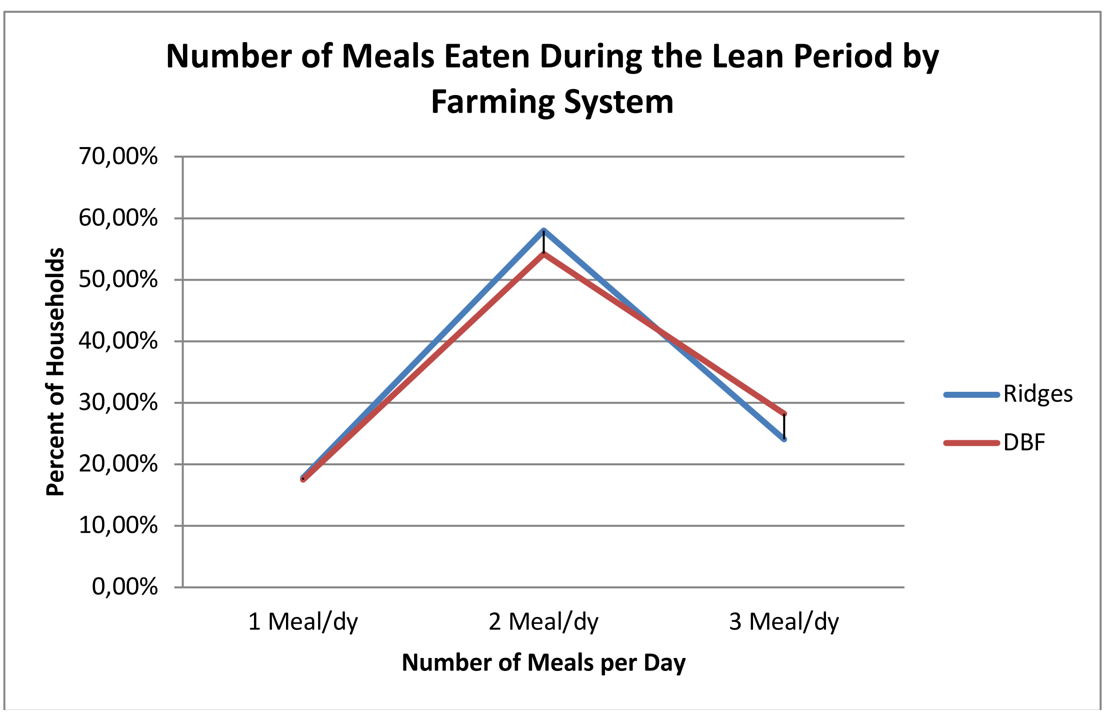



*Figure 16: Graph of Number of Eaten Meals During the Lean Period by Farming System*

### 6.15.3 Food Insecurity Experience Scale (FIES) (The Rasch Model).

The one-parameter logistical model was run and it shows that we had significant results giving a coefficient of 3.355086 at a *P*-value of 0.00 and also most questions were highly significant. This means that our results are credible.

Table 22: The Rasch Model

One-parameter logistic model

| | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Discrim | 3.355086 | .1887141 | 17.78 | 0.000 | 2.985213 | 3.724959 |
| Diff | | | | | | |
| FIES_2 | -.4908438 | .0622662 | -7.88 | 0.000 | -.6128834 | -.3688043 |
| FIES_3 | -.4347256 | .0612401 | -7.10 | 0.000 | -.554754 | -.3146972 |
| FIES_5 | -.2772468 | .0591194 | -4.69 | 0.000 | -.3931187 | -.1613749 |
| FIES_1 | -.2294728 | .0586867 | -3.91 | 0.000 | -.3444966 | -.1144489 |
| FIES_4 | -.0615963 | .0578953 | -1.06 | 0.287 | -.1750691 | .0518764 |
| FIES_6 | .058815 | .057993 | 1.01 | 0.311 | -.0548493 | .1724792 |
| FIES_7 | .1913029 | .0587075 | 3.26 | 0.001 | .0762383 | .3063674 |
| FIES_8 | .7815717 | .0696495 | 11.22 | 0.000 | .6450611 | .9180822 |

The entire dataset had 560 observations but 533 observations had complete data on the FIES questions. All cases with any missing responses were omitted to fit with assumptions of measurement in the Rasch model. The questions in the FIES are arranged in terms of their level of severity in food insecurity. There are four levels used to classify food insecurity and these are: food secure, mild food insecurity, moderate food insecurity and severe food insecurity. To define the classes of food insecurity, say of "moderate" and of "severe" levels of food insecurity, their two thresholds would be used. The threshold "moderate food insecurity" (lower bound of the range of severity) corresponds to the condition of a household that has a 50% probability of reporting to have been forced to eat less than they should eat, due to lack of money or resources (i.e. the severity of question FIES_5). Similarly, the lower bound of the "severe" range corresponds to the situation of a household that has a 50% probability of reporting to having gone a whole day without eating (i.e. the severity of question FIES_8) (Ballard, T.J., Kepple, A.W., & Cafiero C., 2013). By running the Rash Model we analyzing each household and get a raw score which shows whether that household is food secure or not.

Table 23: gives the frequencies raw scores characterizing different households. Respondents with a raw score of 0 will be characterized as being food secure (16.67%), those with a raw score of 1-2 will be mildly food insecure (9.86%+9.32%), those with a raw score of 3-7 will be moderately food insecure (7.17%+8.78%+8.24%+8.78%+13.26%), and those with a raw score of 8 will be severely food insecure (17.92%).

Table 23: The Raw Scores From FIES Questions

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. tabulate FIES
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| Raw score of FIES questions | Freq. | Percent | Cum. |
|---|---|---|---|
| 0 | 93 | 16.67 | 16.67 |
| 1 | 55 | 9.86 | 26.52 |
| 2 | 52 | 9.32 | 35.84 |
| 3 | 40 | 7.17 | 43.01 |
| 4 | 49 | 8.78 | 51.79 |
| 5 | 46 | 8.24 | 60.04 |
| 6 | 49 | 8.78 | 68.82 |
| 7 | 74 | 13.26 | 82.08 |
| 8 | 100 | 17.92 | 100.00 |
| Total | 558 | 100.00 | |

By analyzing Raw Scores we draw the levels of food security for the farmer. Table 23 shows the distribution of food insecurity levels from all the farmers that were interviewed. It shows that only 16.67% of the farmers are food secure.

Table 24: The Distribution of Food Insecurity Levels Amongst All Farmers

| FIESCALE | Freq. | Percent | Cum. |
|---|---|---|---|
| Food Secure | 93 | 16.67 | 16.67 |
| Mildly Food Insecure | 107 | 19.18 | 35.84 |
| Moderately Food Insecure | 258 | 46.24 | 82.08 |
| Severely Food Insecure | 100 | 17.92 | 100.00 |
| Total | 558 | 100.00 | |

The table above is a summary of how all the interviewed farmers distributed were along the scale of food insecurity.

The food insecurity levels were then analyzed according to how many years the farmer has practiced DBF. The assumption was that DBF improves food security and the results are shown in the table below.

Table 25: The Distribution of Food Insecurity Levels Amongst Farmers Who Never Practiced DBF

| FIESCALE | Freq. | Percent | Cum. |
|---|---|---|---|
| Food Secure | 25 | 13.59 | 13.59 |
| Mildly Food Insecure | 32 | 17.39 | 30.98 |
| Moderately Food Insecure | 83 | 45.11 | 76.09 |
| Severely Food Insecure | 44 | 23.91 | 100.00 |
| Total | 184 | 100.00 | |

Table 24 shows that farmers that have never practiced DBF. It acts like the baseline of the farmers in the sample areas. Only 13.59% are food secure, 17.39% of the households are mildly food insecure, 45.11% are moderately food insecure and23.91% of the households are severely food insecure. It shows that this group of farmers are less food secure because against the whole group of farmers we see a drop in the food secure households from 16.67% to 13.59% and an increase in the severely food insecure households from 17.92% to 23.91%.

Table 26: Levels Food Insecurity Amongst Farmers who practiced DBF for one year

| FIESCALE | Freq. | Percent | Cum. |
|---|---|---|---|
| Food Secure | 26 | 14.29 | 14.29 |
| Mildly Food Insecure | 35 | 19.23 | 33.52 |
| Moderately Food Insecure | 86 | 47.25 | 80.77 |
| Severely Food Insecure | 35 | 19.23 | 100.00 |
| Total | 182 | 100.00 | |

In Table 25 which shows food insecurity for farmers who have practiced DBF for one year we see that food insecurity starts to drop slowly compared with to Table 24

Table 27: Levels Food Insecurity Amongst Farmers who practiced DBF for at least 2 years

| FIESCALE | Freq. | Percent | Cum. |
|---|---|---|---|
| Food Secure | 42 | 21.88 | 21.88 |
| Mildly Food Insecure | 40 | 20.83 | 42.71 |
| Moderately Food Insecure | 89 | 46.35 | 89.06 |
| Severely Food Insecure | 21 | 10.94 | 100.00 |
| Total | 192 | 100.00 | |

Table 26 in which farmers have practiced at least 2 years we see a significant drop in food insecurity. Only 10.94% households reported severe food insecurity and also those that reported that they are food secure rose to from 13.59% to21.88% showing that the more the farmers practiced DBF the more they became food secure.

Table 27: Levels Food Insecurity Amongst Farmers who practiced DBF for at least 6 years

| FIESCALE | Freq. | Percent | Cum. |
|---|---|---|---|
| Food Secure | 6 | 42.86 | 42.86 |
| Mildly Food Insecure | 2 | 14.29 | 57.14 |
| Moderately Food Insecure | 6 | 42.86 | 100.00 |
| Total | 14 | 100.00 | |

Table 27 above shows that, after 6 years of practicing DBF, there is no farmer in the severely food insecure category and those that are food secure have risen to 42.86% which is almost half of the farmers.

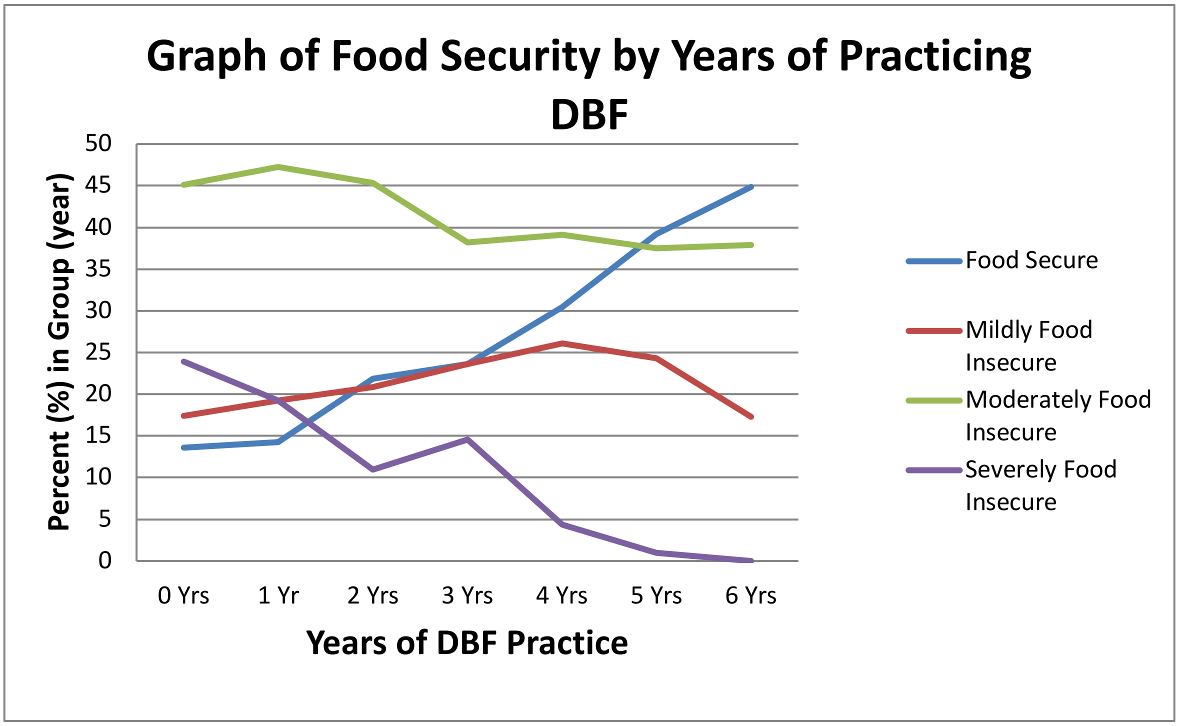


*Figure 17: Graph of Food Security by Years of Practicing DBF*

Graph 15 above was plotted by using the values food insecurity of the various years. It shows that there is steady decline in all levels of food insecurity (mild, moderate and severe). However with 6 years of DBF there is no more severe food insecurity thus eradication of hunger is sure with DBF.

## 7 CONCLUSION

The survey shows farmers start practicing DBF on small pieces of land of about 0.1ha and steadily increase the land sizes with time. It is possible for farmers to convert their whole endowment of land to DBF since about 14% said they will convert 100% of their land to DBF and close to 22% said they will convert 75%. The adoption rate of DBF is very high at about 400%.

The reasons that motivate farmers to adopt DBF are many and they include that DBF is used for almost all crops grains, legumes and root crops and it increases their yields. For maize it more than doubles its current yields. Because the farmers get a general yield increase from all crops it also increases their income. The most common sources of income to these farmers are maize and common beans and DBF increase the yield of both crops which are also grown as intercrops.

It can be concluded that DBF is one of the best Climate Smart Agricultural technologies at the current rate of technology adoption and benefits to the farmers.

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# APPENDIX 1. SURVEY QUESTIONNAIRE

**Note to Enumerator:**

*i. Explain the purpose of the survey,*
*ii. The approximate length of time it will last and request participation of the designated household.*
*iii. Interview should be with the head of household or principal decision maker.*
*iv. Completed questionnaires must be checked by the enumerator before submitting to the supervisor.*
*v. The supervisors should also check the questionnaire before being submitted to the Principal Investigator at the end of each day*

## Q1: Control Panel Identification

| | | |
|---|---|---|
| 1.1 Name of interviewer | | **For Official Use** |
| 1.2 Date of the interview | | *1.4 Name of data entry clerk* |
| 1.3 Name of supervisor after checking the questionnaire | | *1.5 Date data entry completed* |

## Q2: Household Identification

| **Indicator** | **Response** | **Indicator** | **Response** |
|---|---|---|---|
| 2.1 Name of Farmer | | 2.6 Centre/Group Name | |
| 2.2 GPS Coordinates of the Homestead | | 2.7 Section Name | |
| 2.3 Name of Household Head | | 2.8 EPA | |
| 2.4 Household head | Male = 1, Female = 2 | 2.9 District | |
| 2.5 Age of Household head in years | | | |
| | | | |

| Size of Household<br><br>**Name of HH Member** | **Male = 1, Female = 2** | **Age** |
|---|---|---|
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |

Q3: What is the amount of Land (land size) used for DBF? (Trend of 8 Years)

| Year of Cultivation | Total Land under cultivation (Ha) | Amount of Fertiliser used (Kg) | Portion of Land on Deep Bed (Ha) | Main Crop grown on DBF (and land size (Ha)) | 2nd Crop grown on DBF (and land size (Ha)) | 3rd Crop grown on DBF (and land size (Ha)) |
|---|---|---|---|---|---|---|
| 2017/18 | | | | | | |
| 2016/17 | | | | | | |
| 2017/16 | | | | | | |
| 2016/15 | | | | | | |
| 2015/14 | | | | | | |
| 2014/13 | | | | | | |
| 2013/12 | | | | | | |
| 2012/11 | | | | | | |
| 2012/10 | | | | | | |

Q4: What is the reason for this trend (increasing/static/decreasing) of use in Deep bed Farming.

| | |
|---|---|
| 1=DBF increases yield compared to conventional farming | |
| 2=DBF is not different to conventional methods | |
| 3=DBF leads to low yields | |
| 99=Others specify | |

Q5: How much of your land do you intend to convert/make to Deep Bed Farming?

| Proportion of the Land | 100% | 75% | 50% | 25% | 10% | Others Specify |
|---|---|---|---|---|---|---|
| *Yes=1, No=2* | | | | | | |
| *Comment* | | | | | | |

Q6: How has Deep Bed Farming affected your use of inorganic fertilisers?

| Method of Application | Effect of DBF<br>(*Increased=1, Decreased=2, None=3)* | Amount of Effect of DBF (if increase or decrease)<br>*By 75%=1, 50%=2, 25%=3 0%=4 Others specify=99* |
|---|---|---|
| Use in overall farming | | |
| Use Before Planting | | |
| Use in Basal dressing | | |
| Use in Top dressing | | |

Q7: Crop produced by the Farmer in 2017/18 (last rainy season).

| 7.1 What crops were grown by the household in season 2017/18?<br>***Use crop codes*** | 7.2 Farming system<br>01= DBF; 02= Ridges; 03= Others specify | 7.3 Area cultivated (ha) | 7.4 Cropping system | 7.5 Used fertiliser<br>Yes=1, No=2 | 7.6 Used manure<br>Yes=1, No=2 | 7.8 Used Pest Management materials<br>Yes=1, No=2 | 7.9 Production in this season<br>***Indicate actual measure e.g. bags, baskets, basins, carts, etc*** | 7.10 Estimate kilogrammes per each unit of measure | 7.11 Total production in kilogrammes of crop |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
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***NB1: 1 ha=2.47acres, 1 acre =0.405 hectares, 1ha = 10000m$^2$, 1 m$^2$=0.0001hectares, 1 acre=405m$^2$***

**<u>Crop Codes</u>**
01 = Local maize; 02 = Composite maize; 03 = Hybrid maize; 04=Cassava; 05=Sweet potatoes; 06=Irish potatoes;
07 = Finger Millet, 08=Sorghum;
09 = Groundnuts; 10=Common Beans; 11=Soya beans, 12=Ground Beans
13 = Tobacco; 14=Cotton;
15 = Leaf Vegetables; 16=Tomato; 17=Onion; 18=Garlic; 19=Pumpkin; 999=Other (Specify)_________________________

**<u>Farming system:</u>** 01= Deep Bed Farming; 02= Ridges; 999= Others specify

**<u>Cropping system Code:</u>** 01= sole/monocropping; 02= intercropping; 03= relay cropping (*ulimi wamwela*); 04= Mixed cropping

Q8: Of which crops' overall yields (*DBF + Conventional*) has been changing due to DBF farming and by how much?

| Name of Crop | Effect of DBF<br>(*Increased=1, Decreased=2, None=3)* | Amount of Effect of DBF (if increase or decrease)<br>*By 150%=1, 100%=2, 50%=3 Others specify=999* |
|---|---|---|
| | | |
| | | |
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| | | |

Q9: What type of manure did you use in 2017/2018?

| Type of Manure | Pit | Bokashi | Chimato | Mbeya | Others Specify |
|---|---|---|---|---|---|
| Manure used<br>*Yes=1, No=2* | | | | | |
| Total amount used (Specify volume) | | | | | |
| Applied before planting *Yes=1, No=2* | | | | | |
| Applied in Basal dressing. (*fertiliser mixed=1, alone=2, none=3)* | | | | | |
| Applied in Top dressing. (*fertiliser mixed=1, alone=2, none=3)* | | | | | |

Q10: What crops are doing well due to use of DBF?

| Method of Manure Application | Maize | Beans | Ground Beans | Ground Nuts | Soya beans | Others Specify | Others Specify |
|---|---|---|---|---|---|---|---|
| Manure applied before planting | | | | | | | |
| Basal dressed. | | | | | | | |
| Top dressed. | | | | | | | |
| Others comments Specify | | | | | | | |

***Code:*** *Yield increased = 1, No Change noticed = 2, Yield decreased = 3, Not Applicable = 99*

**Q11: What soil related problems do you encounter in your field?**

| **Soil Problem** | **Rate of the problem**: | **Method used to address the problem** |
|---|---|---|
| Soil infertility | | |
| Soil erosion | | |
| Water logging | | |
| Nematodes | | |
| Witch-weed (*Kaufiti*) | | |
| Others Specify | | |
| Others Specify | | |

***Code:*** *1=Very Bad, 2=Bad, 3=Manageable, 4 low, 5= No Problem*

**Q12. Production costs of main crops during 2017/18 (last agricultural) season**

| 12.1 Crop (code 1) | 12.2 Area (ha) | 12.3 Land rent (MK) | 12.4 Seed | | 12.5 Fertilizer | | | 12.7 Pesticide Specify | | | 12.8 Ganyu (MK) | 12.9 Marketing (MK) | 12.10 Other Specify (MK) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Qty (kg) | Total Cost (MK) | Type (Code 2) | Qty (kg) | Total Cost (MK) | Type | Qty | Total Cost (MK) | | | |
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**Crop code (Code 1):**

01 = Local maize; 02 = Composite maize; 03 = Hybrid maize; 04=Cassava; 05=Sweet potatoes; 06=Irish potatoes;

07=Finger Millet, 08=Sorghum; 09=Groundnuts; 10=Common Beans; 11=Soya beans, 12=Ground Beans

13=Tobacco; 14=Cotton; 15=Leaf Vegetables; 16=Tomato; 17=Onion; 18=Garlic; 19=Pumpkin;

999=Other (Specify)________________________

**Code 2: Fertilizers:** 01=23:21:0+4S; 02=CAN; 03=Urea; 04=Compound Fertilizers; 05=Other (specify)__________________

**Pesticide Code (Code 3):** 01=Dithane; 02=Malathion; 03=Other (Specify)____________________________________

Q13: Crops sold by farm family. (Indicate if crops were harvested from the agricultural season of 2017/2018 or of 2016/17)

| 13.1 What crops were sold by the household from their harvest?<br>*(Use crop codes)* | 13.2 Indicate the season of harvest?<br>2017/2018 =1<br>2016/2017=2 | 13.3 Specify units of sale for each crop.<br>***Indicate actual measure e.g. bags, baskets, basins, carts, etc*** | 13.4 Price per unit of sale<br>(MK/kg) | 13.5 Estimate kilogrammes per each unit of sale measure | 13.6 Calculate Total Revenues (Kwacha) from these sales |
|---|---|---|---|---|---|
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**Crop Codes**

01 = Local maize; 02 = Composite maize; 03 = Hybrid maize; 04=Cassava; 05=Sweet potatoes; 06=Irish potatoes;
07=Finger Millet, 08=Sorghum;
09=Groundnuts; 10=Common Beans; 11=Soya beans, 12=Ground Beans
13=Tobacco; 14=Cotton;
15=Leaf Vegetables; 16=Tomato; 17=Onion; 18=Garlic; 19=Pumpkin; 999=Other (Specify)________________________

Q14. Where do you sell your crop produce, how far are the selling points from your house, and what were the costs of transportation for the produce last season (2017/18)?

| 14.1 Crop produce<br>(Code 1) | 14.2 Market<br>(Code 2) | 14.3 Distance<br>(km) | 14.4 Mode of transport to the market (Code 3) | 14.5 Cost of transport<br>(MK) |
|---|---|---|---|---|
| | | | | |
| | | | | |
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**Crops (Code 1):**

01 = Local maize; 02 = Composite maize; 03 = Hybrid maize; 04=Cassava; 05=Sweet potatoes; 06=Irish potatoes;
07=Finger Millet, 08=Sorghum; 09=Groundnuts; 10=Common Beans; 11=Soya beans, 12=Ground Beans
13=Tobacco; 14=Cotton; 15=Leaf Vegetables; 16=Tomato; 17=Onion; 18=Garlic; 19=Pumpkin;
999=Other (Specify)________________________

**Market (Code 2)**

01= ADMARC; 02=Local market; 03=Scheme Management; 04=Private traders; 05=Direct export; 06=Farm gate; 07=Other (specify)________________________

**Mode of Transport (Code 3)**

01 = on foot, 02 = own bicycle, 03 = hired bicycle, 04 = privately owned vehicle, 05 = public vehicle transportation, 06= boat

**Q15. What are your sources of market information for both farm inputs and crop produce? (Multiple responses are possible, please report starting with most importance in order of importance)**

| Market for | Source of market information (Code 1) |
|---|---|
| 15.1 Farm inputs | |
| 15.2 Crop produce | |

**Code 1 – Source of information**

01=Friends/relatives; 02=Radio; 03=Extension Agent; 04=Traders; 05=Cell Phone; 06= Other (specify)__________________

## Q16. Household income

What are your priority sources of income and what is the income estimate from these sources for the last 12 months? PLEASE PROVIDE TOTAL FOR THE WHOLE HOUSEHOLD. ADD FOR EACH MEMBER OF THE HOUSEHOLD IF MORE THAN ONE HOUSEHOLD MEMBER OBTAINS THAT INCOME. *(Ask for each source one at a time and if the household does not get income from that source, move to the next)*

| 16.1 Income source | 16.2 Do you get income from this source<br>Yes=1<br>No=0 | 16.3 How regularly do you get income from this source Code1 | 16.4 What is the estimated amount that you have got from this source in the last 12 months (MK) | 16.5 What importance would you give this source of income in terms of contributing to total household income Code2 |
|---|---|---|---|---|
| Sale of crops (irrigated) | | | | |
| Sale of crops (rain fed) | | | | |
| Sale of livestock | | | | |
| Sale of other products e.g. firewood, trees | | | | |
| Regular employment | | | | |
| Casual employment (agricultural related) | | | | |
| Artisan employment | | | | |
| Running own business | | | | |
| Remittances | | | | |

Code 1 ***Regularity of income source:*** *1=Do not get, 2=Occasionally, 3=Regularly 4=All the time*

Code 2 ***Importance of source****: 1=Not important, 2=Moderate importance 3=High Importance 4=Very High Importance*

Q17: Livestock kept by the household

| Livestock | *Number of* | *How acquired* | *How much manure used from the animal 2017/18* | *Income generated by animal 2017/18* | *How income was generated* |
|---|---|---|---|---|---|
| Cattle | | | | | |
| Goats | | | | | |
| Pigs | | | | | |
| Sheep | | | | | |
| Poultry | | | | | |
| Others Specify (except pets like dogs and cats) | | | | | |

Q18. Farmer Training

| Indicate whether the Farmer received training on any of these listed subjects? | Response Yes=1, No=2 | Source of Extension message *Govt =1, Tiyeni =2, Others specify=999* | Frequency *1 = weekly, 2 = bi-weekly, 3 = monthly, 4 = rarely, 5 = never* | Availability of advice from government extension services. *Good =1, Fair = 2, Poor = 3, No extension advice = 4.* |
|---|---|---|---|---|
| **18.1** Crop husbandry, agronomy and productivity | | | | |
| **18.2** Environmental issues | | | | |
| **18.3**. Business farming | | | | |
| **18.4** Enterprise record keeping | | | | |
| **18.5** Integrated pest management | | | | |
| **18.6** Post-harvest handling | | | | |
| **18.7** Deep Bed making | | | | |
| **18.8** Deep Bed Maintenance | | | | |

Q19. How many months did your maize take to last previous season 2016/17(Kodi nanga chakudyachi chitenga/chinatenga nthawi yotalika bwanji chisanathe?) (put a line across month of harvest to when maize run out)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan16 | Feb16 | Mar16 | April16 | May 16 | Jun16 | Jul16 | Aug16 | Sept16 | Oct16 | Nov16 | Dec16 |
| Jan17 | Feb17 | Mar17 | April17 | May 17 | Jun17 | Jul17 | Aug17 | Sept17 | Oct17 | Nov17 | Dec17 |

**Q20. What are your other sources of food in the household in order of importance?** (Kodi kwina komwe chakudya chimachokera ndi kuti kuwonjezera chomwe mumalima- mndondomeko yakufunikira kwake?)

_____________ _____________

_____________ _____________

_____________ _____________

_____________ _____________

(Buys from the Market=1, relations=2, government/NGO free handouts=3, food for work=4,)

Q21. How many meals do you take per day during period of plenty? (Kodi pa tsiku mumadya kangati chakudya nthawi yomwe chakudya ndi chambiri?) ____________________

Q22. How many meals do you take per day during lean period? (Kodi pa tsiku mumadya kangati chakudya nthawi yosowa chakudya?)_________________________________

Q23. Name coping mechanisms (in order of importance) in the household when food is finished **(Use codes).**

_____________ _____________

_____________ _____________

_____________ _____________

_____________ _____________

(Ganyu =1, food for work=2, food remittances=3, appeal for funds to relatives=4, selling firewood/charcoal=5, selling livestock=6, selling household belongings=7, eating wild fruits/roots/leaves=8, reducing number of meals per day=9, eating chitibu=10, Others Specify=99)

Q24. What are the main causes of food shortage for the household in order of importance? (Kodi zifukwa zomwe zimabweletsa kusowa kwa chakudya pa banja lanu ndi ziti-mndondomeko ya kufunikira kwake?)

_____________ _____________

_____________ _____________

_____________ _____________

(Festivities=1, large size family=2, theft=3, low production=4, overselling=5, natural disasters =6, Others Specify=99)

Q25. List reasons for losses of production, in 2017/18, in order of importance.

_____________

_____________

_____________

_____________

(Pests and diseases=1, Theft=2, Premature harvest=3, Others Specify=99)

Q26. What type of storage facilities do you use in order of importance? (Kodi njira zosungira mbewu zanu ndi ziti- mndondomeko ya kufunikira kwake?)

_____________

_____________

_____________

(Granary=1, bags=2, heaped in a room=3, Others Specify=99)

Q27. Main food crops stored and quantities stored

| **Row** | **27.2 Food** | **27.2 Has your household stored**<br><br>**1=Yes, 0=No** | **Quantities Stored (kgs)** | |
|---|---|---|---|---|
| | | | **27.3**<br><br>**May 2017- April 2018** | **27.4**<br><br>**May 18 to April 2019** |
| 1 | Maize | | | |
| 2 | Rice | | | |
| 3 | Cassava | | | |
| 4 | Leaf relish | | | |
| 5 | Other food (specify)…….. | | | |
| 6 | Other food (specify)…….. | | | |
| 7 | Other food (specify)…….. | | | |

**Q28: FOOD INSECURITY EXPERIENCE SCALE**

***Now I would like to ask you some questions about your food consumption in the last 12 months. During the last 12 MONTHS, was there a time when*:**

| Food Insecurity Question | Sure response | If not Sure |
|---|---|---|
| 28.1. You were worried you would run out of food because of a lack of money or other resources? | 0 = No<br>1 = Yes | 98 = DK (Do not Know)<br>99 = Refused |
| 28.2. You were unable to eat healthy and nutritious food because of a lack of money or other resources? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |
| 28.3. You ate only a few kinds of foods because of a lack of money or other resources? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |
| 28.4. You had to skip a meal because there was not enough money or other resources to get food? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |
| 28.5. You ate less than you thought you should because of a lack of money or other resources? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |
| 28.6. Your household ran out of food because of a lack of money or other resources? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |
| 28.7. You were hungry but did not eat because there was not enough money or other resources for food? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |
| 28.8. You went without eating for a whole day because of a lack of money or other resources? | 0 = No<br>1 = Yes | 98 = DK<br>99 = Refused |

Q29 Assets acquired by the household

| Name of Asset | Number of |
|---|---|
| Houses (Burnt brick thatch) | |
| Houses (Iron sheet) | |
| Bicycles | |
| Motorcycles | |
| Cars | |
| Radios | |
| Phones | |

**The End of the Interview – Thank You!!!!!**