Key climate change coping strategies used by smallholder farmers in Zambia

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Musika Development Initiatives

Foreword

This report was generated to serve as a reference document for Musika and its implementing partners. Musika Development Initiatives (Musika) is a non-profit company that works to stimulate private sector investment in rural agricultural markets. It does this by helping businesses develop mutually beneficial and transparent commercial relationships with smallholder farmers that integrate the provision of information and technology adoption, and provides long term incentives for farmers to invest in their farming businesses. It provides its clients with high quality, commercially focused technical advice and business model support, and were relevant smart subsidies to bring down the initial risks of doing business with the smallholder market. Musika also supports innovative market-based solutions to environmental issues and strives to ensure that women are key participants in improved agricultural markets. Musika acknowledges and appreciates the financial support from the Swedish Embassy in Lusaka.

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Acknowledgements

The authors would like to sincerely thank Indaba Agricultural Policy Research Institute (IAPRI) for organising the Rural Agricultural Livelihood Survey (RALS) from which the data used in this study was obtained. Many thanks also go to the Musika staff who took part in the entire exercise leading up to the collection of this data.

Executive Summary

In order to increase and sustain farmers' production, productivity, income and food security in the wake of climate change, various methods of production have been invented and published to counter effects of climate change. However, many farmers in rural areas do not get to have the resources needed to adopt some of these climate mitigation strategies. Various studies have shown the devastating effects of climate change on farmers and the nation at large as food is needed by all. Farmers have experienced the effects of droughts, floods, high temperatures etc. and have had to adapt to the current changes for survival. This study focused on finding out the techniques used by the farmers to mitigate against climatic hazards and how they access the information needed to fight climate change. The following were highlights of the study findings:

1. There was a general increase in occurrences in climate change hazards from 2015/16 to 2018/19

i. With the exception of Eastern province, all the provinces observed an increase in the number of drought occurrences. The most affected provinces in the 2017/18 season were Southern (98%), Western (96%), Lusaka (93%) and Central (78%).

ii. Drought had the largest effect on the smallholder households compared to floods with the exception of Muchinga and Northern which had most areas of their fields cultivated affected by floods more. Southern (85%), Western (72%) and Lusaka (72%) had the largest areas of the fields cultivated affected by drought.

iii. Over 50% of households in 7 out of 10 provinces experienced an increase in temperatures since 2015/16. On the other hand, over 75% of households from 6 out of 10 provinces experienced a decreased in the amount of rainfall they received since 2015/16.

iv. Because of climate change effects, it was observed from secondary data that quantity of crop produced for Maize, Soya beans and Groundnuts had reduced between 2017/18 and 2018/19. This was despite a general increase (or marginal decrease in the case of groundnuts) in the area planted.

2. Early planting was practised the most, however, there was low adoption of conservation tillage methods

i. Rural households ranked different strategies used in counteracting climate change in order of importance. Three categories were highlighted as either Most important, second most important, and third most important. The study found that Early *planting*, *changing the crop mix* and *having other income sources were the commonly used methods to counteract climate change across* all the provinces. *Early planting* was generally the most dominant strategy used by rural households in counteracting climate change.

ii. The majority of the 45% of households that received rainfall forecast information in all provinces had used this information to make agricultural decisions. Eastern (79%) and Southern (78%) province had the most households using rainfall forecast information to make agricultural decisions.

iii. Nationally, the most popular tillage methods are ploughing (34%) conventional hand hoeing (27%) and *Ridging* (24%). The minimum tillage methods were not popular, only a handful indicated *ripping* (2%) and *planting basins* (1%) as their most important tillage methods. Thus there is still limited adoption of conservation farming methods amongst smallholder farmers, and this is despite being touted as playing a key role in climate change mitigation.

iv. In terms of agroforestry, the analysis showed that households in Northern and Lusaka province had planted the most trees per hectare of cultivated fields. For instance, Northern Province planted 12,011 trees, followed by households in Lusaka which planted 9,959 trees per hectare of cultivated fields.

v. Excluding those that were indifferent, the majority of households were either somewhat prepared or extremely prepared for rainfall or temperature changes. About 39% were somewhat prepared and 18% were extremely prepared for rainfall changes, whereas 37% were somewhat prepared and 13% were extremely prepared for temperature changes.

3. Radio was the main medium of information access whereas MoA was the main supplier

i. The majority of households received weather information through the radio with Central (78%) having the highest number of households receiving information through such means. Radio remains the most popular mode of receiving agricultural information by rural households. This could also play a key role in delivering customized agricultural extension information, which could help farmers to receive and understand technical information on climate change.

ii. The main suppliers of this weather information were the Ministry of Agriculture (46%) and fellow farmers (15%) with only one private firm (COMACO) making the main suppliers list with 7%.

iii. Using phones to get weather information (11%) for use in agricultural decision making was the least used method amongst the majority of cell phone users. As expected, the majority of households used phones for their primary use – communication. Given that the majority of Zambians own mobile phones, this provides an opportunity for the private sector to use digital platforms for information provision. This platform remains underutilised.

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Abbreviations and Acronyms

CA	Conservation Agriculture
CT	Conservation Tillage
CFU	Conservation Farming Unit
COMACO	Community Markets for Conservation
DT	Drought Tolerant
ECA	Economic Commission for Africa
ERB	Energy Regulations Board
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GRZ	Government Republic of Zambia
ICT	Information and Communications Technology
IFRC	International Federation of Red Cross and Red Crescent Societies
Kg	Kilogram
IAPRI	Indaba Agricultural Policy Research Institute
MoA	Ministry of Agriculture
MoLNR	Ministry of Lands and Natural Resources
Musika	Musika Development Initiatives
PSU	Primary Sampling Unit
RALS	Rural Agricultural Livelihood Survey
SEA	Standard Enumeration Area
ZESCO	Zambia Electricity Supply Company
ZICTA	Zambia Information and Communications Technology Authority
ZNFU	Zambia National Farmers Union

1.0 Introduction

1.1 Background

Southern Africa has over the recent years seen an increase in extreme weather conditions such as droughts, dry spells, floods, erratic rainfall among others. All these are as a result of changes in the regions climate. There is no doubt anymore that climate change is real and that our climate is not the same as it was years ago (Kotir 2011, Zulu-Mbata and Chapoto 2018). Because the majority of rural households depend on agriculture for survival, effects of climate change are a serious adversary that they have to contend with. Failure to do so has many direct and indirect effects, with the most outstanding effects being reduced agricultural food production leading to acute hunger (Dejene et al. 2011). For instance, World bank (2019) projects that due to climate change, yields of key crops could decrease by 25% in 2050, depending on agro ecological zone.

Smallholder farmers in Zambia have not been exempted from climate change effects. These climatic hazards have affected the country from smallholder farmers at household level (Micro economy) to the nations GDP (Macro economy) (ECA n.d.). Zambia has seen a decrease in rainfall received, an increase in occurrences of dry spells and droughts and high temperatures. This is evident in the reduction in crop production in most parts of the country despite an increase in area planted for some crops in recent seasons as seen in the Crop Forecast Survey (CFS) results (MoA 2019). Because of these hazards, the nation has spent millions of Kwacha in relief food and necessities to affected households (GRZ 2019, GRZ 2020).

A lot needs to be done as a country to mitigate against climate change and one of the major things is disseminating accurate information to the farmers on how best they can cope with these extreme conditions without worsening the situation. Some of the suggested mitigation strategies are reduced deforestation, reforestation, carbon sequestration (specifically the promotion of use of compost manure), and improved cultivation techniques e.g. conservation tillage (FAO 2009, 2012). Most of the rural farmers in Zambia are poor and cannot afford to get out of poverty, which as of 2015 was at 54.4%, without increased agricultural productivity and improved access to markets(Zambia Statistics Agency, 2018). Some live in areas with no proper communications network, access to radio or TV and no phones. This tends to hinder them from accessing important agricultural related information such as weather forecasts and have to solely rely on the information from extension officers who visit them intermittently over a given period of time.

It is against this background that this study endeavoured to find out the key copying strategies used by smallholder farmers in the wake of climate change. The generation of such information could play a key role for agricultural stakeholders to devise interventions which could augment already adopted practices which help farmers cope with climate change. And in some instances, the availability of such information might call for a complete turnaround of intervention designs.

1.2 Specific Objectives

The specific objectives of this study were:

- To determine some of the effects of climate change that could be drawn from smallholder farmers.
- To identify the main practices that farmers were using to counteract climate change.
- To identify some of the main channels utilised by farmers to receive climate change information.

1.3 Methodology and Data

This study used data collected for the Rural and Agricultural Livelihood Survey (RALS) 2019 which was nationally representative.

The RALS is a panel survey that is carried out every three years and the 2019 RALS was the last wave of the first panel which started in 2012. The sampling frame for the first wave was based on the 2010 Census of Housing and Population. The first stage involved identifying the Primary Sampling Unit (PSU). The PSU was defined as one or more Standard Enumeration Areas (SEAs) with a minimum of 30 agricultural households. The SEA is the smallest area with well-defined boundaries identified on census sketch maps. At the second stage, all households in selected SEAs were listed and agricultural households identified. Listed agricultural households were then stratified into three categories, A, B, and C, on the basis of total area under crops; presence of some specified special crops; numbers of cattle, goats and chickens raised; and sources of income. Systematic sampling was then used to select 20 households distributed across the three strata in each SEA (IAPRI 2015).

A total of 7241 households were successfully interviewed for the 2019 RALS and this is the same number of households that was used for analysis in this study. A multivariate logistic regression model was used to determine factors affecting farmers' adoption of various climate mitigation strategies at household level for maize.

$$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

Where the left hand side expression [log (p / 1– p)] represents the log likelihood and **P** is the target or dependent variable, **β0** represents the constant or point of intercept on the graph when all independent variables (**Xi**) are equal to zero, **βi'**s are the coefficients of independent variables.

The dependent variable was whether or not a farmer used a conservation farming strategy or not. Since parameter estimates only show direction of association between regressors and regressands, discussions will instead focus on marginal effects for significant variables.

I. KEY FINDINGS:

A1. Demographic characteristics

Demographic characteristics give an in-depth picture of some factors that may have an effect on the outcomes or decisions of households in relation to various aspects of their livelihood. Table 1.1 below shows the demographic characteristics of this study sample. A total of 7,241 households were interviewed, the majority of which came from Eastern province (1,917 households). The average household size was 7 members with the household heads' average age being 52 years. The majority of the households interviewed were headed by a male (76%). The study also highlighted that Western province had the highest number of female (30%) headed households followed by the Copperbelt (27%). It was further highlighted that the majority of the household heads of the interviewed households were monogamously (65%) married, with the highest polygamous marriages recorded in Southern province. In trying to understand the effects it has on agricultural decisions, income and productivity, this study collected information on current education status of household heads and the highest levels attained. The study revealed that the majority of household heads had obtained primary (57%) school education seconded by Secondary education (27%). Luapula province had the highest number of household heads who had attended at least primary level of education, with just 6% having no education level or missing information. The study further highlighted that 5% of the household heads were still attending some form of school at the time of the interview.

Table 1. 1: Demographic characteristics

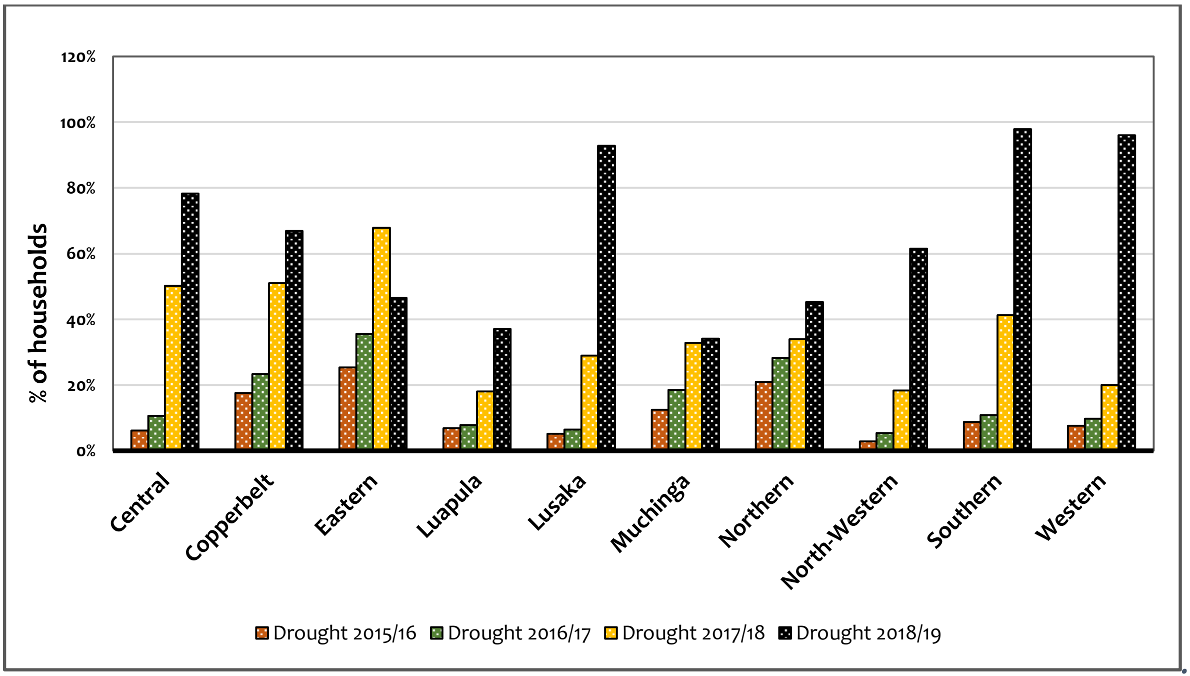
Characteristics	Total/Average	Central	Copperbelt	Eastern	Luapula	Lusaka	Muchinga	Northern	North-Western	Southern	Western
No. of Households	7241	566	502	1917	615	404	680	707	486	810	554
Household size	7	8	7	7	7	7	6	7	7	8	7
HH's Age	52	53	54	51	52	55	50	52	52	52	54
Sex HH head											
Male	76%	78%	73%	76%	77%	77%	76%	78%	77%	79%	70%
Female	24%	22%	27%	24%	23%	23%	24%	22%	23%	21%	30%
Marital status											
Never married	1%	1%	2%	1%	0%	2%	1%	0%	3%	1%	3%
Monogamous	65%	64%	68%	64%	71%	72%	64%	68%	69%	55%	63%
Polygamous	11%	12%	2%	13%	6%	1%	13%	10%	5%	25%	5%
Divorced	7%	7%	8%	7%	8%	6%	5%	6%	8%	6%	9%
Widowed	15%	16%	20%	14%	13%	16%	14%	14%	15%	12%	17%
Separated	1%	1%	1%	1%	1%	3%	3%	2%	1%	1%	3%
HH head's Education level											
Non/Missing	13%	9%	8%	21%	6%	13%	9%	11%	11%	9%	11%
Primary	57%	58%	55%	55%	62%	44%	58%	61%	57%	60%	58%
Secondary	27%	30%	33%	21%	26%	32%	30%	27%	26%	28%	27%
Tertiary	4%	2%	4%	2%	6%	11%	4%	2%	6%	3%	3%
Attending School	5%	2%	3%	4%	5%	5%	4%	5%	8%	4%	7%

Source: RALS 2019 and author's computations

A2. Effects of climate change on smallholder farmers

Climate change has made headlines over the years and for good reasons. In agriculture, it is for the negative effect it has had on smallholder farmers' productivity and high post-harvest losses it comes with (Kuteya et al. 2018). It is now common knowledge that the weather is not the same as it was years ago and studies have proven that this change in climate is due to various factors but mostly human activities that include pollution, indiscriminate cutting down of trees etc. Among the hazards climate change has induced are droughts, floods and extreme temperatures among others (FAO 2020). This study tried to identify the effects such changes caused by climate change had on smallholder farmers. As has been observed over the years, the study found that drought occurrences had generally been increasing from 2015/16 farming season to 2018/19 across all provinces with the exception of Eastern province which observed a reduction in drought occurrence in the 2018/19 season. Increased occurrences of droughts means reduced productivity and production, which in turn threaten household food security. The provinces most hit by droughts in the 2018/19 season were Southern (98%), Western (96%), Lusaka (93%) and Central (78%). These findings are consistent with what the International Federation of Red Cross and Red Crescent Societies (IFRC 2020) reported.

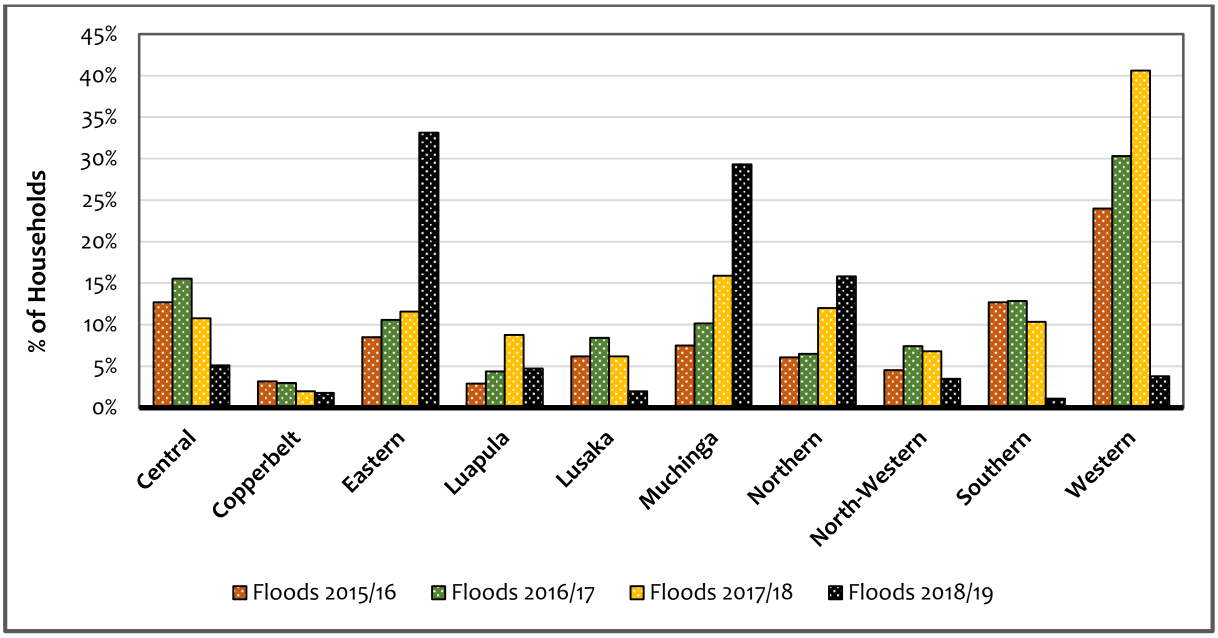
Figure 2. 1: Drought occurrences by agricultural season



Source: RALS 2019 and author's computations

Another aspect of climate change focused on in this study was floods. Over the past few years, some parts of Zambia have been reported to have experienced some floods in their agricultural fields, sometimes these areas experience both floods and droughts. The study showed that between 2015/16 and 2017/18 farming seasons, Western province was generally the most hit by floods, see figure 2.2. The 2018/19 season was an exception for Western province because as shown in figure 2.1 above, it was amongst the most hit by drought that season.

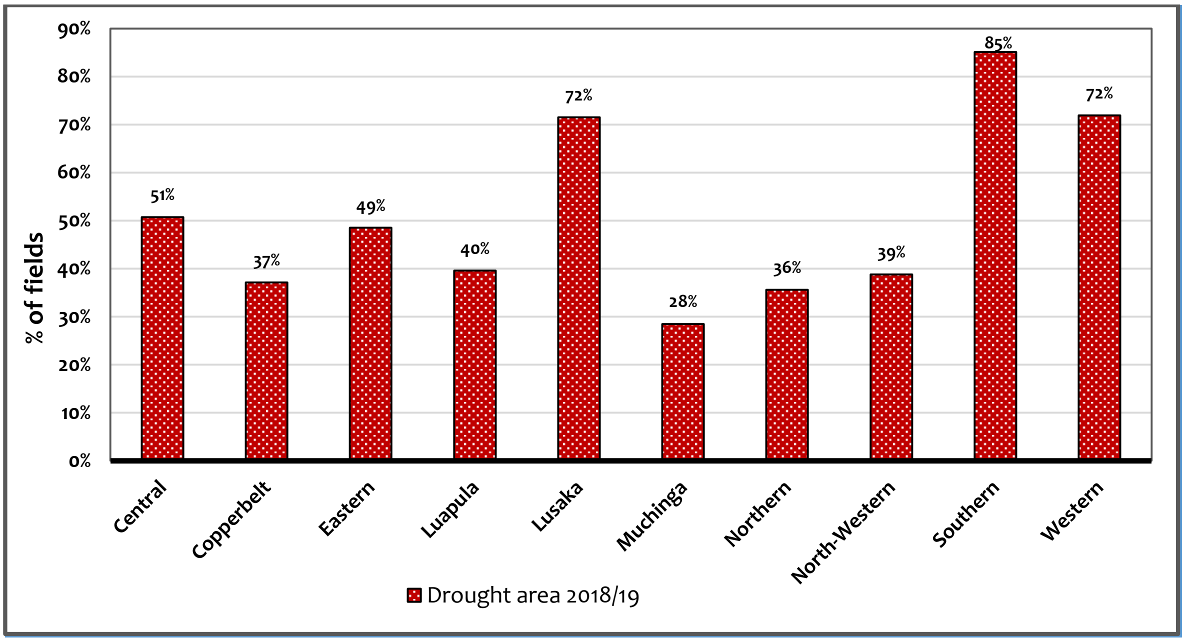
Figure 2. 2: Flood occurrences by agricultural season



Source: RALS 2019 and author's computations

The study showed that the majority of the provinces in the country were affected by drought in 2018/19 farming season with the exception of high rainfall provinces such as Luapula, Muchinga and Northern provinces. These provinces are in agro ecological zone III which receives the most rain in the country with mean annual rainfall of roughly 1200mm (Jain 2007). Other areas affected by floods were Eastern, Muchinga and Northern provinces, but none of these areas had households affected by floods as much as the number of households affected by droughts. The four provinces most affected by drought had the highest proportions of fields affected by the drought, with Southern, Lusaka and Western recording over 70% of their fields being affected, refer to figure 2.3. Such effects call for interventions by governments, and other stakeholders, to provide relief food to prevent people from suffering from acute hunger (GRZ 2019).

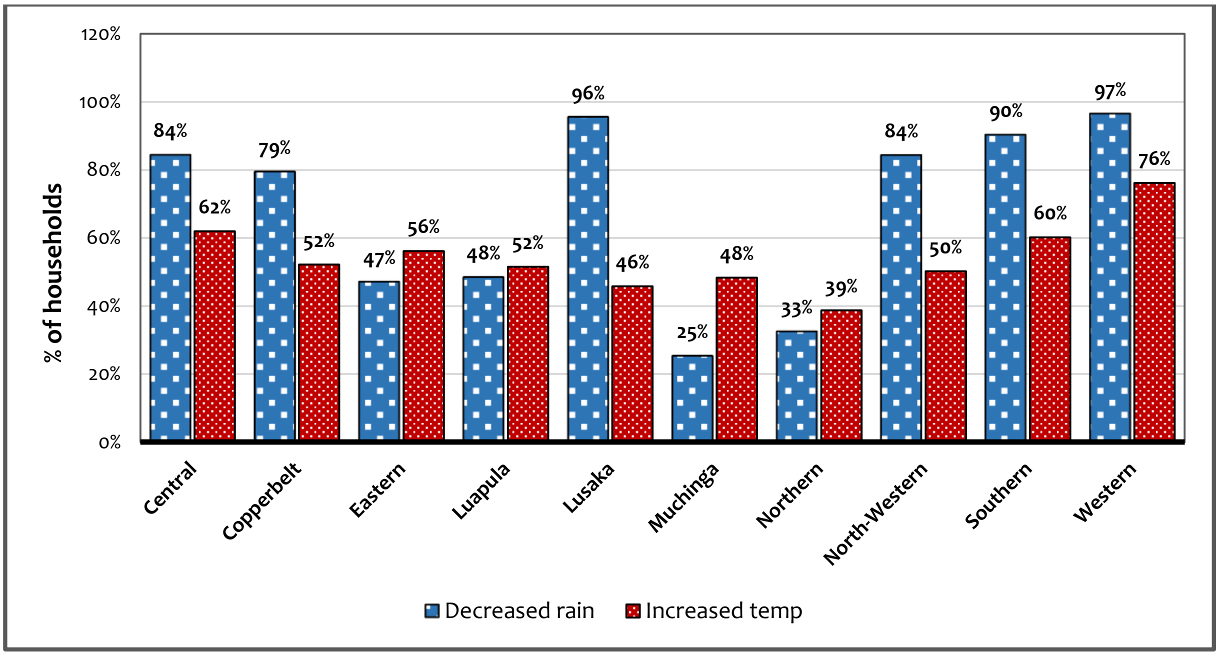
Figure 2. 3: Proportion of field affected by droughts



Source: RALS 2019 and author's computations

The interviewed households also highlighted the changes in average temperature and amount of rain received since the 2015/16 agricultural season. The majority from 6 provinces observed that there was a decrease in the amount of rain received, see figure 2.4. However, the majority in 4 provinces (Eastern, Luapula, Muchinga and Northern) which are in high rainfall zones observed either an increase in rainfall or no change since 2015/16 season. The premise is that there is less rainfall received now than 2015/16 so those that said same were technically saying they had not felt any impact of climate change since 2015/16 with regards to rainfall. Comparing the responses against themselves for Luapula and Eastern province, it was observed that there were more households observing a decrease in rainfall received compared to those that observed an increase or no change respectively. The only exceptions were Muchinga (50%) and Northern (41%) provinces which had more households that observed an increase in rainfall compared to those that observed a decrease or no change. It was further observed that there was generally an increase in temperatures since the 2015/16 agricultural season. This makes sense given the general increase in drought occurrences as observed by the trends in figure 2.1 above.

Figure 2. 4: Changes in temperatures and rainfall received



Source: RALS 2019 and author's computations

In order to illustrate the effect of droughts on smallholder farmers' production, the study compared production and area planted between 2017/18 and 2018/19 farming seasons. Both these years had experienced prolonged dry spells, with the worst dry spell experienced between the two being the 2018/19. Four crops of interest were selected and from the results, production went down by significant amounts despite the area planted increasing significantly or marginally reducing. The only exception was mixed beans which had an increase in both area planted and production by significant amounts. This may be due to the fact that the majority of mixed beans growers are in agro ecological zone III. In fact, 73% of the total area planted nationwide for mixed beans was from that zone. In support of this finding, a World Bank report (2019) projects that climate change might have a positive effect on crops such as barley, dry beans, cassava and rice but this could be contextualised by agro-ecological region. The 16% reduction in maize has been reported as being due to prolonged dry spells, one of many climatic hazards (Kaunda et al. 2020). Refer to figure 2.5.

Figure 2. 5: Crop production over the last two seasons

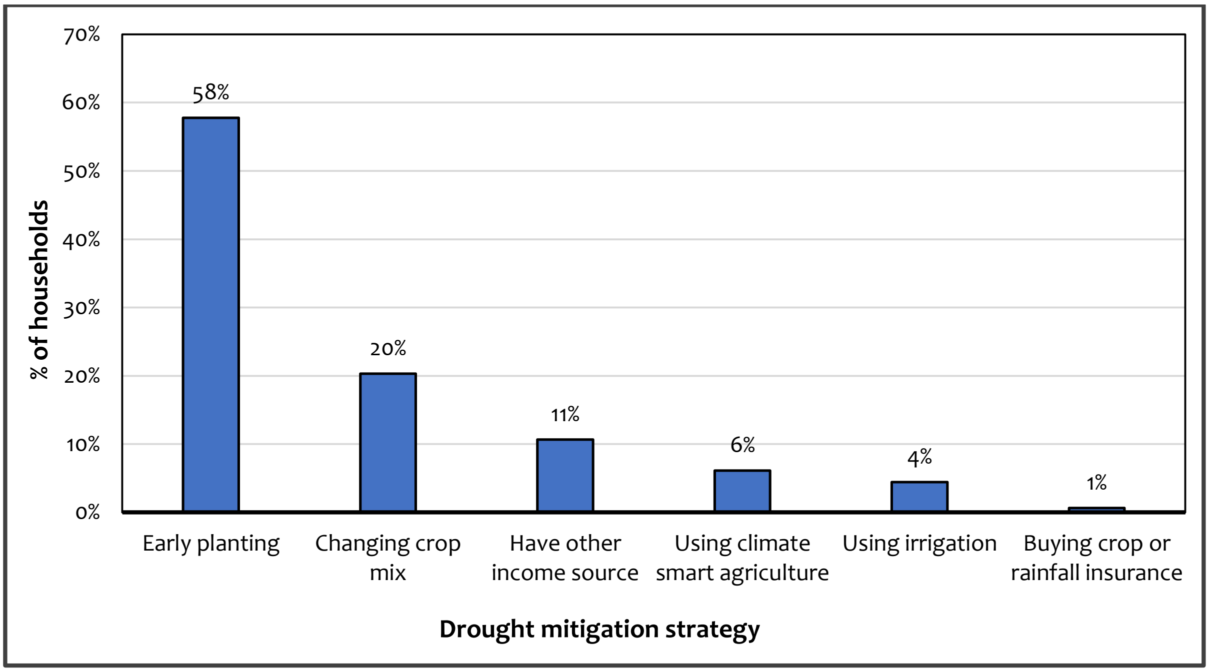
Crop	Characteristic	2017/18	2018/19	Difference (%)
Maize	Qty. Produced	2,394,907	2,004,389	**-16%**
	Area planted	1,392,546	1,557,314	**12%**
Soya beans	Qty. Produced	302,720	281,389	**-7%**
	Area planted	205,508	237,601	**16%**
Groundnuts	Qty. Produced	181,722	130,825	**-28%**
	Area planted	284,708	276,383	**-3%**
Mixed beans	Qty. Produced	52,351	58,705	**12%**
	Area planted	84,566	100,279	**19%**

Source: RALS 2019 and author's computations

A3. Main practices used by farmers to counteract climate change

Given the threat that climate change has on farmers' productivity, food security and income, it is only imperative that farmers find ways to mitigate against it. Drought is a hazard emanating from climate change that has over the years affected Zambian smallholder farmers more than any other climatic hazard. In this study, farmers were asked to state the top three strategies they could utilise to mitigate against drought according to importance, and the most important strategies highlighted are as shown in figure3.1. The farmers stated that *early planting (58%)* and *changing the crop mix* (20%) were the most important strategies of their preference that they could use to counteract climate change. *Early planting* was generally the most dominant in all three categories of importance.

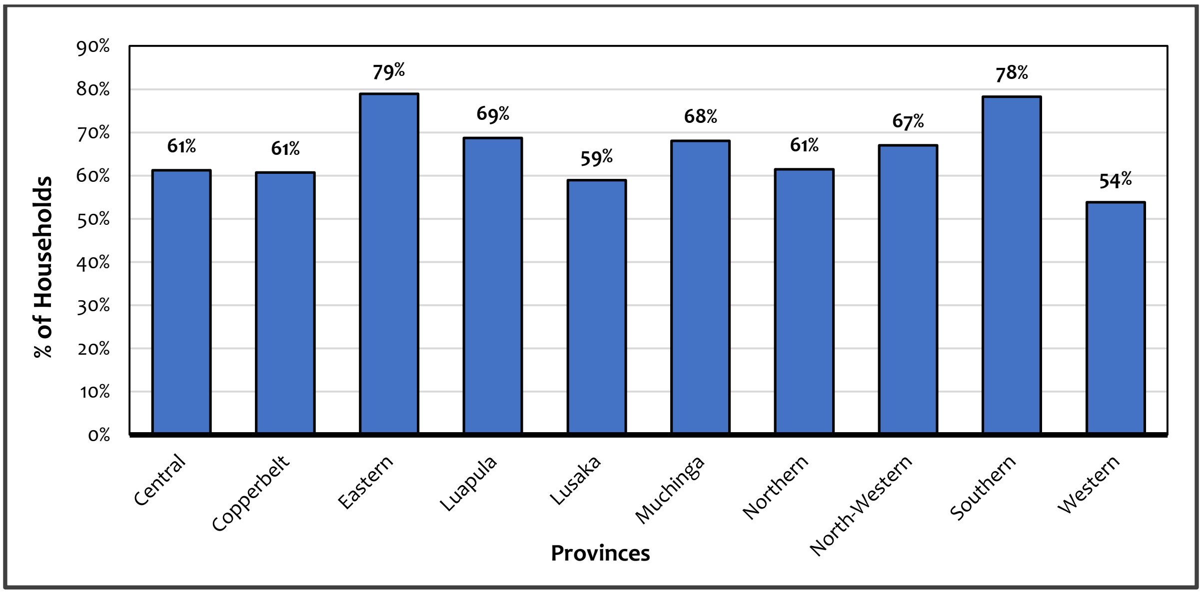
Figure 3. 1: Most outstanding drought mitigation strategies



Source: RALS 2019 and author's computations

In order to get ahead of the effects of climate change on agriculture, farmers have resorted to use weather forecast information to make agricultural decisions. With increased access to information through various platforms, both traditional and technological, farmers can now easily access weather forecast information. The study found that in the 2017/18 farming season, about 45% of smallholder farmers received rainfall forecast information. Of these, the majority (over 50% in across all provinces, with the highest being Eastern (79%) and Southern (78%) province) had used that information to make agricultural production decisions during the 2017/18 season, see figure 3.2. Use of weather forecast information to make decisions such as crop to plant, type of seed, when to plant etc. is very helpful to farmers as this helps them prepare for the impact of extreme weather conditions which have over the years become a norm.

Figure 3. 2: Use of rainfall forecast information in 2017/18 farming season

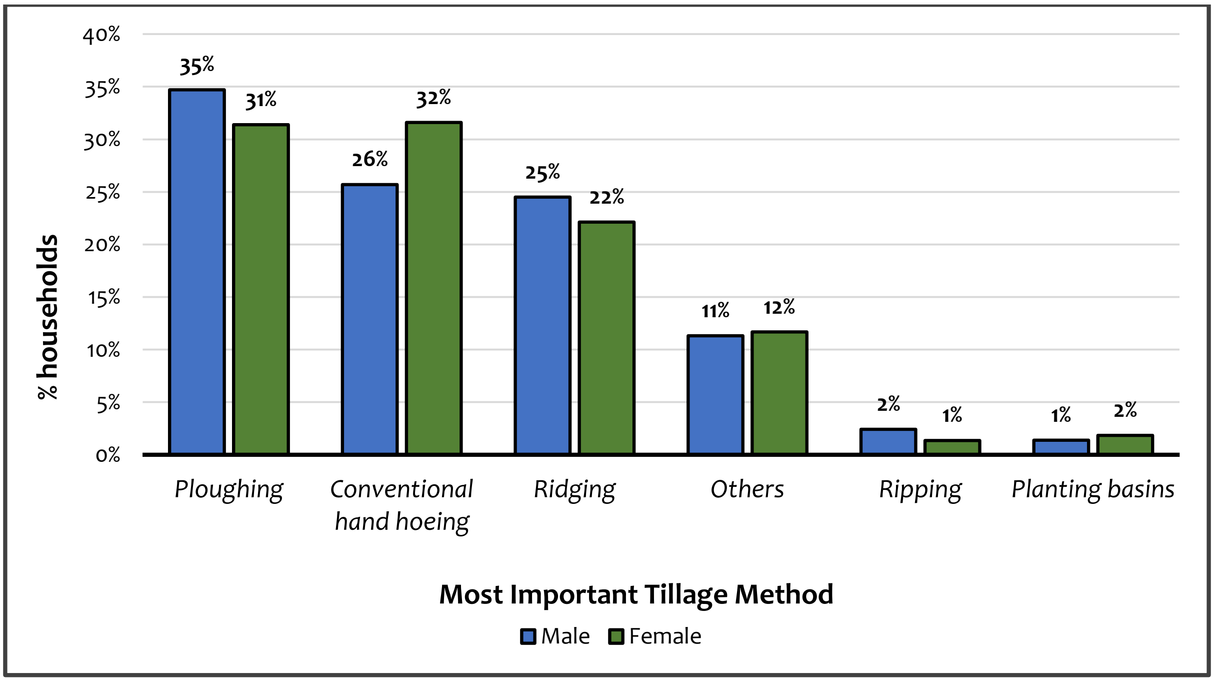


Source: RALS 2019 and author's computations

Some tillage methods used by farmers have caused soils to become poor, this has led to deforestation as farmers leave that land for more fertile land. This cutting down of trees has escalated deforestation rate to an estimated 79,000 – 150,000 ha per year. It has been reported that Agriculture expansion activities were found to be the main drivers of forest cover loss or deforestation between the year 2000 and 2014 (Chakravarty et al. 2012, MoLNR and FAO 2016). Deforestation leads to soil erosion, hotter and drier weather conditions which causes the soil not to hold water for long among others. These factors tend to affect agriculture leading to poor production and low productivity. This cycle of farmers expanding farming area leading to drier conditions, erosions, poor soils etc. should be stopped and the effects reversed through application of proper tillage methods that can help conserve the soil. The most common conservation tillage methods in Zambia are *ripping* and *planting basins* (potholing). Unfortunately, the use of these methods in the 2017/18 season among smallholder farmers was low as shown in figure 3.3 below. The most common and most important tillage methods used were *ploughing*, *conventional hand hoeing* and *Ridging*. The study further found that there was a marginal difference in the use of ploughing methods among males (35%) and among females (31%). This difference could be as a result of women not having easy access to agricultural equipment and implements as men do. This is evident in the high numbers amongst females who were using *hand hoeing* methods (32%) compared to the use of the same method amongst males (26%). The minimum tillage methods were not very popular among the farmers, only a handful indicated *ripping* (2%) and *planting basins* (1%) among male headed households. These findings were similar among female headed household, the only difference was females, unlike the males, preferred *planting basins* (2%) to *ripping* (1%).

These findings should inspire the need to invest in extension services and more research to provide farmers an incentive to adopt these tillage methods and help in conserving the land. There is also need for improved, easily accessible and female-farmer affordable Conservation Agriculture (CA) equipment that can make farmers want to leave their conventional tools and purchase CA tools (Fouzai et al. 2018). But there is need for more as farmers would not want to spend their money to buy alternative equipment when they already have equipment they can use for the same job. Perhaps engaging partners that can supply farmers with CA equipment on a pay as you go basis, coupling that with extension services. It might be better to have farmers gradually shift from the conventional to CA so that they can be comparing the pros and cons of CA and conventional methods.

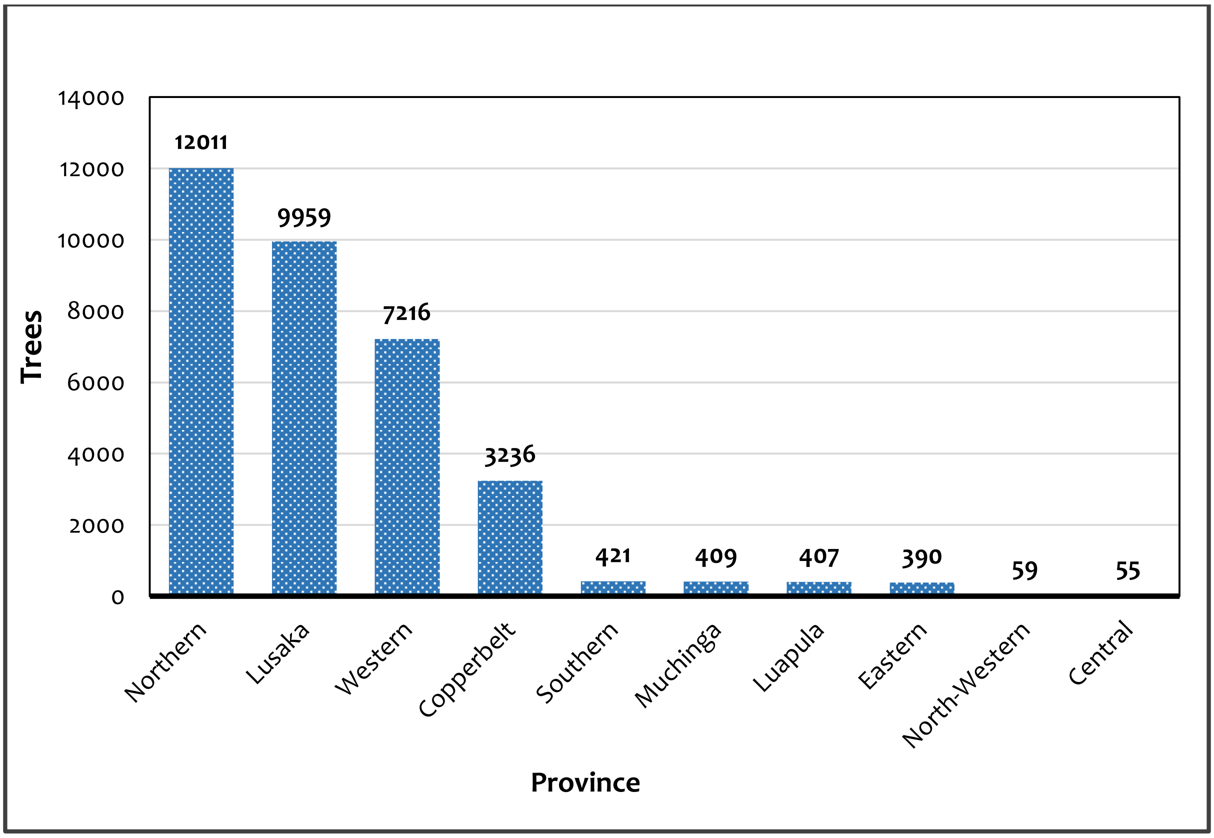
Figure 3. 3: Most important tillage method used



Source: RALS 2019 and author's computations

Because of the high levels of deforestation in Zambia, it would be prudent to encourage planting of trees among farmers since cutting trees down is somewhat inevitable. The increase in electricity tariffs and load shedding in recent years has increased the demand for charcoal especially among urban people (Mwila et al. 2017, ERB 2019). Instead of just discouraging them not to cut down trees, extension officers can encourage farmers to engage in agroforestry. Since many farmers would cut down trees for charcoal as they clear land for farming, encouraging them to plant trees they cannot use for charcoal, like fruit trees, would prove beneficial and effective because they would benefit in generating revenue from the sale of fruits as well as consumption. In this study, farmers were asked the number of trees they had in their fields, figure 3.4 shows the results.

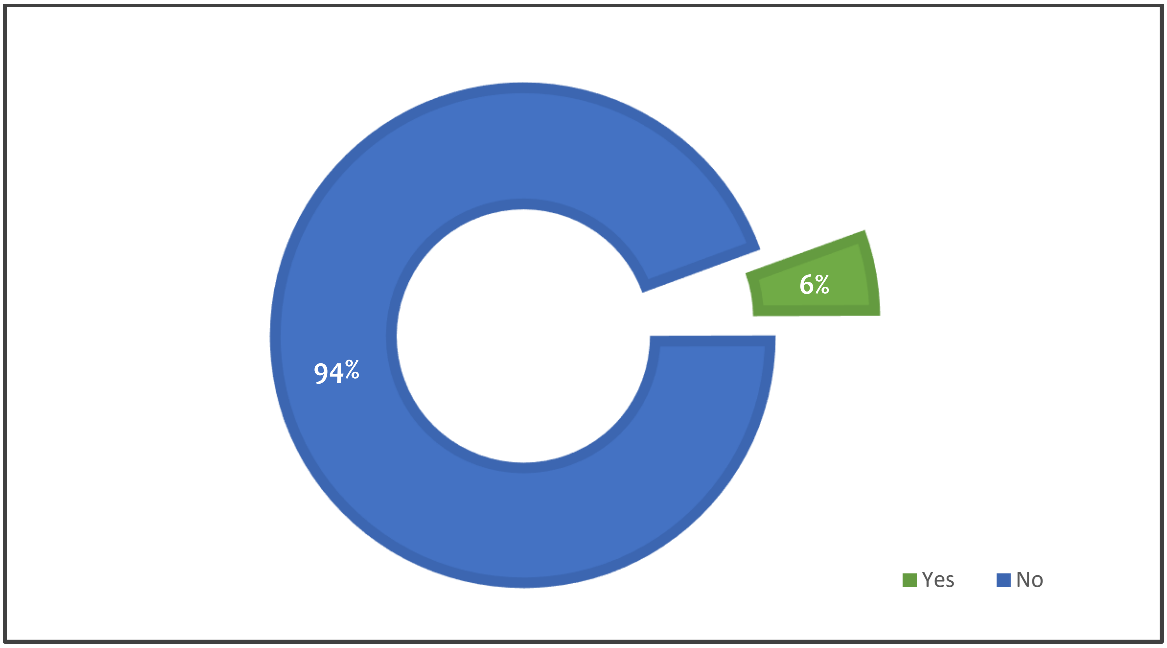
Figure 3. 4: Average number of trees per hectare planted by province



Source: RALS 2019 and author's computations

Use of organic fertilisers or animal and/or crop manure can greatly improve soil fertility. Manure has been reported to increase concentration of certain beneficial elements in the soil, increase fertility and eventually increase productivity. Manure is cheap as it is readily available to farmers, it improves the soils water retention ability and saves money as purchasing manure is way cheaper than chemical fertilizer. However, all manures should be composted before use to minimise emissions of greenhouse gases. A study by Biala (2011) actually showed that use of compost manure can contribute to the mitigation of climate change. This study showed that only 6% of smallholder farmers used animal/crop residue/compost manure in the 2017/18 farming season. What this study could not establish is how many composted the manure. See figure 3.5.

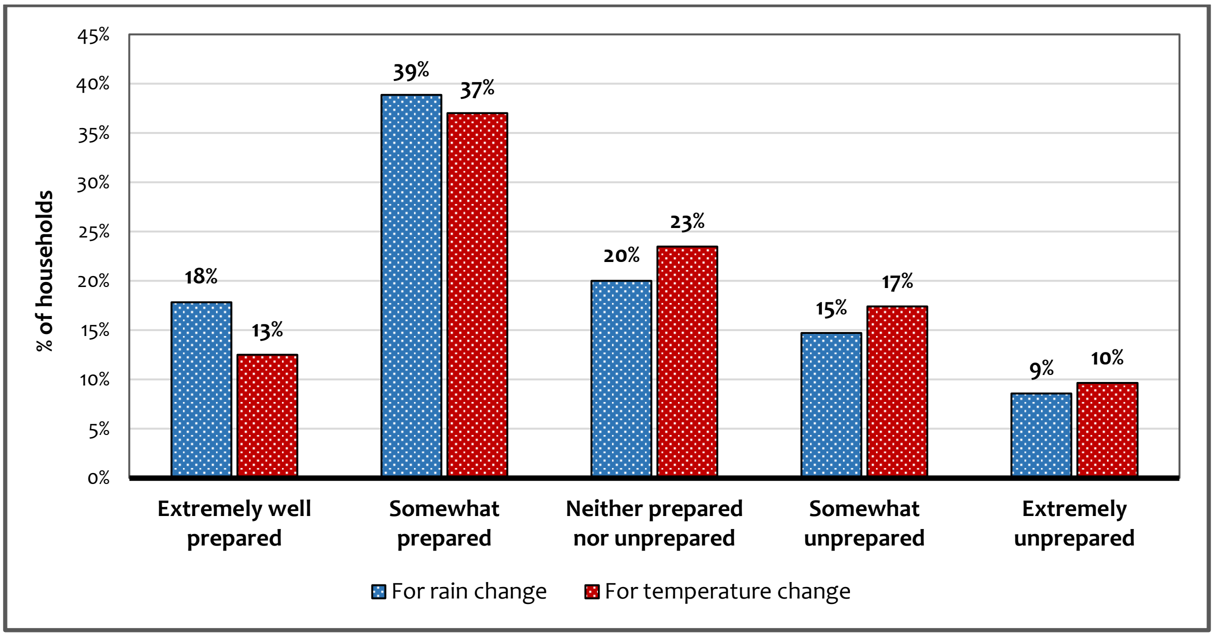
Figure 3. 5: % of households that applied manure



Source: RALS 2019 and author's computations

Having highlighted some of the activities they engaged in that helped to mitigate climatic hazards, farmers further highlighted their levels of preparedness for the next climatic hazard on their agricultural activities. The majority of households were somewhat prepared for change in amount of rain (39%) received and changes in temperature (37%). The households stating that they were extremely unprepared were quite low for both changes in rain (9%) and temperature (10%). This could imply that farmers are not only aware of climate change but are doing something to mitigate its effects. This could further imply that interventions to mitigate climate change, if designed with the farmers needs at the core, could easily be adopted.

Figure 3. 6: Farmers' level of preparedness for next hazard



Source: RALS 2019 and author's computations

A4. Main channels utilized by farmers to receive climate change information

Access to information by rural smallholder farmers is the first step on their journey to adopting climate smart agricultural practices. With properly understood evidence-backed information, farmers are in a better position to make decisions that could not only improve climate in the long run but also increase their productivity and incomes. The majority of agricultural practices that majority of households received information on were climate friendly and these include information on: *Rotating cereals with legumes/nitrogen-fixing crops (69%); leaving crop residues in the field and incorporating it into the soil (67%); leaving land fallow to rest the soil (62%);* and *applying manure (62%)* amongst others. Meetings, most likely with extension officers, and informal conversations were the most common mode of information transfer. What is clear from table 4.1 below is the importance of extension workers as they play major roles in meetings, trainings, field days and demonstrations. Others mostly included workshops and visits.

Table 4. 1: Receipt of information on various agricultural practices

Agricultural practise	Received info on	Mode through which info was received						
		Meeting	*Informal*	*Training*	*Field day*	*Radio programme*	*Demons*	*Others*
Zero tillage (excluding chitemene)?	43%	45%	16%	8%	9%	7%	7%	7%
Minimum tillage using planting basins (potholes)?	55%	46%	12%	8%	8%	7%	12%	8%
Minimum tillage using ripping?	43%	46%	11%	8%	8%	7%	12%	8%
Leaving crop residues in the field and incorporating it into the soil?	67%	44%	21%	7%	8%	6%	5%	9%
Using crop residues as mulch (cut and spread on field)?	43%	46%	16%	9%	8%	7%	6%	8%
Rotating cereals with legumes/nitrogen-fixing crops?	69%	46%	18%	8%	8%	7%	5%	9%
Intercropping cereals with legumes/nitrogen-fixing crops?	45%	44%	19%	9%	9%	6%	5%	8%
Applying animal manure?	62%	40%	26%	7%	7%	6%	5%	9%
Applying plant manure/green manure or compost?	42%	44%	19%	9%	7%	7%	7%	8%
Applying lime?	35%	49%	13%	10%	9%	7%	5%	8%
Leaving land fallow to rest the soil?	62%	38%	32%	6%	7%	6%	3%	8%
Growing crops that are well suited to soil and weather conditions in your area?	38%	48%	18%	9%	7%	8%	3%	8%
Agroforestry (Use of trees to protect/improve your crop or crop yields)	43%	50%	12%	9%	7%	9%	6%	8%
Information about the problems associated with aflatoxin in maize and/or groundnuts?	28%	51%	18%	8%	8%	8%	2%	6%
Use of chemical grain protectants (e.g., Actellic chirinda matura dust) to protect maize in storage from weevils?	57%	42%	25%	6%	6%	10%	1%	9%

Source: RALS 2019 and author's computations

When it came to the number of households that were accessing weather information at the time of the study, it was discovered that half the sample (50%) highlighted access. The majority of those accessing weather information were from Lusaka (67%) and Eastern (63%) province whereas the province with the least number of households with access was Western (31%) province, see table 4.2. This makes sense as most of these provinces that were accessing weather information had radio stations, especially that the majority received this information through radio programmes. There is no efficient way of receiving weather information than using digital platforms and tools such as radios, Televisions (TV), phones and other ICTs etc.

Table 4. 2: Sources of weather information

Province	Accessing weather info	Info source					
		Radio	*TV*	*Govt. extension*	*Friends*	*Own observation*	*other*
Central	48%	78%	11%	0%	9%	1%	1%
Copperbelt	54%	57%	21%	1%	6%	13%	2%
Eastern	63%	69%	5%	7%	16%	2%	2%
Luapula	44%	65%	13%	1%	15%	3%	3%
Lusaka	67%	46%	32%	3%	13%	3%	2%
Muchinga	35%	70%	12%	6%	6%	4%	2%
Northern	45%	67%	10%	2%	14%	7%	1%
North-Western	39%	51%	20%	3%	24%	0%	2%
Southern	54%	72%	5%	5%	12%	1%	5%
Western	31%	66%	6%	6%	18%	0%	4%

Source: RALS 2019 and author's computations

In order to improve farmer's access to information, it is imperative that we first identify the players already providing this information so that an intervention can either learn from how they do it or use their dissemination channels. Table 4.3 shows the most important suppliers of weather information among rural farmers. The commonest among the most important suppliers highlighted were *Ministry of Agriculture (MoA) extension* (46%) and *Fellow farmers* (15%). These results could be explained by the spread of MoA extension network, and the spill-over effects that come about as a result of farmer-to-farmer contacts. The private sector should also aim at forging alliances with government on extension services in order to improve the delivery of technical information to the smallholder communities.

Table 4. 3: Main suppliers of weather information

Supplier	Number of farmers	% of recipient farmers
MoA Extension	24710	46%
Fellow farmer	7712	15%
Others	6665	13%
COMACO	3694	7%
Relatives	3623	7%
ZNFU/CFU	3458	7%
Cooperative/farmer group	1801	3%
Radio/TV - unspecified	1511	3%

Source: RALS 2019 and author's computations

With about 74% of households in Zambia owning mobile phones as of 2018, having access to information has become very easy as most phones have provision for radio even if there is no internet access. That means farmers in rural areas, where 62% of households own phones, can be receiving weather information based on their respective districts in order to use this information to make farming decisions (ZICTA 2018). The study showed that the majority of households that owned phones used them for their primary use – Communication. The other uses that were related to agriculture directly were to *locate buyers for farm products* (31%), *obtain information about farm produce prices* (29%) and *get extension information* (13%), refer to table 4.4. Clearly phones are being underutilised for agricultural purposes and this is probably because there are very few agricultural, non-internet requiring, mobile apps or functions that are available or known by farmers. Investing in such apps and programmes by the private sector would increase coverage, reduce cost of taking information to these farmers using the conventional ways and would also increase revenue for the private firms. A willingness to pay study for different services may need to be carried out to ascertain the prices farmers may be willing to pay for weather information that can be accessed any time of day and year. Alternatively, access to weather information could be provided as an auxiliary service on digital platforms being offered by developers or providers. Given that farmers have seen the effects of climate change on their productivity, it is highly likely that they would pay for such information on their phones especially if it can include suggestions of crops they may grow that season given the weather forecast.

Table 4. 4: Main uses of rural household cell phones

Phone Use	% of Households
Talk to family and other general communication	95%
Cell phone functions and internet – calculations, etc.	53%
Send or receive money	47%
Locate buyers for farm products	31%
Assist in running own non-farm business	30%
Obtain information about farm produce prices	29%
Do phone banking	20%
Get extension information	13%
Get **weather predictions**	11%

Source: RALS 2019 and author's computations

A5. Factors affecting adoption of climate smart agricultural practices among farmers

In order to understand some of the factors that significantly affected the adoption of agricultural practices that can mitigate climate change effects, a multivariate regression analysis was conducted. Some of the most outstanding climate mitigation strategies used by farmers were used as dependent variables to determine factors that affect the adoption of these strategies. Maize was the crop of focus because of the significant role it plays in household food security in Zambia. The results on these factors are presented in table 5.1.

DT Maize varieties

Farmers make decisions every day of their lives from production decisions all the way to selling decisions. One of the most important decisions a farmer has to make is what to grow given the resources and information they have at hand. In the wake of climate change, farmers have had to decide whether to plant drought tolerant or other varieties. This study attempted to find out factors that affected a farmer's decision to adopt DT maize varieties. From the analysis, it was discovered that of all the factors affected DT maize varieties' adoption, only education level, seed quantity planted per ha, yield, and occurrence of drought in three most affected provinces in the 2018/19 season had a statistically significant effect. These results meant that having acquired primary, secondary or tertiary education increased adoption of DT maize varieties by 11%, 15% and 15% respectively. Attainment of formal education could act as a proxy to farmers' ability to assimilate technical information received via various platforms. The implication of this finding therefore suggests that for farmers, mostly in rural areas with low literacy levels, there will be need for special efforts or interventions in terms of how information is packaged or delivered. The packaging might involve delivering technical information in local languages through radio or through farmer groups as a significant proportion of farmers received information from fellow farmers. Increasing seed quantity planted per ha by 1Kg marginally reduced adoption (by less than 1%) whereas increasing yield by 1Kg marginally increased adoption (by less than 1%). Furthermore, occurrence of drought was expected to increase adoption among farmers and this was the case for Central (9%) and Southern (14%). However, Western province was an exception, as the occurrence of drought seemed to have discouraged adoption of DT maize varieties by 9%. This could be because Western province is prone to floods as could be deduced from the findings that showed that the majority of farmers that experienced floods in the 2018/19 season were from Western province (refer to figure 2.3).

Conservation Tillage

In this study, Conservation Tillage (CT) referred to only two types of tillage methods; ripping and/or potholing. Some studies have shown that CT is not only environment friendly but can increase productivity remarkably. One such study was by Chisha and Tembo (2019), who found that adopting CT methods increased crop production by 52% for pothole adopters and 111% by ripping adopters.

This study found that having secondary education increased adoption by 4% whereas having access to weather information and using rainfall forecast information to make agricultural decisions increased adoption by 3% each. Increasing quantity of seed planted by 1Kg per ha had a marginal effect of less than 1% on the adoption. On the other hand, occurrence of drought in Central and Western provinces during the 2018/19 season decreased chances of adoption by 5% each. This could be because the majority of farmers interviewed may have had limited access to productive resources or information about the benefits of practising CT especially in relation to curbing effects of climate change. This could explain the low rate of adoption of Conservation Agriculture (CA) at national level, which was reported at 5% for full CA adoption and 7% for partial Zulu-Mbata and Chapoto (2018).

Using Climate Smart Agriculture (CSA)

CSA by definition integrates all three dimensions of sustainable development and it targets to (1) sustainably increase agricultural productivity for equitable increases in incomes, food security and development; (2) adapt and build resilience to climate change from farm to national level; and (3) reduce and /or remove greenhouse gas emissions where possible (SIDA 2017). In trying to understand factors affecting the adoption of CSA, the study found that farmers that had access to weather information and those that used rain forecast information to make agricultural decisions had higher chances of adopting CSA than those that did not. The occurrence of drought, as was expected, increased the chances of adoption in Central and Southern provinces by 4% each. However, the occurrence of drought in Western province had a negative effect on adoption of CSA.

Changing crop mix

Changing crop mix referred to planting early maturing or drought tolerant varieties. Farmers highlighted this as one of the mitigation strategies they would use to curb climate change. This strategy was found to be marginally affected by household size, increasing by 1 household member increased adoption by less than 1%. Acquiring Primary education reduced adoption chances by 4% whereas accessing weather information increasing adoption by 5%. It was further observed that increasing area planted marginally reduced adoption by 1%. As would normally be expected, the occurrence of drought in Southern and Western provinces increased the adoption of this strategy by 8% and 13% respectively.

Early planting

Early planting was the most preferred drought mitigation strategy by farmers. The study showed that education had a negative effect on adoption of this strategy, specifically acquiring secondary and tertiary education reduced the adoption of this strategy by 8% and 21% respectively. This suggests that attainment of formal education which could mean improved knowledge levels is likely to result in farmers adopting less of early planting. This outcome amongst farmers with more education could be encouraged by the persistent pattern of late onset of rains, which results in most farmers replanting their fields. Increasing seed planted per ha and yield by 1Kg each had marginal yet opposite effects on the adoption. Seed planted had a positive coefficient but it could be rounded off to zero, the same was the case for yield though it had a negative effect. However, increasing area planted by 1ha and having access to weather information had positive effects on adoption albeit marginal. The 2018/19 drought that occurred in Central and Southern provinces increased adoption chances by 20% and 6% respectively.

Table 5. 1: Multivariate regression analysis results[1]

Variables	DT maize variety dy/dx	Conservation tillage dy/dx	Use of CSA dy/dx	Changing crop mix dy/dx	Early planting dy/dx
Sex#	-0.0547583	-0.0105915	-0.0103658	0.0259593	-0.0535864
Marital status#	0.0553921	0.0157665	0.0273442*	-0.0493051	0 .0178553
Age	0.0009621	0.0004324	-0.0000448	0.0002716	-0 .0001696
Household size	0.001533	-0.0010664	0.0008106	0.0039785*	-0 .0029424
Education level					
Primary#	0.1058543***	0.0261726	0.0037487	-0.0444724**	-0 .036176
Secondary#	0.1454066***	0.0411779*	-0.0081613	-0.0018464	-0 .0747419**
Tertiary#	0.1499631***	0.050706	0.0044306	-0.0092001	-0 .2094087***
Seed planted/ha	-0.0044169***	0.000218	-0.0002639	-0.0000696	0 .0009212**
Area planted (ha)	0.0039319	0.0058322***	-0.0015202	-0.0126879**	0 .0213507***
Yield	0.0000491***	--1.35e-06	-3.57e-06	-6.19e-06	-0 .000012**
Making decisions using rain forecast#	0.0287163	0.0318662***	0.020009**	0.0135013	0 .0594442***
Access to weather info#	0.0286254	0.0331066***	0.0240796**	0.0465697***	0.0067028
Provinces most affected by drought					
Central#	0.0883292**	-0.0526504***	-0.0375744***	0.0479489	0 .2004743***
Southern#	0.1349077***	-0.0041359	-0.0449986***	0.082551***	0 .0582663**
Western#	-0.0894921***	-0.0480079***	-0.0262426**	0.1313951***	0 .0090415

Source: RALS 2019 and author's computations

[1] ** is significance at 10%; ** is significance at 5%; *** is significance at 1%.*

dy/dx is for discrete change of dummy variable from 0 to 1.

II. Conclusion

The study clearly showed that climate change was affecting farmers' agricultural production negatively. The recent droughts and floods caused a reduction in the quantity of food crops produced. Evidently farmers need more help in terms of information if the fight against climate change is to be won. Majority of the households were getting their weather information though radio programmes. The use of improved seed varieties that can tolerate drought was very significant to increasing maize production. This is especially important that majority of farmers observed a decrease in the amount of rain they received and an increase in the temperatures.

Farmers' decision to plant DT maize varieties was somehow significantly affected by education levels, and occurrence of drought in southern province. Use of CT and CSA methods were generally marginally affected by the regressors that were statistically significant. Adoption of changing crop mix strategy was somehow significantly affected positively by drought occurrences in Southern and Western provinces.

Early planting was the most common mitigation strategy probably because it is easy for farmers to understand and apply. And it was also the strategy whose adoption was significantly affected by tertiary education (negative effect) and central province drought.

These findings entail the need to intensify sensitization on the actual economic benefits of these strategies in order for farmers to adopt them quickly. Farmers also need access to resources or them to be able to switch to these new practices, especially the females. The effects are statistically significant but are only having marginal effect on the adoption of proportion of adoption. If more farmers can have access to the technical knowhow of these strategies and the means of accessing resources to make adoption possible there would be an exponential growth in adoption of climate mitigation strategies especially now that the effects of climate change are being observed everywhere.

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