FACTORS AFFECTING ADOPTION OF CLIMATE CHANGE ADAPTATION STRATEGIES IN ZAMBIA: THE CASE OF CHANGING CROP VARIETIES AND PLANTING DATES

A report submitted to the department of Agricultural Economics and Extension Education of the University of Zambia

By

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First and foremost I thank God almighty for his wonderful mercies and compassion to enable me complete my studies. Many thanks also go to the following individuals whom without their help and support the successful completion of this study would not have been possible.

My sincere gratitude goes to Dr E. Kuntashula lecturer at the University of Zambia who was my supervisor during this study for his advice and timely help offered .I owe so much for the knowledge I gained and timeless effort in making sure that my work was in good shape. Many thanks also go to the members of staff in the department of agricultural economics and extension education for their assistance in my academic endeavours.

Finally my deepest gratitude go to mum and dad for their moral and financial support they gave me and their words of encouragement and inspiration during my five years of study that kept me going even when all hope was lost.

May the good lord bless you unprecedentedly!!!

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ABSTRACT

FACTORS AFFECTING ADOPTION OF CLIMATE CHANGE ADAPTATION STRATEGIES: A CASE OF CHANGING CROP VARIETIES AND PLANTING DATES

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University of Zambia, 2014

This study examines the factors affecting adoption of climate change adaptation strategies narrowing down the focus on changing of crop varieties and planting dates based on secondary data obtained from a household IAPRI/UNZA survey of 2013 that covered six districts of Zambia. The specific objectives of the study are to determine the proportion of farmers that have adopted change of crop varieties (CCV) and changing of planting dates (CPD) and to identify the factors that affect the adoption of the two strategies. A probit model was employed in the study.

Thirty six percent of the sampled farmers had adopted CCV while 42% had adopted CPD. Findings further reveal that sex, farm size, being a member of an agricultural group and being in one of the districts Sinazongwe, Serenje, Mpika, Nyimba and Petauke all positively and significantly affected farmer's decision to adopt both CCV and CPD while being polygamous married was not significant in the adoption of CPD and access to credit was not significant in the adoption of CCV but was negatively significant in the adoption of CPD.

Therefore, there is need for the government to develop and strengthen institutional mechanisms that enhances farmers' social capital through formation of groups such as cooperatives. This would promote farmer to farmer extension services in order to harness the farming experience in some of the farmers. This study only covered two adaptation strategies, there is therefore need for future studies to focus on other adaptation strategies such as increased reliance on irrigation, crop diversification etc and identify the factors that affect adoption and their adoption rates.

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LIST OF ACRONYMS

CPD	Changing Of Planting Dates
CV	Changing crop Varieties
SPSS	Statistical Package for Social Scientists
IAPRI	Indaba Agricultural Policy Research Institute

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Climate change is a pertinent issue affecting the livelihood and food security in both developing and developed countries. Studies indicate that Africa's agriculture is negatively affected by climate change (Pearce *et al.,* 1996; McCarthy, 2008). Adaptation is one of the policy options for reducing the negative impact of climate change (Adger *et al.,* 2003). Adaptation to climate change refers to adjustments in natural or human systems in response to actual or expected climate stimuli or their effects which moderates harm or exploits beneficial opportunities (IPCC, 2011). Common strategies include; the use of new crop varieties that are better suited to conditions, crop diversification, irrigation and changing of planting dates.

Adaption to climate change has become a major concern to farmers, researchers and policy makers alike. Adaptation strategies are seen to be linked to poverty reduction measures (Halsnaes & Traer Up, 2009). According to Hichilema and Vaatainen (2011), current efforts to mitigate climate change are not sufficient to stop future climate changes while the effects are already having a negative impact on the rural poor who are more vulnerable. Adaptation to the effects of climate change has therefore become increasingly important. In most parts of sub Saharan Africa, the most critical sectors such as agriculture that provides livelihood to majority of the people are the ones that are more vulnerable to climate change.

According to Thornton *et al.* (2006), Sub Saharan African agriculture employs 60% to 90% of the total labor force, making the impact of climate change worse in this region. Zambia's economy is mainly dependent on the exploitation of natural resources and the agricultural sector continues to be an important source of livelihood, supporting about 70% of the population. The country's significant sector is dominated by small scale farmers who largely depend on rain for crop production, mainly due to the absence of irrigation equipment in most rural communities. Thus any change in climate, mostly manifested as an increase in frequency and severity of extreme weather events such as drought, has a potential to significantly reduce agricultural production and household food security and would ultimately affect agricultural sector which generates 18% to 20% of the national GDP and employs about two thirds of the labor force.

In Zambia, despite the recognition of the damaging effects of climate change and accompanying farmer adaptation strategies, there is thin empirical literature on the proportions of farmers that have adopted adaptation strategies and factors affecting adoption of these strategies. The proportion of households adopting adaptation strategies such as change in planting dates and crop varieties need to be known. Further, the factors affecting the adoption of the adaptation strategies among farmers need to be properly identified and isolated. It is against this background that this study is premised.

1.2 PROBLEM STATEMENT

Increases in temperature and variability in rainfall patterns coupled with frequent droughts are evident that climate is changing in Zambia's three agro ecological regions. Small holder farmers in Zambia are aware that climate is changing through observation of changes in rainfall and temperature trends over a long period of time (Kuntashula *et al.*, 2014). Temperatures have increased and there are more frequent droughts than in the past. Generally rainfall season is shortening and so is the amount of annual rainfall in these agro ecological regions.

Responding to climate change through mitigation will take time and therefore adaptation becomes critical particularly where ability to adapt is low (Evangelista, 2010). The negative impact of climate change can be reduced through adaptation, which requires involvement of farmers, the majority of which are small-scale farmers. With the awareness of the farmers about climate changing, farmers in all the three agro ecological regions are employing a number of strategies.

Despite the recognition of the damaging effects of climate change and accompanying farmer adaptation strategies, there is thin empirical literature on the proportions of farmers that have adopted adaptation strategies and the factors affecting adoption of these strategies. This study therefore seeks to estimate the proportion of farmers that have adopted these strategies and the factors that affect the adoption of climate adaptation strategies.

1.3 STUDY OBJECTIVES

1.3.1 GENERAL OBJECTIVE

The general objective of this study was to determine the proportion of adoption and factors that affect the adoption of climate change adaptation strategies.

1.3.2 SPECIFIC OBJECTIVES

- To determine the proportion of farmers that have adopted changing crop varieties and changing planting dates as strategies for adapting to climate change
- To determine the factors affecting adoption of changing crop varieties and changing planting dates.

1.4 RATIONALE OF THE STUDY

Climate change is now a pertinent issue in agriculture and is a threat to the promotion of food security not only in Zambia but Sub-Saharan Africa as a whole. This therefore calls for emphasis on the adoption of climate change adaptation strategies among farmers if the production risks called for by climate change are to be reduced. The findings of this study are necessary because they will provide information to the government agricultural policy makers and other organizations that are involved in the promotion of food security. This information will enable the stakeholders to put up measures that support adoption of these strategies thereby increasing the chances of improving food security in Zambia.

1.5 ORGANIZATION OF THE REPORT

This study opens with chapter one which highlights the background information about the subject matter. It covers the problems statement, objectives, and rationale of the study. Chapter two focuses on literature review where the terminologies are defined and a number of empirical studies done concerning the same are reviewed. Chapter three looks at the methodology that was used for the study. Chapter four interprets and explains the findings of the study. It ends with Chapter five where conclusions and recommendations of the study are made.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the meaning and definitions of changing of planting dates and changing crop varieties. It then highlights the major literature on the factors affecting the adoption of changing of crop varieties and planting dates as strategies of climate change adaptation. It is divided into two parts namely; terminology definition and the empirical studies done on the factors that affect the adoption of changing crop varieties and changing of planting dates.

2.2 TERMINOLOGY DEFINITION

Changing of planting dates can be defined as the year to year shifts in the planting dates or the changing of sowing dates due to the changes in climate (Wikipedia). Crop varieties on the other hand can be defined as the variance in the genetic and phenotypic characteristics of plants that are used in agriculture, these crops may vary in the seed size, branching pattern, in height, fruiting time or flavor (Wikipedia). Because of their genetic differences, these crops are subjected to different growing conditions while Adoption is defined as a decision to make full use of an innovation as the best course of action once the individual has known and assessed the attributes of the innovation. Most empirical studies using econometric models often relate the adoption decision to households and technological characteristics (Rodgers, 1995).

2.3 EMPIRICAL LITERATURE REVIEW

There is extensive literature on studies relating to factors affecting adoption of adaptation strategies. A number of studies done in this area involved the use of different methodologies and hence had different outcomes. Hassan and Nhemachena (2007) examined farmer's adaptation strategies to climate change in southern Africa based on cross sectional data for South Africa, Zambia and Zimbabwe that was collected as part of global Environmental facility/world bank climate change and African agricultural project. Access to credit, extension services and awareness of climate change were some of the important determinants of farm level adaptation to

climate change. Other key factors positively influencing the farmer's decision included female headed households, farming experience, increasing mean annual temperature, increasing mean annual precipitation as well as access to electricity, tractors and heavy machines.

Seo and Mendelssohn (2006) explored how farmers in Africa have adapted to various to various climates across Africa data was collected from 10 African countries; Burkina Faso, Cameroon, Egypt, Ethiopia, Ghana, Kenya, Niger, Senegal, South Africa and Zambia between 2002 and 2014.in this study the logit model was used to determine whether farmers have adapted livestock management to the ranges of climates found in Africa. Many findings of this study were that farmers are more likely to choose to have livestock as temperature increases and as precipitation decreases. Cooler temperatures and wetter conditions on the other hand favor crops. All the climate coefficients except the linear term on warm temperature are found to be significant. The study reveals that religion determines whether or not a farmer adopts livestock

Deressa et al (2009) used a multinomial logit model to study the determinants of farmer's choice of adaptation strategies. The study analyzed perception of and adaptation by farmers in the Nile basin of Ethiopia for mixed crop and livestock farmers. This study was conducted during the 2005 production year as a household survey and revealed that most farmers perceived that temperatures had increased and that precipitation had increased. Findings reveal that education, age, non farm income, livestock ownership, access to extension services, access to climate information, access to credit, and number of relatives in the community positively influenced the farmer to adapt. Contrary to Deressa (2010), household size was found to be insignificant in influencing the farmer's decision to adapt to climate change.

Apata et al (2009) used the logit model to analyze climate change perception and adaptation among arable food crop farmers in south western Nigeria. The main findings of this study reveal that increased temperature, intercropping of cereals, mulching, zero tillage making ridges, farm size, farm experience, education status of the farmer, access to extension services ,credit facilities positively influence adaptation .The study also reveals that change in timing of rains ,own heavy machines ,and household size are also significant factors but influence adaptation negatively.

Literature from these studies shows that there is mixed evidence or results particularly on those variables such as household, farm size, and high annual average precipitation. Both theoretical

and empirical models show that adaptation is determined by education of the household head, age of the household head, household size, and access to extension services, access to credit, wealth, farm size, soil fertility and climate change variables. Theory says that all these positively influence the farmers' decision to adapt.

2.4 CONCEPTUAL FRAMEWORK

When a farmer is faced with the new agricultural technologies, he/she will be faced with options of whether or not to adopt a given course of action. To explain the behavior and determinants of farmer's decision to adopt or not to adopt a technology, three paradigms are used .These are; innovation –diffusion model, adoption perception model and the economic constraint model.

2.4.1 INNOVATION DIFFUSION MODEL

This model considers access to information about an innovation to be key factor in determining adoption decisions .It assumes that appropriateness of innovation is as given and thus reduces the problem of technology adoption to communication of information on a given technology to potential end users. The model emphasizes on extension contact, use of mass media and opinion leaders as a means of influencing adoption of new technologies. Classical examples of works in this line of thought include Rodgers (1962), Agrawal, 1983) and Benor et al (1984).

2.4.2 ECONOMIC CONSTRAINT MODEL

This model considers economic constraints to distribution patterns of resource endowments as the major contributor to adoption decisions(Aikenset *et al* ,1975).The lack of access to land and capital has been demonstrated as being significant constraints to adoption decisions (Havens and Flinn,1976).Qualitative effects of factors such as farm size ,liquidity and risk attitudes on decisions to adopt new technologies have been examined (Just and Zilberman,1983) and just showed the impact of risk attitude and farm size adoption. Theoretical work has shown that the farm size affects adoption decisions through the availability of some hecterage where innovation occur the study demonstrated that given series of technological components ,adoption patterns is a function of profitability ,riskiness, initial capital requirement ,complexity in use and availability of each component.

2.4.3 ADOPTER PERCEPTION MODEL

This model contends that farmers' subjective perception of new technology in light of prevailing socio-economic environment conditions their adoption behavior. The model was proposed by Wossink et al (1997), this is according to Sarker et al (2008).in this model, farmers are assumed to hold specific perceptions regarding the effects of an innovation and these subjective evaluations can be significant factors in their adoption decisions. Thus once the potential adopters are exposed to new technologies, they will seek information about the attributes of this technology

2.5 THEORETICAL MODEL

This research adopts the probit model. The probit model was developed by McFadden (1973) is based on the utility theory, or rational choice perspective behavior (Gujarati).In this model, it is assumed that the decision of the farmer to adopt the strategy or not depends on an unobserved utility index I_i (also known as the latent variable) say income, that is determined by one or more explanatory variables, in such a way that the larger the value of the I_i index the greater the probability of the farmer adopting the strategy.

2.6 DISCRETE CHOICE THEORY

Lancaster (1966) put forward that consumers derived utility from the attributes of a commodity rather than from the commodity itself. The random utility theory assumes that consumers act rationally to maximize their utility from a set of choices that are viable. According to the choice theory of economics, the decision is determined by the utility level (U_{ij}) that household i associates with alternative j. A household will choose whether to adopt the strategy or not depending on the utility levels derived relatively from the two choices. This then implies that the probability that alternative j will be chosen will be given by

$$P\ (y_i = j) = \text{probability}\ (U_{ij} \geq U_{ik} \mid X,\ k \neq j) \qquad (1)$$

Where the observed outcome for the i^{th}observation,i=1... N index the household is y_i. The alternatives to be selected are such that j=1… j and k=1… k. The decision of a household is taken as a qualitative binary outcome such that

$$j \in j = \begin{cases} 1 if & V > 0 \\ 0 if & V < 0 \end{cases} \quad (2)$$

Where the difference in utilities of adoption and non adoption as shown by equation (3) is not observed.

$$V = U_{ij} - U_{ik} \quad (3)$$

Ceteris paribus, the household is assumed to be rational and selects the alternative offering the greatest utility. The household will then decide to adopt only if the utility derived from adoption is greater than that derived from non-adoption. This implies that the household chooses the alternative j if the probability that the utility of the alternative j is greater than that of the other alternatives k. A random disturbance term (ε_{ij}) accounts for the differences that arise in household choices and is assumed to be normally distributed.

$$U_{ij} = X_{ij}\beta_j + \varepsilon_{ij} \quad (4)$$

Where X represents the observed explanatory variables, β represents the unknown parameters to be estimated.

MODEL SPECIFICTION

Based on the utility theory or the rational choice on perspective behaviour the probit model is used and specified as

$$Y_i = \beta_0 + \beta_1 X_{1i} + ...\beta_k X_{ki} + \varepsilon$$

Where y equals 1 when a household decides to adopt and 0 otherwise, β_i^{s}' are unknown parameters to be estimated.X_i is the vector of exogenous explanatory variables expected to influence the participation decision. The variables used in the model included;

X_1 is the age of the household head (Age HH)

X_2 is the sex of the household head (Sex HH)

X_3 is the education level of the household head (Ed HH)

X_4 is hired labour (Hired lab)

X_5 represents access to credit (Access credit)

X_6 is animal labour (Animlab)

X_7 is the farm size (Famsize)

X_8 is (Info Access)

X_9 (Polymarr)

X_{10} (Cf Advice)

F is the normal cumulative distribution function (CDF) and ε is the error term.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the methods and procedures used to determine the factors affecting the adoption of changing crop varieties and changing of planting dates as climate change adaptation strategies. The chapter is divided in the sections; area of study, data collection and analysis tools that were used in the study.

3.2 STUDY AREA

Zambia is divided into three main agro ecological zones with rainfall as the main distinguishing climatic attribute. Zone 1 covers the western and southern part of the country and receives an average annual rainfall of less than 800 mm; the observed meteorological data suggests that this zone is currently the driest zone ,very prone to droughts and has limited potential to crop production (Jain,2006),Zone 2 covers the central part of the country, extending from east through to the west ,and has the highest agricultural production because of fertile soils and the evenly distributed rainfall throughout the crop season

The study involved data from 6 districts: Serenje, Sinazongwe, Mpika, Nyimba, Petauke and Choma. The districts reflect all the three agro-ecological regions of the country. The districts are shown in the map of Zambia (fig.1)

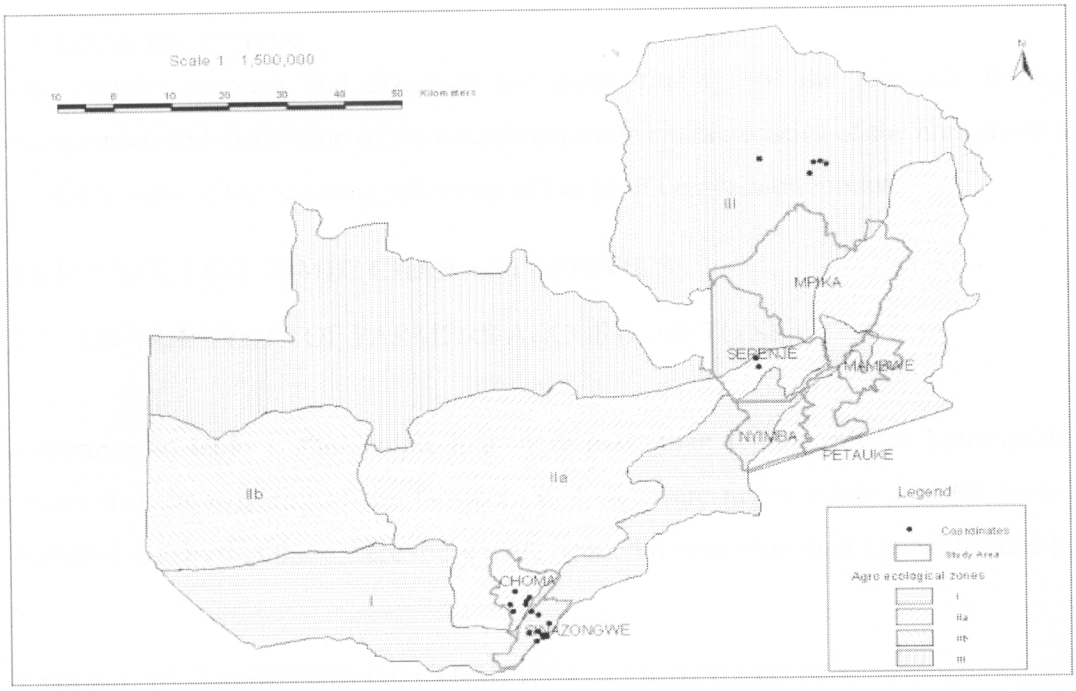

FIGURE 1: MAP OF ZAMBIA SHOWING SELECTED SURVEY DISTRICTS AND AGRO ECOLOGICAL REGIONS

3.4 DATA COLLECTION AND ANALYSIS

The study uses secondary data which is household data obtained from 2031 households in the study area by IAPRI. This data was based on forecast survey of 2013 and was representative of six districts. The data was analyzed in excel and SPSS to produce descriptive statistics .It was first tested for heteroskedasticity, omission of variables and multicollinearity .Data was tested for heteroskedasticity to find out if there was equal variance in the error terms so as to improve efficiency. The omission of variables was done to find out if there were any relevant variables that were omitted from the model. Multicollinearity was done to examine if one variable was affected by other variables in the model. From all these tests, there was no multicollinearity among the variables, no heteroskedasticity and no omitted variables. The probit model was then run in stata.

CHAPTER FOUR

4.0 STUDY FINDINGS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter presents and discusses the study findings of the research. It begins with the presentation and discussion of the social economic characteristics of the household and ends with the discussion of the resulting estimates of the probit regression model.

4.2 SOCIAL ECONOMIC CHARACTERISTICS

4.2.1 DISTRIBUTION OF FARMERS ACCORDING TO SEX

According to table 1, the sample had more male than female headed households' .The Table shows that the majority of the farmers (80.42%) were males while 19.58% were female. This therefore means that there were more male headed households than female headed household.

TABLE 1: DISTRIBUTION OF FARMERS ACCORDING TO SEX

SEX	FREQUENCY	PERCENTAGE
Female	241	19.58
Male	990	80.42
TOTAL	1231	100

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

4.2.2 DISTRIBUTION OF FARMERS ACCORDING TO MARITAL STATUS

From the pie chart, it can be seen that ,the majority of the farmers were monogamously married and this accounted for 74% of the population followed by12% those that were widowed 8% polygamously married ,4% divorced ,1% never married and none were cohabiting.

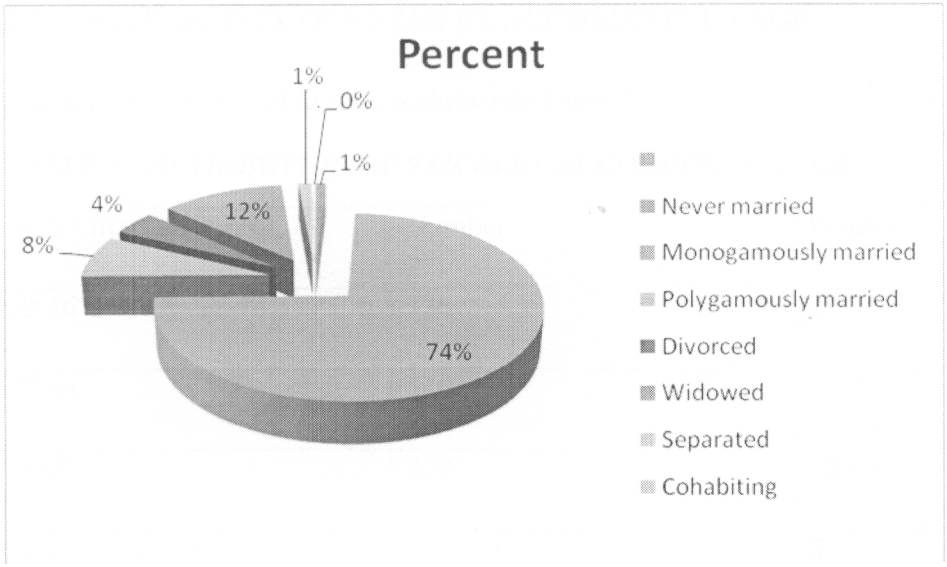

FIGURE 22: DISTRIBUTION OF FARMERS ACCORDING TO MARITAL STATUS

4.2.3 DISTRIBUTION OF FARMERS ACCORDING TO AGE

The age distribution of famers is shown in Table 2.

TABLE 2: DISTRIBUTION OF FARMERS ACCORDING TO AGE

AGE GROUP(years)	Number	Percent
20-36	336	29.7
37-53	526	42.7
54-70	229	18.6
71-87	133	8
88-104	7	5
TOTAL	1231	100

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

From the table, it can be seen that the majority of the farmers had ages between 37 and 53 years (42.7%). The youth age is 35 years and this therefore shows that the majority of the farmers were above youth. About 29.7% of the farmers constituted those that were between the ages 20 and36, while 18.6% constituted those that were between 54 and 70 .further those that were between 71 and 87 constituted of 8.4% while 6% were above 88 years.

4.2.4 DISTRIBUTION OF FARMERS ACCORDING TO EDUCATION

The bar chart below shows the distribution of farmers according to education level (fig .3)

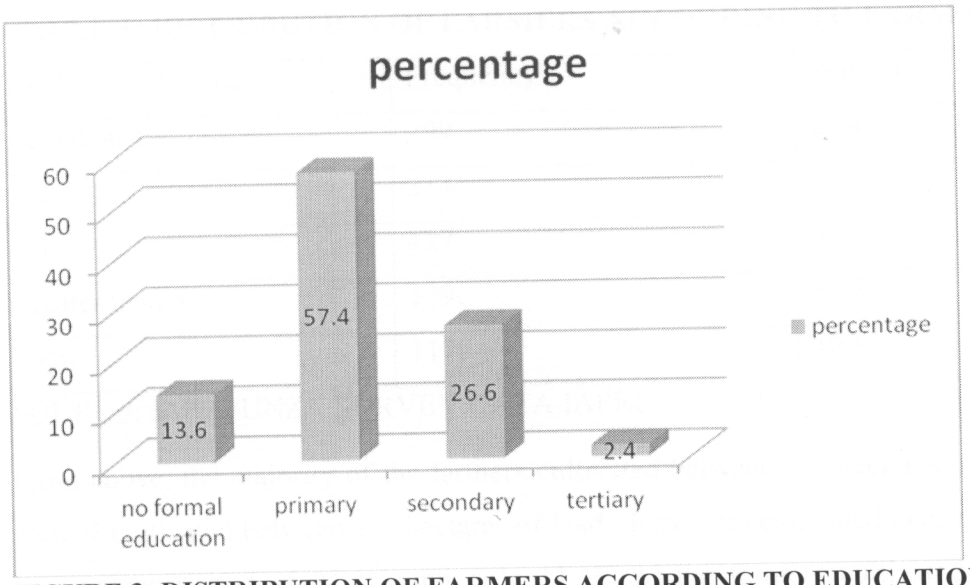

FIGURE 3: DISTRIBUTION OF FARMERS ACCORDING TO EDUCATION

From the bar chart, 13.6% of the farmers had no formal education, 57.4% of the farmers had attained primary education, 26.6% of the farmers had attained secondary education and 2.5% of the farmer had reached tertiary. This shows that the majority of the farmers had primary education and very few attained tertiary.

4.2.5 DISTRIBUTION OF FARMERS ACCORDING TO FARM SIZE

The distribution of farmers according to farm size is shown below (table 3).

TABLE 3: DISTRIBUTION OF FARMERS ACCORDING TO FARM SIZE

Hectares cultivated	Frequency	Percent
Less than 1	299	24.4
1-2	314	26.6
2-5	427	36.2
Greater than 5	139	11.8
Total	1179	100

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

From above, the majority of the farmers cultivated between 2-5 hectares of land (36.2%) while 26.6 % cultivated between 1-2 hectares of land, those who cultivated hectares of land less than 1 hectare constituted of 24.3% and only 11.3% of the farmers cultivated land greater than 5 hectares.

4.2.5 DISTRIBUTION OF FARMERS BY DISTRICT

The distribution of farmers by district s as shown below(table 4) the table shows that there were 312 farmers from Petauke, 285 farmers from Nyimba, 220 from mpika,142 from Serenje, 120 from Sinazongwe and 152 farmers from Choma. This shows that a high percentage of farmers were from Petauke.

TABLE 4: DISTRIBUTION OF FARMERS BY DISTRICT

DIST	Frequency	Percent
Choma	152	12.35
Sinazongwe	120	9.75
Serenje	142	11.54
Mpika	220	17.87
Nyimba	285	23.15
Petauke	312	25.35
TOTAL	1231	100

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

4.3 ADOPTION OF ADAPTATION STRATEGIES

4.3.1 FARMERS WHO HAVE ADOPTED CHANGE IN CROP VARIETIES

TABLE 5: FARMERS WHO HAVE ADOPTED CHANGE IN CROP VARIETIES

	FREQUENCY	PERCENTAGE
ADOPTERS	439	35.64
NON ADOPTERS	792	58.16
TOTAL	1231	100

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

The table above shows the proportion of farmers who have adopted changing of crop varieties as an adaptation strategy. It shows that 439 farmers accounting for 35.66% have adopted crop varieties while 792 farmers accounting for 58.16% of the farmers'. This therefore implies that the majority of the farmers have not adopted changing of planting dates as an adaptation strategy as the number of adopters is less than the non adopters.

4.3.2 FARMERS THAT HAVE ADOPTED CHANGE OF PLANTING DATES

TABLE 6: PROPORTION OF FARMERS THAT HAVE ADOPTED CHANGING OF PLANTING DATES

	FREQUENCY	PERCENTAGE
ADOPTERS	516	41.84
NON ADOPTERS	715	64.34
TOTAL	1231	100

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

From the table above, it can be seen that the proportion of farmers who have adopted changing of planting dates as a strategy is 515 accounting for 41.84%, while those who did not adopt were 716 accounting for 64.34% of the farmers .This therefore implies that the majority of the farmers had not adopted changing of planting dates. This could be attributed to the reason that there are other strategies that could yield more benefits than changing of planting dates and farmers succumb to those better strategies.

TABLE 7: ADOPTION ADAPTATION STRATEGIES BY DISTRICT

The table below shows the proportion of farmers that have adopted CV and CPD in out of the total number in each district.

	CHOMA	SINAZONGWE	SERENJE	MPIKA	NYIMBA	PETAUKE
CV	10.53	38.33	55.63	25.91	49.82	56.09
CPD	6.58	26.67	42.25	20.91	37.54	58.97
TOTAL	152	120	142	220	285	312

SOURCE: IAPRI/UNZA SURVEY DATA IAPRI

From above, the proportion of farmers that have adopted crop as an adaptation strategy by district were 56.09% from Petauke, 55.63% from Serenje, 38.33% from Sinazongwe, 25.91% from Mpika and 10.53% from Choma. This implies that the majority of the farmers that adopted changing of crop varieties as a strategy was highest in Petauke district with the least being Choma district.

With respect to changing of planting dates, the proportions by district were 58.97% in Petauke, 42.25% Serenje, 37.54% Nyimba, 26.67% Sinazongwe, 20.91% Mpika and 6.58% Choma. This shows that the majority of the farmers that adopted changing of planting dates were highest in Petauke and least in Choma district.

From these results, therefore, the highest proportion of farmers that have adopted the strategies was highest in Petauke and least Choma. This could be attributed to the fact that farmers in Choma might have adopted strategies that are better than these strategies.

4.4 REGRESSION MODEL RESULTS ON FACTORS AFFECTING ADOPTION

4.4.1 PROBIT RESULTS FOR FACTORS AFFECTING CHANGING OF CROP VARIETIES

The probit regression was done for a total of 1231 observations from the sample survey. The overall model was highly significant as shown by p-value of 0.000.The value of R-squared in

this model was 0.1211, implying that only 12.1% of the variations in the dependent variable are explained by the independent variables. The results of the model only show the impact of explanatory variable as just increasing or decreasing the likelihood of the farmer to adopt the strategy and therefore to measure the magnitude of the explanatory variables on the decision to adopt, marginal effects are used .

From the table (Table 8), the variables that are significant are sex, farm size, member of a group, being polygamously married, being in either Sinazongwe, Serenje, Mpika, Nyimba, Petauke districts.

Sex is a dummy and is significant at 10% with a p-value of 0.076 and marginal effect of 0.069. The positive sign on the marginal effect implies that there is a positive relationship between sex and adoption of CV, that is being male increases the probability of adopting crop varieties by 6.91%, this could be attributed to the fact that the majority of household in the sample were male headed as compared to those that were female headed and hence more males adopted the strategy than females.

Farm size is also significant at 1% level with a p-value of 0.009 and positive marginal effect of 0.0560 implying that an increase in farm size increases the probability of adopting changing of crop varieties by 5.6% .Farm size determines the proportion of land allocated to crop varieties, therefore as the farmsize increases, more land will be allocated to changing of crop varieties and as the farm size decreases less land will be allocated to changing crop varieties. Small farm size limits the amount of land that is allocated to changing of crop varieties.

TABLE 8: CHANGING OF CROP VARIETIES MARGINAL EFFECTS RESULTS

VARIABLE	COEFFICIENT	STD.ERR	Z	P>Z
Age	0.019093	0.05033	0.04	0.970
Hsize	-0.013256	0.35536	-0.37	0.710
Sex	0.0691*	0.3904	1.77	0.076
Educ 2	0.013623	0.0241	0.57	0.572
Farmsize	0.0560***	0.02148	2.61	0.009
CF advise	0.01119	0.0326	0.34	0.731
Lab hired	0.01665	0.0414	0.40	0.680
M group	0.132577***	0.03441	0.380	0.000
Windex	-0.0049006	0.02251	-0.22	0.828
Polymarr	0.117677*	0.06253	1.88	0.060
Sinazongwe	0.4530572***	0.05554	8.16	0.000
Serenje	0.5650661***	0.04305	13.13	0.000
Mpika	0.535914***	0.06878	5.15	0.000
Nyimba	0.54588***	0.05066	10.78	0.000
Petauke	0.59085***	0.04666	12.66	0.000

Note; *...**....***significant at 10%, 5% and 1% level

These results are in support of (Gershon *et al*, 1985) who found that there is a positive relationship between farm size and the adoption of climate change adaptation strategies.

In addition to this, being a member of a group is also significant at in the adoption of changing of crop varieties as an adaptation strategy. As shown by a positive sign on the marginal effect, this implies that there is a positive relationship between being a member of an agricultural group and adoption of crop varieties. This has a p-value of 0.000 and the marginal effect of 0.13257 implying that if a farmer decides to join an agricultural group, the probability of the farmer adopting the strategy increases by 13.26%. This could be because farmers belonging to agricultural groups are able to share their experiences on the strategies that they have adopted and those who have not adopted will be able to learn from the experiences of others. This therefore increases the probability of adoption because the inexperienced farmers would be willing to try out the strategy based on the shared experience during group meetings.

Being polygamous married is also significant also significant in the adoption of changing of crop varieties .It has a p-value of 0.060 and a positive marginal effect of 0.1176 implying that being polygamously married as compared to either being single, divorced, cohabiting ,being monogamously married increases the probability of adoption by 11.76%.This could attributed to the fact that those that are polygamous married would want to try out different strategies that would increase their yield to enable them feed their large families that usually result from polygamy.

The districts in which the farmer is are all significant at 1% with p-values of 0.000.These are dummies' and have positive marginal effects implying that there is a positive relationship between the district to which the farmer belongs and the adoption of crop varieties. In this case, since Choma was used as a base, a farmer from Sinazongwe, Serenje, Mpika, Nyimba or Petauke, had increased probability of adopting crop varieties by 45%, 56%, 53%, 54% and 59% respectively than a farmer from Choma. This could be attributed to the fact that each of these districts have climate conditions that support the production of a particular variety of crop, for example some varieties require high temperature, others high rainfall or humidity and this therefore influences the decision to adopt changing of crop varieties by farmers in these districts.

Other variables like Age of household head, household size, conservation farming advice, access to credit, access to information, wealth index ,whether labour is hired, animal labour and level of

ducation are not significant in this study though other studies show that there is a positive elationship between education, age of household head and information access.

.4.2 PROBIT RESULTS FOR FACTORS AFFECTING CHANGING OF PLANTING DATES

'he probit results for crop varieties had R –squared of 12.71 % implying that 12.72 percent of he variations in the dependent variable are explained by the independent variables.

'ABLE 9: CHANGING PLANTING DATES MARGINAL EFFECTS RESULTS

/ARIABLE	MARGINAL EFFECT	STD .ERR	Z	P>Z
\ge	0.03548	0.04806	0.74	0.460
Hsize	-0.0029772	0.0337	-0.09	0.430
ex	0.01343***	0.03577	2.89	0.004
Educ2	-0.01515	0.02306	-0.66	0.511
armsize	0.0470711**	0.02045	2.30	0.021
CFadvise	-0.0076599	0.03155	-0.24	0.808
Lab hired	0.0149785	0.03995	0.37	0.708
Anim lab	-0.0510617	0.03573	-1.43	0.153
Access c	-0.067534*	0.03987	-1.69	0.090
Info acc	-0.048801	0.04919	-0.99	o.321
M group	0.0869***	0.0333	2.61	0.009
Windex	-o.0342	0.0213	-1,61	0.108
Polymarr	0.0198084	0.06057	0.33	0.744
Sinazongwe	0.4081***	0.07309	5.58	0.000
Serenje	0.4829***	0.0666	7.25	o.000
Mpika	0.2597***	0.079986	3.25	0.001
Nyimba	0.4446***	0.06621	6.72	o.000
Petauke	0.6506***	0.04866	13.37	0.000

*...**...*** significant at 10%, 5% and 1% level

From the probit results above, the variables that are significant in explaining adoption of changing of planting dates are sex, farm size, access to credit, being a member of an agricultural group and being in the districts Sinazongwe, Serenje, Mpika, Nyimba and Petauke.
Sex is significant at 1% with a p-value of 0.004 and a positive marginal effect of 0.01343,it is a dummy and this implies that being male increases the probability of adopting CPD by 1.3% because the majority of the households are male headed.

Farm size is also significant with p-value 0.021 and a positive marginal effect of 0.0471 implying that an increase in farm size increases the probability of adopting changing of planting dates by 4.7%.

Apart from that, access to credit is also significant at 10% with a p-value of 0.090 and a negative marginal effect of -0.0675.This implies that there is a negative relationship between access to credit and the adoption of CPD and in this case, having access to credit reduces the probability of adopting CPD by 6.75%.The reason for this could be that as farmers gain access to credit, they would choose other strategies that are better than CPD and are more convenient for them even though they require a significant amount of capital.

In addition, being a member of a group is significant at 1% with a p-value of 0.009 and a positive marginal effect of 0.0869 implying that the decision to join a group by the farmer increases the probability of adopting CPD by 8.69%

Other variables include the farmer being in the districts Sinazongwe, Serenje, Nyimba and Petauke. These are all significant at 1% with p-values 0.000 and marginal effects O.4081, 0.4829, 0.2597, 0.4445 and 0.6506 respectively. This implies that if the farmer is to move from Choma to either of these districts the probability of adopting CPD increases by 40.81%, 48.29%, 25.97% 44.455 and 65.065 respectively.

The other factors like Age of household head, education level conservation farming advice, animal labour used, hired labour, wealth index being polygamously married are not significant in explaining adoption.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the findings conclusions and recommendations based on the findings and interpretations of the study.

5.2 CONCLUSION

From the study it can be concluded that though literature suggests that though farmers in Zambia are aware of climate change, few seem to actively take a step in adjusting their agricultural activities as is evident by the proportion of farmers that have adopted changing of crop varieties and planting dates which were 41.6% and 35.66% respectively. This shows a small proportion of farmers who have adopted the strategies as compared to those that have not adopted.

In addition to this, the variables that were significant in explaining adoption of these strategies were Sex, farm size, being a group member and whether the farmer was belonged to one of the districts Sinazongwe, Nyimba, Serenje, Mpika and Petauke. Being polygamous married was significant in the adoption of changing crop varieties but was not significant in the Adoption of changing planting dates. Having access to credit on the other hand was significant in the adoption of changing planting dates but was not significant in the adoption of crop varieties. Other variables like age of household head, education level attained, conservation farming advice, information access, wealth index and whether animal or hired labour was used were not significant.

5.3 RECOMMENDATIONS

As a follow up to the findings of this research, the following recommendations that could lead to an increase in the proportion of farmers that can adopt the strategies were made; there is need for the government to strengthen and develop institutional mechanisms that support farmers to ensure sustainability of their agricultural activities and enhanced food security. This could be done by the government ensuring the intensification of the provision of extension services to

ensure increased interactions between farmers and extension officers. Through this, farmer to farmer extension can be encouraged thereby allowing farmers to exchange information on the experience they have had with the strategies thereby allowing inexperienced farmers to tap into experience of the experienced farmers.

Apart from that, future studies on adoption should focus on other climate adaptation strategies not covered in this study due to limited time, for example irrigation reliance, crop diversification and identify the factors that affect the adoption of these strategies and their adoption rates by farmers.

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