UNDERSTANDING THE DIFFUSION OF WEATHER INDEX INSURANCE AMONG SMALLHOLDER FARMERS IN ZAMBIA: CASE OF FOUR (4) SELECTED DISTRICTS

BY

MUNKOMBWE JOSHUA

A Dissertation submitted to the University of Zambia in partial fulfilment of the requirements for the award of Degree of Doctor of Philosophy in Business and Management.

THE UNIVERSITY OF ZAMBIA

LUSAKA

2024

DECLARATION

I, MUNKOMBWE JOSHUA, do hereby declare that this work is my original work achieved through personal reading and research. This work has never been submitted to the University of Zambia or any other University. All sources of data used and literature on related works previously done by others, used in the production of this Dissertation have been duly acknowledged. If any omission has been made, it is not by choice but by error.

Signed: …….. Date……

COPYRIGHT

APPROVAL

This Dissertation by Joshua Munkombwe is approved as a partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy in Business Management.

Examiner 1	**Signature**	**Date**
…….	……..	……..
Examiner 2	**Signature**	**Date**
…….	……..	…….
Examiner 3	**Signature**	**Date**
……	……	……..
Chairperson (Board of examiners).	**Signature**	**Date**
……	……..	…….
Supervisor	**Signature**	**Date**
…….	…….	…….

ABSTRACT

Understanding the reasons why smallholder farmers do not use financial instruments to protect themselves against losses brought on by climate change concerns is currently a subject of rising relevance. Getting to the bottom of the underlying issues contributing to this status is important for future designs of financial innovations like a weather index insurance (WII) that can help farmers hedge their losses. Therefore, this study considered testing the 5 technology characteristics that Rodgers identified for uptake to take place. These include trialability, complexity, compatibility, relative advantage, and observability, covering a period from 2016 to 2020. The study used a concurrent mixed methods approach to ensure both quantitative and qualitative aspects of the study were considered, given the complexity of the inquiry. The study used purposive sampling to select 4 districts in Zambia: Choma, Petauke, Chongwe, and Mumbwa using the standard sample size table provided by Sekeran (2003), which provided for a sample size of 1024 at a concentration of 0.05 with an accuracy level of 95% confidence. The farmers were interviewed using structured questionnaires. To determine factors associated with WII the adjusted binary logistic regression model was used at 95% confidence level and thematic analysis was used to analyze qualitative data. Further, an IBM statistical analysis in social science (SPSS) was used to analyze quantitative data. From the study 50.82% of the farmer's said WII is not consistent with its modalities, compatibility, and information with the p-value of 0.001, which was significant, and further, 40.8% of the farmers indicated the importance of bundling the services to have relative advantages of the product with a p-value of 0.001. 47.87% of farmers indicated they were not satisfied with the payout system, with a p-value of 0.001, which was significant as an important enabler in the uptake of WII. Easiness of utilization indicated a p-value of 0.001, which was significant. Farmer cooperatives indicated a p-value of 0.001, which had significant influence as an appropriate distribution model through which the farmers got information, premiums, payouts, and aggregation. In conclusion, from the first technology characteristic called trialability, it is important to highlight the fact that smallholder farmers have been experiencing various challenges in the diffusion of WII since its inception. Since such challenges are various, they are responsible for the broad or multifaceted nature of the problem of diffusion of WII. This included among other issues related to awareness and promotions, trust, affordability, and access. Further, the theory can extend its views by considering the functionality of the market. The government, policy makers, business community, agricultural industry, and smallholder farmers will all benefit from the study. The recommended model will be key in facilitating the uptake and scale up of WII among the Smallholder farmers.

KEY WORDS: *Climate Change, Diffusion, Smallholder Farmers, Weather Index Insurance, adoption.*

ACKNOWLEDGEMENTS

First and foremost, I wish to thank the Lord Almighty for having accorded me this opportunity of successfully completing my Doctorate Degree. Indeed, it was such a mammoth intellectual journey that I will live to remember in my life. The fact that I cannot mention every person that has assisted me to reach this far, there are some against whom omission would be an affront.

Thus, my foremost appreciation goes to my Research Supervisor, Prof. Jackson Phiri for his unwavering mentorship and insightful commentaries rendered to me during my study. The strength to publish research work is an excellent way of contribution to the body of knowledge.

Furthermore, I owe my tribute to my Research Assistants/teams in the four districts in Mr. Timothy, Anderson Mvula, Rabbeca Sakala, Kaseba Owen, Hitra Lwiindi, Makasa Samuel, Pelekelo Namushi. Above all Mr. Singongolo Sakubita's critiquing of the whole document has been very useful for my study.

Finally, special thanks also go to my course mates; Mr Siankwilimba Enock, Mr Hauma, Mr Daniel Manda fellow work mates.

DEDICATION

I dedicate my PhD to my wife Viola Mwiinga Munkombwe, and children Joshua, Luyando, Lushomo, Chabota and Chileleko for their endurance and continuous support during the long period of my study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONOMYS

ARC	African Risk Capacity
FAO	Food and Agriculture Organization
FISP	Farmer Input Support Program
FSD	Financial Sector Deepening
GDP	Gross Domestic Product
GHG	Green House Gasses
GAID	Ghana Agriculture Insurance Pool
GIZ	German Agency for International Cooperation
GIIF.	Global Index Insurance Facility
GRZ	Government of the Republic of Zambia
PMRC	Policy Monitoring and Research Centre
SSA	Sub Saharan Africa
SPSS	Statistical Package for Social Sciences
SAP	Structural Adjustment Programme
UNDP	United Nations Development Plan
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
IAPRI	Indaba Agriculture Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IBCI	Indexed Based Crop Insurance
IBM	International Business Machines
IBLI	Indexed Based Livestock Insurance
IRIN	Integrated Regional Information Networks
IMF	International Monitoring Fund
MGEE	Ministry of Green Economy and Environment
MOA	Ministry of Agriculture
NASFAM	Nation Small Association of Malawi
NDVI	Normalised Difference Vegetation Index
NTEs	Non-Traditional Exports

OECD	Organization for Economic Cooperation and Development
WII	Weather Index Insurance
WRSI	Water Requirement Satisfaction Index
WFP	World Food Programme
ZIAMIS	Zambia Integrated Agriculture Management Information System
ZNFU	Zambia Nation Farmers Union
ZDA	Zambia Development Agency
ZSIC	Zambia State Insurance Corporation

CHAPTER 1

INTRODUCTION

1.1 Introduction

The chapter presents an overview and background of the study to understand the broader perspectives and motivation of the study and to appreciate the general outlook of agriculture, climate change, and what is obtaining in the globe, region, and Zambia. Further, the chapter presented the study objectives, questions, scope, aim, and problem statement.

It is a well-known fact that risks are high in agriculture and that exposure to uninsured risks is an underlying factor and major cause of low yields, slow growth, and persistent poverty. Global warming has made this worse by causing more severe weather and more losses to the agricultural sector (Swiss Re, 2017, UNDP, 2021). The issues of low productivity and poor access to technical information have challenged smallholder farmers for a long time in the agricultural sector in most developing countries (Jayne et al., 2021; Ngoma et al., 2021). In addition, climate change problems continue to be one of the factors that pose a threat to the future production and productivity of smallholder agriculture (Muhammad et al., 2018; Wright et al., 2014).

In many developing countries, there is enough evidence to show that the majority of local and rural communities involved in agriculture are the most marginalized among many agricultural-based stakeholders (Branca & Perelli, 2020; Nara et al., 2021; Nshankra, 2021). Some researchers have posited that smallholder farmers are marginalized in the market system because of the business risks they are involved in, which are termed multidimensional (Rapsomanikis, 2015; Gisela et al., 2022; Sun, 2014). The type and severity of these risks vary by crop or farming system, agroecological conditions, and policy and institutional settings (Hill et al., 2019). A seemingly ubiquitous source of agricultural risk is production risk due to weather uncertainty and variability, particularly those associated with deficient rainfall. It is therefore important to develop ways to better protect this crucial industry and, particularly, farmers' incomes. There are various strategies to mitigate such drought risks, including investments in infrastructure (irrigation facilities), technological innovations (drought-tolerant cultivars), crop management practices (changes to the timing of production activities), and financial instruments (credit or insurance) (Osakwe, 2021; Hill et al., 2019; Wamuyu, 2017).

In Sub-Saharan Africa (SSA), agriculture is a key contributor to gross domestic product (GDP), forming a larger part of non-traditional exports (NTEs) and contributing to employment creation (Njue et al., 2021). The sector is dominated by smallholder farmers, who contribute over two-thirds of the total agricultural output in countries such as Kenya (Wairimu et al., 2016). In 2018, the sector was reported to have accounted for 4 percent of global GDP (World Bank, 2019; Jain, 2017). In Zambia, the agricultural sector continues to be the backbone of the economy as it contributes to the growth of the economy and to exports. As such, agriculture has continued to receive priority attention by the government through increased budget support aimed at increasing agriculture productivity to ensure food security, income generation, the creation of employment opportunities, and poverty reduction (ZDA, 2011). Smallholder farmers' crop production accounts for about 90% of total production and is reliant on rain-fed agriculture. Therefore, the Zambian agriculture sector rests on the shoulders of an estimated 3.6 million small-scale farmers (ZIAMIS, 2023). Analysis of the Second National Agricultural Policy 2016–2020 reports by the Policy Monitoring and Research Centre (PMRC) in Zambia estimates that maize production declined by 16% between the 2017–18 and 2018–19 farming seasons due to climate change.

Therefore, risk transfer mechanisms such as weather index insurance (WII), which have been proven in recent times to help buffer farmers against many complex hazards, have been suggested (Munkombwe et al., 2022). However, WII programs struggle to attract the clients most in need of protection, including marginalized women and men (Aheeyar et al., 2019).

Evidence shows that the uptake levels of WII vary from country to country according to the implementation strategies (Bucheli et al., 2022). Many constraints exist in developing markets, particularly in non-developed agriculture, such as transactional challenges, price and cost, price discovery, production information, and risk mitigation (Rehman et al., 2019). Considerations that would determine which mode of innovation is suitable for smallholder farmers could include support systems such as value-added products and services, understanding the agriculture sector requirements and needs, size, and business goals (Evers et al., 2014). It appears that climate change adaptation is fundamentally tied to development issues in lower-income countries that are characterized by low technology development (Todaro & Smith, 2015; Walter et al., 2021). The least developed countries, with economies principally reliant on agriculture, limited social safety nets, and little or no risk alleviation setup, appear most

vulnerable to climate change (Obour & Owusu, 2021). Financial innovation decisions should, to some extent, reflect the interests of various stakeholders, such as customers, farmers, and government policymakers (Fanconi & Scheurle, 2017).

According to the World Development Report, 2.5 billion people live "in households involved in agriculture" in low-income and developing nations (Jeehye, 2020), which are notably less industrialized, putting them in danger from climate change (Clark et al., 2020; Nima et al., 2020; Oko, 2018). Therefore, achieving global food and nutrition security demands a global approach to food systems. All four pillars of food and nutrition security must be addressed: availability, access, utilization, and stability, to ensure that the basic human right to food is met for everyone. This is the challenge set by Sustainable Development Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture (United Nations, 2015). Global population growth continues apace, with most recent estimates of 9.4–10.1 billion by 2050 and an extra 0–2.7 billion people by 2100 (United Nations, 2019). A recent study presents a more optimistic analysis in which the global population will peak at 9.7 billion people in 2064 and decline to 8.8 billion by 2100 (Vollset et al., 2020). Even with these revised calculations, the population of Sub-Saharan Africa will reach 3.1 billion in 2100—almost 2.5 times what it is now. Thus, there is no doubt that global and regional food production must increase to meet the future demand of the growing population, but by how much? Where in the world will it be produced? And above all, who are the farmers of the future who will produce the food to feed us all? Smallholder production is estimated to account for 50–70% of global food production (Giller et al., 2021).

Agriculture-based households with no hedging mechanisms are nevertheless vulnerable to severe economic losses, notably in food security, due to these experiences. To this effect, the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) both underscore the importance of strengthening insurance markets in low-income countries to increase endurance and toughness to climate change impacts (Friedrich et al., 2017; FAO, 2021; World Bank, 2018). Weather index insurance (WII) insures a weather risk highly correlated with agricultural production losses, which are frequently reliant on rain fed based crop production as a proxy for economic loss (Jianjun et al., 2015; Nyambo et al., 2021). Over the years, especially in developing countries, WII has gained popularity. The instrument can provide many poor farmers in

developing countries with a climate change-adaptive solution based on its low-cost agriculture production and productivity while mitigating the challenges of climate change.

Through the World Food Program (WFP), multilateral institutions such as the World Bank and United Nations have advocated that WII could help stakeholders in low-income countries adapt to climate change, agreeing with the arguments that WII can help offset output losses as a result of poor weather (Tay et al., 2021).

However, the diffusion of the technology remains unclear. Worse off, the uptake of WII between farmers is also considered insignificant, as shown by many studies (Jianjun et al., 2015; Olorunfemi et al., 2021). It, therefore, requires and calls for different practitioners in the sector to re-think the workable solutions that offer continued hope for smallholder farmers to increase their agriculture production and productivity while mitigating the challenges of climate change. WII tends to increase the ability of vulnerable farmers to face climate shocks and disruptions (Munkombwe et al., 2022).

Therefore, with all the variations experienced in weather index insurance adoptions from various countries of the world, there arose a study on understanding the diffusions of weather index insurance among the smallholder farmers in Zambia aimed at recommending a framework that would help to adopt the WII by the small-scale farmers.

1.2 Background of the study

1.2.1. Climate Change Global Level

Global average temperatures are expected to continue rising as a result of a continued build-up of greenhouse gases (GHGs). The projected temperature rises range between 2.4 to 6.4 degrees Celsius by the year 2100 under increasingly high emissions, but under low emissions, the range is 1.1 to 3 degrees Celsius by the year 2100. Rainfall patterns on the other hand are expected to significantly vary across continents and even within countries. The IPCC has consistently projected variations in precipitation levels almost on a North- South divide with the North generally expected to receive more rainfall compared to the South. These changes in precipitation, temperatures and carbon dioxide (CO_2) will have a profound effect on natural systems and economic sectors including agriculture and health. In some areas, the effects will be positive while in others, the impacts will be more negative (Lewanika, 2013).

1.2.2 Climate Change Regional Level

The Southern African region, including Zambia has experienced negative impacts associated with climate change especially in the recent past decades where extreme events such as droughts and floods with varying severity have occurred more frequent than usual compared to past similar length of periods. There is also a notable associated reduction in precipitation because of extreme droughts. Ngoma (2021) observes not only a reduction in precipitation but also changes in the pattern of onset of rain where there is a notable delay in the onset of rainy season and early cessation which has serious implication for systems including farming systems as well as crop or plant growing season (Ngoma,2021).

1.2.3 Climate Change National Level -Zambia

According to recent studies, climate change influenced trends have been observed and these include changes in the start and cessation of the rainy seasons, increased or decreased average precipitation and increasing average and maximum temperatures (Lewanika,2013). It has been observed that the start of the rainy season has changed generally towards late start and early ending resulting in shortened crop growing season (Ngoma,2021). As a sign of its strong commitment to addressing climate change, the Government of the Republic of Zambia (GRZ) established the Ministry of Green Economy and Environment (MGEE).

1.3 Weather Index Insurance in Zambia

WII has the potential to make micro-insurance for smallholder farmers against adverse weather events, such as drought and excess rain, commercially viable. By using weather stations and agronomical models instead of farm inspections to monitor crops, index insurance can drastically reduce per-farmer transaction costs (Rose Gosilinga, 2012)

Two major insurance companies offer WII in the country - Mayfair Insurance and Professional Insurance, with a number of other insurance companies indicating to commence offering the service. WII for small scale farmers was piloted in the earlier part of this decade around 2014 but the coverage increased exponentially in the 2017/2018 season. The number of policies sold, and sum insured increased from less than 20,000 farmers and US$ 2 million in 2016/17 to over 1 million farmers and US$ 176 million respectively in 2017/18. Average premium rate approximately 6% of sum insured (World Bank, 2018). This increase is largely due to the government subsidies through the FISP programs. The study therefore wants to understand how many farmers are adopting the technology based on the fact that smallholder farmers are exposed to the risk of weather uncertainties.

1.3.1 Major Challenges with index based Agricultural Insurance in Zambia

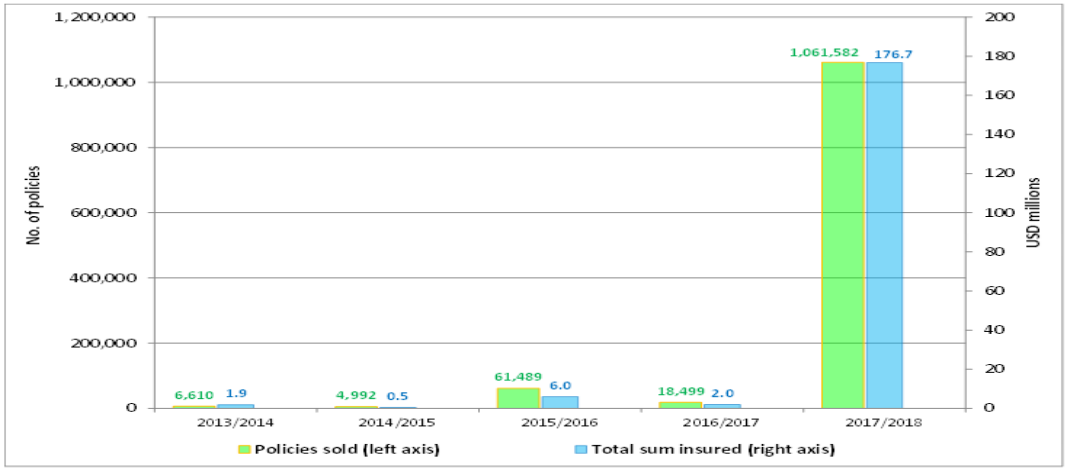
Limited local technical capacity for index insurance design, implementation, and supervision and lack of a comprehensive agricultural insurance framework in which the roles of the different parties are clearly established.

1.3.2 Farmer Input Support Programme (FISP) – Linked WII

Zambia piloted the FISP WII during the 2013/2014 season with 6610 farmers (Hamasaka & Chanda, 2021, Pensions and Insurance Commission). The product has been marketed as a bundled service along with inputs under the FISP by GRZ in partnership with some private sector players such as NWK cotton company. Below are some of the specific experiences during the pilot of FISP WII.

- Failure to make any pay-outs in 2017-18 small holder farmers posed major risks to future uptake.
- Potential issues in farmers' awareness and understanding of how the FISP index insurance scheme should work.
- Lack of an independent third-party calculation agency that, on behalf of the insured parties, can verify the accuracy of pay-outs triggered (World Bank, 2018)

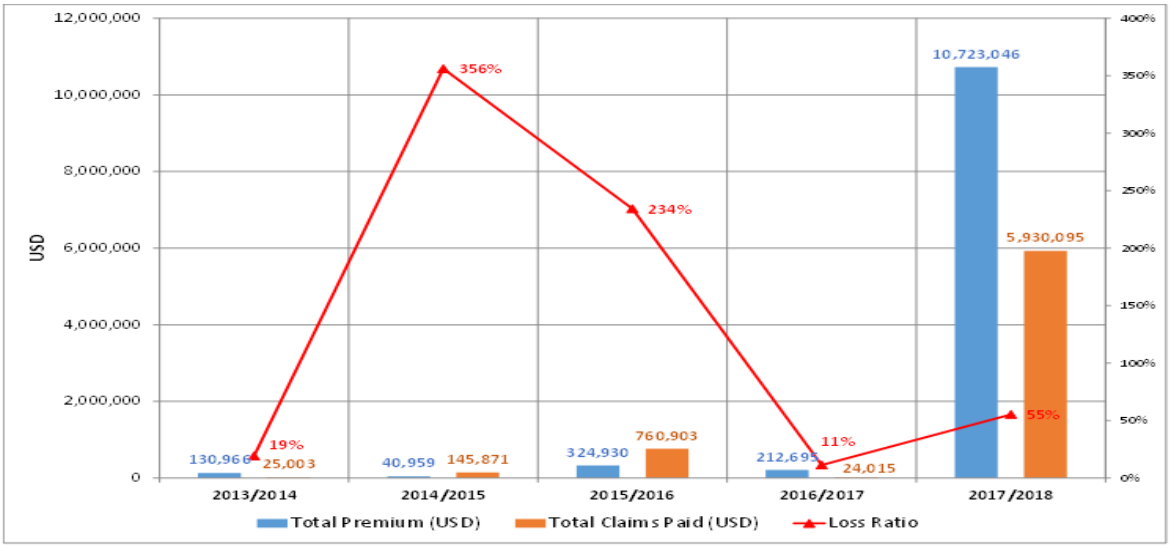
The figures below show the number of WII policies sold and aggregated sums insured from 2013 to 2018, claims and losses.



Source: Pension and Insurance Authority, Personal Communication to Report team

Figure 1. 1:WII update number of farmers

Figure 1.1: WII Update Number of Farmers



urce: Pension and Insurance Authority, Personal Communication to Report team;

Figure 1. 2: WII updates amount of pay-outs

The graphs indicate WII attempts way back in 2013 with poor diffusion/adoption rate on the instruments away from the FISP induced subsidies though even with it, its overall contribution to the national aggregated number of hectarage under the smallholder farmers is far below smallholder farmers' exposure to weather related risks. For example, in Mumbwa district the total population of farmers is 63,435 only 16,925 are on FISP. Similarly, in Choma district the total population of farmers is 45,000 and only 25,464 are on FISP. In fact, even the indicated numbers in the mentioned districts are as a result of FISP. There is clear need to investigate the amount of diffusion of the instrument among smallholder farmers in the sector. Hence, this study tried to understand the reasons why this situation and to recommend the framework that can enhance the uptake of WII among small holder farmers. However, the private sector led WII out grower initiative indicated some progress which McCarthy *et al.*, (2020) noted that FISP WII was being marketed to cotton farmers by the agro-processing company NWK. Smallholder cotton farmers signed up voluntarily for the insurance coverage packaged with inputs at the beginning of the season, when they also received their input packages. Premiums were being recovered from the sales of the produce at the harvest.

According to Kaunda and Chowa (2023), as of 2021, the World Food Program (WFP) had developed an improved FISP product designed with a mechanism for tuning coverage to target the times that have the most vulnerability. The improvements embedded into the FISP WII included combining satellite data, farmer reports and Ministry of Agriculture (MoA) and the GRZ MoA agro-ecological zone classifications to identify the dominant perils in each district such as drought, excess rainfall, or both.

In spite of this introduction of the FISP WII, an easy-to-administer policy meant to enhance access to formal insurance services by smallholder farmers, evidence from empirical studies demonstrate that uptake, in general, is still low, especially from less developed countries. Even with the introduction of the FISP WII in Zambia by WFP and its partners, FISP WII is estimated at 51,000 smallholders (Kaunda & Chowa, 2023).

1.3.3 Current Trends and Initiatives of Weather Index Insurance in Zambia: The Case of Pula Consortium Insurance Scheme

Pula is an agriculture insurance and technology firm that produces and delivers new agriculture insurance and digital services to help smallholder farmers and rural clients manage climate risks, enhance their farming techniques and bolster their earnings (Pula Stakeholder Workshop,

2023). The firm has many products and services: it designs and delivers index insurance products to manage farmers' risks working with leading insurance and reinsurance firms to place insurance risk. Yield index covers all peril including those affecting livestock. Weather index insurance covers germination failure and drought while livestock insurance covers, drought, diseases and theft. The firm also develops digital products like digital agronomy via SMS, WhatsApp, to help farmers improve productivity.

There are a number of efforts being tested and investigated to determine how distribution channels might be created that are responsive to both the business sector and the smallholder farmers. Pula has been collaborating with a consortium of four companies in Zambia i.e., Professional Insurance, Madison Insurance, Zambia State Insurance Company (ZSIC) and Hollard Insurance in improving technical and implementation capacities for WII. The Pula Consortium has been progressively working in eight of the country's ten provinces using direct individual farmer delivery and aggregator GRZ FISP based model – the latter of which involves input supplier firms and aggregates farmers for easier engagement. Pula handles the design of the product and capacity building for the consortium participants. The consortium partners leverage data to gain insights on how to engage and serve farmers. Field based advice helps the partners to track farmer performance (crop yields), climate, and disease challenges through the season. Progress made to date in the scheme indicates presented by the consortium progress and insurance companies based for the consortium.

Table 1. 1: Pula Consortium WII Experience Highlights

Season	**Pilot Scheme**	**Number of Farmers**	**Total Premiums**	**Total Claims**
2019/2020	FISP	149,914	14,541,755.27	**5,201,521.00**
2020/2021	FISP	405,013	31,811,989.57	**14,896,001.00**
2021/2022	FISP	1,024,422	101,418,966.00	**53,532,029.00**
2022/2023	FISP	1,024,422		

Source: Pula Insurance Presentation (2023)

1.4 Problem Statement

Weather Index insurance (WII) is an innovative financial instrument in the agriculture sector that mitigates against area-based weather risks associated with high temperatures and high rainfall. This financial innovation appears to be better suited for smallholder farmers in Zambia who are the most vulnerable to risks associated with climate change effects. In the years prior

to the introduction of WII, it was noted that insurance companies promote agricultural insurance policy covers in rural areas with most insurance products not designed to be inclusive of smallholder farmers (Mukombwe et al.,2022).

Since the 1980s, Zambia has been experiencing an increase in frequency and intensity of droughts and floods [(Ngoma,2021); WFP (2002- 2022); Zambia Metrological Dept, 2022) with over 1.6 million smallholder farmers suffering from weather-based losses. According to the Food and Agriculture Organization (FAO), production of maize, the main staple food, declined for a second consecutive year in 2019 and remained at well below-average level (FAO, 2019). The decrease was associated with forecasted production declines in Southern, Western and, to a lesser extent, Central Provinces, which combined, account for almost one-third of the national maize output. Seasonal rainfall deficits were the main factor behind the unfavourable production prospects with subsequent declining production and productivity trends recorded as 2016/2017 season 3,646,000 tons, 2017/2018 season 2,395,000 tons, 2018/2019 season 2,200,000 tons (MoA crop focus, 2019). The unpredictable weather patterns in the past years warranted that every farmer in drought and flood prone provinces access weather-based insurance products.

In an effort to mitigate against climate related risks, increase and improve agricultural productivity, the Zambian Government with support from its development and cooperating partners Zambia National Farmers' Union (ZNFU), Risk Shield, Musika Zambia and German Agency for International Cooperation (GIZ) among others introduced WII during the 2013/2014 farming season. The GRZ WII was linked to FISP and only insured a lima (50m x 50m) of a farmer's production with any additional majority fields remaining uninsured and exposed to climate risk. The table 1.2 below shows the number of FISP linked WII policies sold from inception to date:

Table 1. 2:The number of FISP linked WII Policies Sold from Inception to Date

Season	**Number of Farmers**
2013/2014	6, 610
2014/2015	4, 992
2015/2016	61, 489
2016/2017	18, 499

2017/2018	907,504
2018/2019	1, 061,582
2019/2020	1,024,422
2020/2021	1,024,422
2021/2022	1,024,422
2022/2023	1,024,422

Source: Pula Insurance Presentation (2023)

Despite these efforts, diffusion of the WII among smallholder farmers remains relatively unknown. Despite numerous attempts to examine the diffusion of weather index insurance among smallholder farmers, the results are often unsatisfactory and confusing (Ngoma, 2021; WFP, 2022; Zambia Metrological Dept., 2022; FAO, 2019; Pula Insurance Presentation, 2023). This has persisted in proposing rationales that motivate the investigation into the adoption of WII among impoverished smallholder farmers.

The above trends do not clearly demonstrate diffusion and/ or adoption by farmers as it is embedded in the FISP package with all participating farmers obligated to pay for it. There is no evidence portraying the rate of diffusion and/or whether farmers appreciate WII beyond their FISP obligations. According to theory of diffusion, farmers should be willing to easily adopt a technology that benefits them if they appreciate it. There is a dearth of information on the diffusion of WII among smallholder farmers in Zambia – a gap that this study aims to fill.

1.5 Aim or Purpose of the Study

The purpose of the study was to understand the diffusion and adoption of weather index insurance by the smallholder farmers in Zambia and develop model that should be used.

1.6 Study Objectives

1.6.1 Research Objectives

i. To assess the extent of diffusion of WII among the smallholder farmers.
ii. To test whether the theory of innovation diffusion applies in explaining the diffusion of WII.
iii. To develop a model that will enhance the diffusion of WII by smallholder farmers.
iv. To demonstrate an implementation plan for the proposed model

1.7 Research Questions

Sweet & Grace-Martin (2003) state that the research question emphasizes a lack or absence of understanding about an issue. It refers to the gap that the researcher intends to address. This study therefore will attempt to answer the following questions:

i. What is the extent of diffusion of weather index insurance among the smallholder farmers?
ii. What are the factors that affect the diffusion of weather index insurance among the smallholder farmers?
iii. How can the diffusion and uptake of weather index insurance among smallholder farmers be enhanced?
iv. How can the proposed framework be implemented?

1.8. Significance and Contribution of the Study

The study explores the extent of diffusion of WII among smallholder farmers and aims to identify marketing models that can be designed or improved to enhance the uptake of the innovation. The study therefore adds to the body of knowledge around financial innovations in Zambia. With over 70% of Zambians being rural based and dependant on agriculture for their livelihoods, financial innovations targeted at farmers are key for the future of agriculture development. Agricultural investment is often regarded as one of the most efficient and effective ways to promote food security and reduce poverty, with some studies demonstrating a four-fold reduction in poverty over other sectors (ZDA, 2011). An understanding of financial innovations such as WII will enable market actors to advise producers on how to respond to key factors that affect agricultural production such as climate related risks.

1.9. Contribution through Publications

The first publication covered the objective of understanding the extent of diffusion of weather index insurance among smallholder farmers in Zambia. The study therefore unearthed that 34% of farmers in Choma district indicated they were not aware of WII. As such, the study advises that it is important to consider market-led incentives in driving the diffusion of WII among farmers. For this objective, the study revealed that training, marketing campaigns, and capacity building for farmers are very important to help change the farmer's mindset. The private sector needs to step up farmer engagements (Munkombwe et al., 2022), which is a critical policy requirement.

The second publication covered objective two, which looked at the reasons why the extent of diffusion is as it is. The study revealed that about 50.8% of farmers said WII is not consistent and, as such, fails to live on the principle of inclusiveness. Given these scenarios, if the smallholder farmers do not see hope and consistency in WII, it is next to impossible for them to adopt the technology. Therefore, a clear understanding of technology visibility, benefits, training, capacity, and demonstrations is required for enhanced diffusion (Munkombwe & Phiri 2022).

The third publication covered objective three and recommended a framework that should help enhance the diffusion of WII by smallholders and other stakeholders. The framework included looking at multiple players playing multiple functions at the macro, macro, and micro levels to enhance farmer uptake of WII (Munkombwe & Phiri 2023). Given the importance of this model in revolutionizing the WII industry, the country would do well to find an implementation strategy that is in line with this model. If this is followed and implemented accordingly, it will help in achieving Vision 2030, the eighth national development goal, the livestock and fisheries policy, and the agricultural policy as stated in their objectives.

The fourth publication covered the financial landscape of smallholder farmers. Therefore, it reveals that WII diffusion cannot work in isolation from other financial systems. This entails that financial inclusion is very important for farmer adoption of WII (Munkombwe et al., 2022). It requires that crowding in many players would help to achieve weather index inclusion for all.

Finally, the study will therefore inform policy makers on:

i. Models that can be adopted to enhance awareness, diffusion, and adoption of WII, thereby reducing the vulnerability of smallholder farmers to climate hazards.
ii. Gaps in both the design and implementation of WII
iii. Factors affecting the uptake of WII by smallholder farmers.

1.10 Scope of the Study/Delimitation of the Study

According to Simon & Goes (2013), delimitation of a study are those characteristics that arise from the limitations in the scope of the study and by conscious exclusionary and inclusionary decisions made during the development of a study plan. This study covered only Petauke, Mumbwa, Chongwe and Choma districts of Zambia. In this study, the inclusions were as follow:

i. The smallholder farmers in the past four consecutive agriculture season 2016 to 2023.
ii. The Ministry of Agriculture (MoA) in the agribusiness and marketing department (ABM), the insurance providers and input suppliers to get the different perspectives of the enquiry.
iii. Financial innovation diffusion and technology adoption theories will guide the study using the pragmatic approach/methodology.
iv. Research approach, sample size and sampling techniques to be included.

The exclusions were only:

i. All the districts in Zambia except Petauke, Mumbwa, Chongwe and Choma districts.
ii. The study was limited to WII and not to any other such as yield index insurance.
iii. The study was limited to agriculture-based weather index insurance.
iv. The study did not include commercial farmers.

1.11. Limitation of the study

I. The COVID-19 pandemic limited the movements during the study.
II. The study was limited to mixed methods.
III. The study was self-sponsored and hence limited resources.
IV. The study was only limited to the four (4) districts.

1.12 Outline of the Thesis

The study is structured in seven chapters. Chapter one (1) gives the overview, background, objectives, questions, significance and scope of the study, brief overview of the agriculture sector and its relevance, insurance as a solution to climate change, the background to the study districts and different perspectives from the global, regional, and domestic perspectives. Chapter two (2) presents the review of relevant related literature and research that have been done and lessons learnt from other studies in different countries. Literature review enriched the study by strengthening the problem statement of the study. Chapter three (3) present the theoretical underpinnings and conceptual understanding of the study area including the conceptual model.

Chapter four (4) outlines the methodology which includes the research design, sampling techniques, sample population, ethical considerations, definitions of key terms and concepts words and philosophical underpinnings. After data collection using the methodology above, chapter five (5) is about the presentation of the research findings of the study from the selected study districts, the actual researched works, and results from the field. Chapter six (6) presented the discussions of the findings including in-depth explanations and analysis of the results from the study. Chapter seven (7) outlines the conclusions and recommendations of the study.

1.13. Summary of the Chapter

Chapter one has provided the relevant aspects of the research by first introducing the background of the topic on, "Understanding the Diffusion of Weather Index Insurance among Smallholder Farmers in Zambia: Case of Petauke, Mumbwa, Chongwe and Choma. The introduction covered such aspects: Outlook of climate change global, region and Zambia; major challenges in agriculture insurance in Zambia; current trends and initiatives of weather insurance index in Zambia, the case of Pula Consortium Insurance Scheme; statement of the problem; research questions; aim or purpose of the study; study objectives; main objective and specific objectives; significance of the study; scope of the study/delimitation of the study and outline of the thesis. Finally, a chapter summary is provided.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Given the diversity of issues on weather index insurance, this chapter reviewed literature to examine and give an understanding of the variables affecting diffusion of WII among smallholder farmers. It therefore looked at existing knowledge on the subject matter and brief definitions. Further, it looked at past studies and the different perspectives, lessons learnt from other studies and countries. It also looked at the practices on financial innovations around the regions and the different case studies. Most importantly, the chapter established the existing gaps around the diffusion of WII among smallholder farmers based on the various literature. Secondary data was sourced from a literature review of relevant studies conducted online, including Google Scholar, Research Gate, Elsevier, Springer Nature, Scopus, Web of Science, and PUMED, as well as grey literature sources such as government reports, donor websites (World, FAO, IMF), and other hardcopy sources. Additionally, the search terms included "diffusion," "Zambia," "smallholder farmers," and "weather index insurance." The major objective, which spanned from 2017 to 2024, served as the basis for the inclusion criterion. Any year before 2017 was employed for discussion reasons. The search terms in any paper that lacked WII non-English articles were excluded.

2.2 Brief Origin of Financial Innovation

Financial innovations are not a new phenomenon as they have been accompanying technological innovations from the very beginning. It is commonly known that financial and technological innovations are bound together, and hence evolve together over time. On one hand, financial innovations provide mechanism to finance innovative technological projects when traditional sources of funds are unavailable while on the other hand, the technological and economic progress resulting in the higher complexity of business processes and new types of risk forces the financial system and financial markets to adapt to the changes and be modernized according to the new requirements of the business entities and challenges of the modern world. This leads to the conclusion that without financial innovations, the technological and economic development would slow down, and the wealth of nations would be lower. At the same time, the application of the financial innovations would be limited without the demand arising from the technological progress (Block, 2002). Thus, the study

used both diffusion theories and technology adaptation theories to clearly understand the issues around the rate of diffusion and how this could be scaled up. Figure 2.1 gives a historical rise of financial innovation (Adopted from Allen and Gale, 1994, Goetzmann and Rouwenhorst, 2005, Sengupta and Aubuchon, 2008, Allen and Yago, 2010, Davies, 2010, Sudhakara, 2012, Wyman, 2012, Murdock, 2014, Malvey et al., 2013 and Reid and Harrigan, 2013).

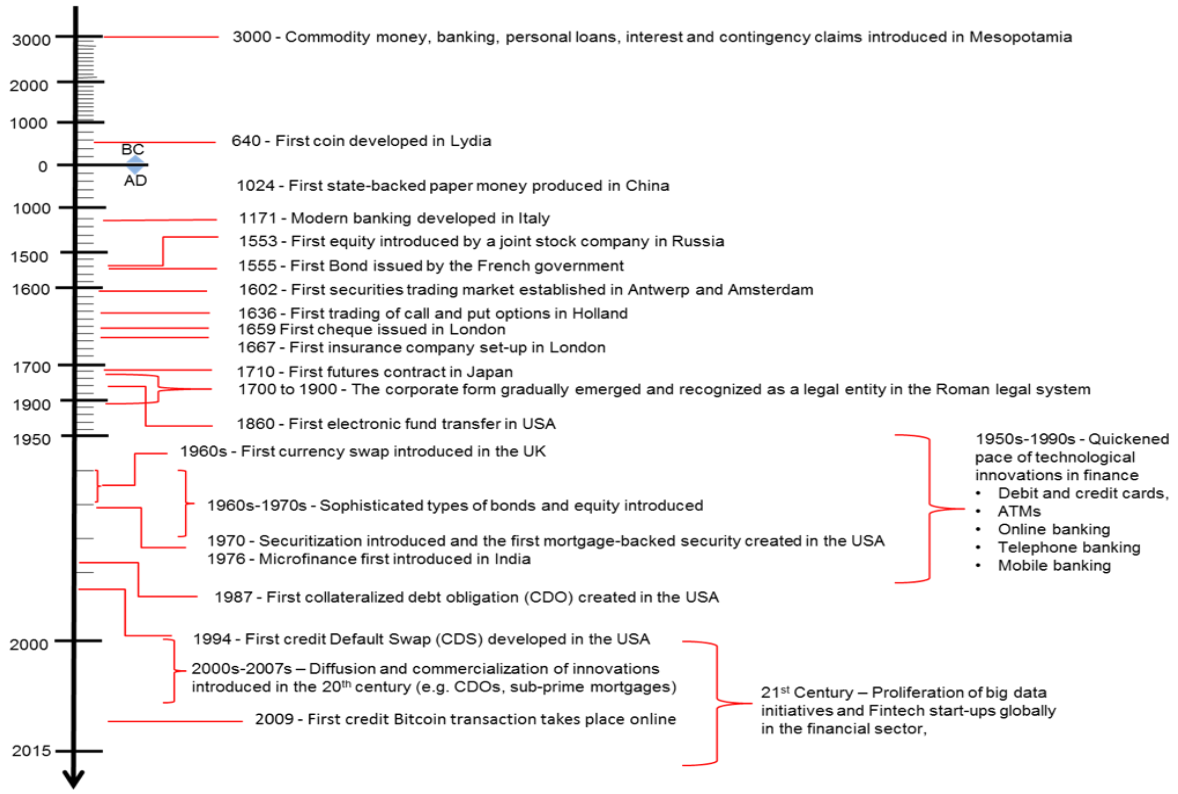


Figure 2. 1 : A Historical Rise of Financial Innovation

2.3 What is Innovation?

Definition of Innovation is a broad concept. The OECD defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD & Eurostat, 2005). This implies that innovation activities are all scientific, technological, organizational, financial, and commercial steps which actually, or are intended to, lead to the implementation of innovations. Innovation is often linked to businesses, but the public domain (which is the other 50% of the European Economy) can innovate too. This includes the public aspects of agriculture ('multifunctionality'). And there is social innovation, a term that not only refers to the social aspects of innovation, but also to innovations in social life. (European Commission, 2016)

2.4 What is Financial Innovation?

According to Tufano (2002), financial innovation is the act of creating and then popularizing new financial instruments as well as new financial technologies, institutions, and markets. According to Lawrence (2010), financial innovation involves the design, the development, and the implementation of innovative financial instruments and processes, and the formulation of creative solutions to problems in finance. Beaver (2002) believes that innovation is an essential element for economic progress of a country and competitiveness of an industry.

A review of the literature on financial innovation reveals that most researchers among them: Llewellyn (1992); White (1997); Tufano (2003); Mishra (2008); Sánchez (2010); Delimatsis (2011) and Gubler (2011). Lerner & Tufano (2011) define financial innovation as the creation and popularisation of new financial products, processes, markets, and institutions. Nevertheless, Mention and Torkkeli (2012; 2014) argue that this definition is narrow thus suggesting a more holistic view of financial innovation which not only acknowledges changes in offerings, and modifications in structures, processes, practices, and distribution channels, by financial institutions, but also emphasizes the need for these to lead to some measurable economic or intangible impact on society. Khraisha and Arthur take a step further and define financial innovation as "a process, carried out by any institution, that involves the creation, promotion and adoption of new (including both incremental and radical) products, platforms, processes or enabling technologies that introduce new ways or changes to the way a financial activity is carried out". They argue in another paper (Khraisha and Arthur, forthcoming) that financial innovation transcends innovations in the financial instruments category and can come from non-financial institutions. The latter definition will be adopted for the purpose of this study (Arthur, 2017).

2.5 Role of Financial Innovation in Emerging Agriculture Markets

The role of financial innovation in agriculture development remains critical. The agricultural revolution will need innovations as drivers to accelerate the rate doing business. In the context of agricultural development, innovation has been defined as "the process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country, or the world" (World Bank, 2012). Innovation of financial products and services continues to play an important function in society to support (among other things) the provision of a medium for

exchange, the funding of economic enterprise, the transfer of resources, the management of risk, the coordination of distributed decisions and the resolution of problems of asymmetric information (Muniesa and Lenglet, 2013). There are a range of financial innovations that farmers can use to reduce risk and increase gains along the value chain, cost, information assimilations, insurance, mobile payments, e-vouchers.

2.6 Financial System.

The modern economy cannot exist without the efficient financial system that is defined as the collection of markets, institutions, instruments, and regulations through which the financial securities are traded, interest rates are determined, and financial services are produced and delivered around the world. The financial system is regarded as one of the most important creations of modern society and it is described as an integrated part of the economic system and by this – a significant part of the social system. Including people in the financial system is much more important than making a bank account. It is a key element of social and economic inclusion. It is about helping people participate in today's connected economy. The evidence suggests that sectors characterized by high technological opportunity and a focus on product innovation perform relatively better in financial systems with large stock markets, competitive banking sectors and good accounting standards (Block, 2002).

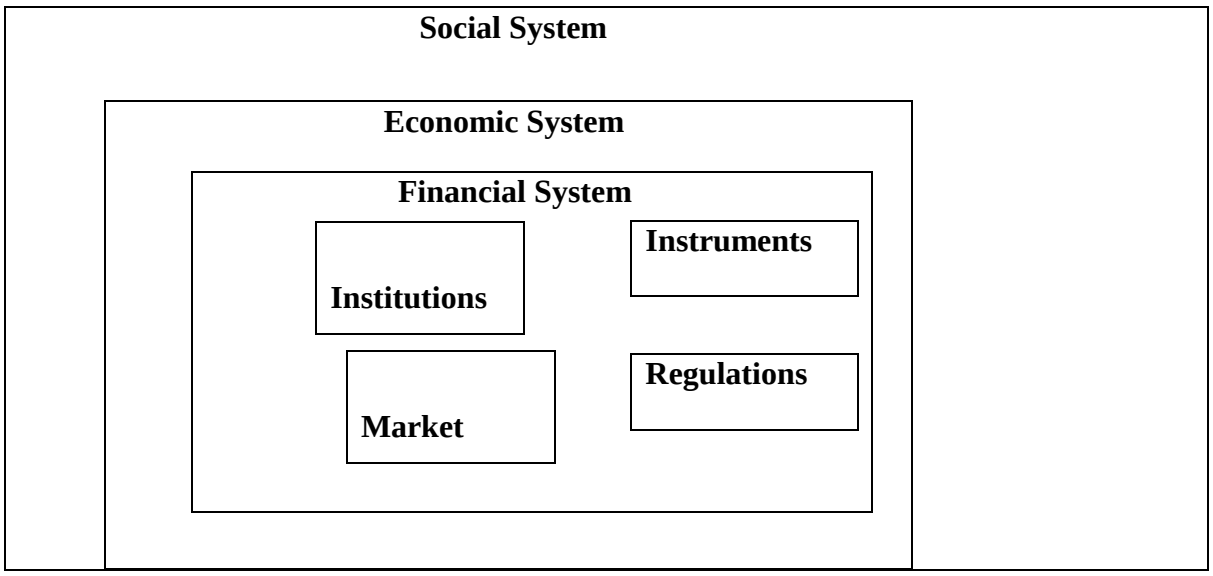


Figure 2. 2: Financial Systems (Block, 2002)

As an integrated part of the global economic system, the financial system determines the cost and the quantity of funds available in the economy to pay for everyday purchases. It creates the mechanism for the flow of funds between various economic entities such as: households,

business firms, governments, and financial institutions. The core role of the financial markets is to transfer the spare funds from the surplus units (households and institutions) to the deficit units (mainly corporations and governments) in the process of transforming savings into investment. Thus, the financial markets attract and allocate savings ((1) investment and (2) financing function), set interest rates and prices of financial assets ((3) pricing function), facilitate transactions ((4) payment function) and (5) risk management (more about financial market functions).

According to the European central bank 2001, the financial system is also particularly important in reallocating capital and thus providing the basis for the continuous restructuring of the economy that is needed to support growth. In countries with a highly developed financial system, it is observed that a greater share of investment is allocated to relatively fast-growing sectors. When we look back more than one century ago, during the Industrial Revolution, we see that England's financial system did a better job in identifying and funding profitable ventures than other countries in the mid-1800s. This helped England enjoy comparatively greater economic success. The banker and former editor of "The Economist" Walter Bagehot expressed this in 1873 as follows:

> "*In England, however, ... capital runs as surely and instantly where it is most wanted, and where there is most to be made of it, as water runs to find its level"(European central bank,2001)".*

Joanna (2011) also observed that as an integrated part of the global economic system, the financial system determines the cost and the quantity of funds available in the economy to pay for everyday purchases. It creates the mechanism for the flow of funds between various economic entities such as: households, business firms, governments, and financial institutions.

According to the Islamic economics, a financial system consists of institutional units and markets that interact, for the purpose of mobilizing funds for investment and providing facilities, including payment systems, for the financing of commercial activity (Kenton,2023). An institutional unit is an entity, such as a household, corporation, or government agency, that can own assets, incurring liabilities, and engaging in economic activities and transactions with other entities.

The role of financial institutions within the system is primarily intermediate between those that provide funds and those that need funds, and typically involves transforming and managing

risk. Particularly for a deposit taker, this risk arises from its role in maturity transformation, where liabilities are typically short term (for example, demand deposits), while its assets have a longer maturity and are often illiquid (for example, loans). Financial markets provide a forum within which financial claims can be traded under established rules of conduct and can facilitate the management and transformation of risk. They also play an important role in identifying market prices ("price discovery"). Figure 2.3 shows financial systems.

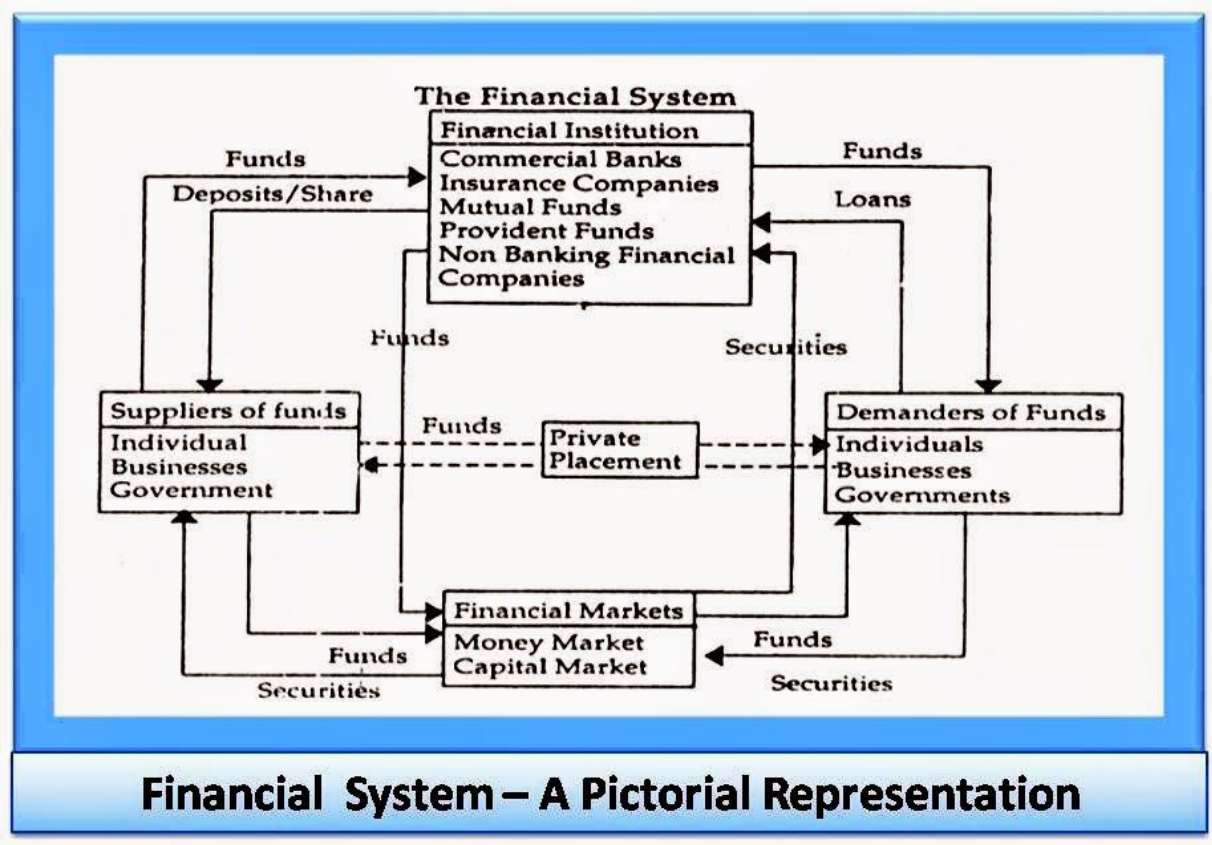


Figure 2. 3: Financial systems (Block, 2002)

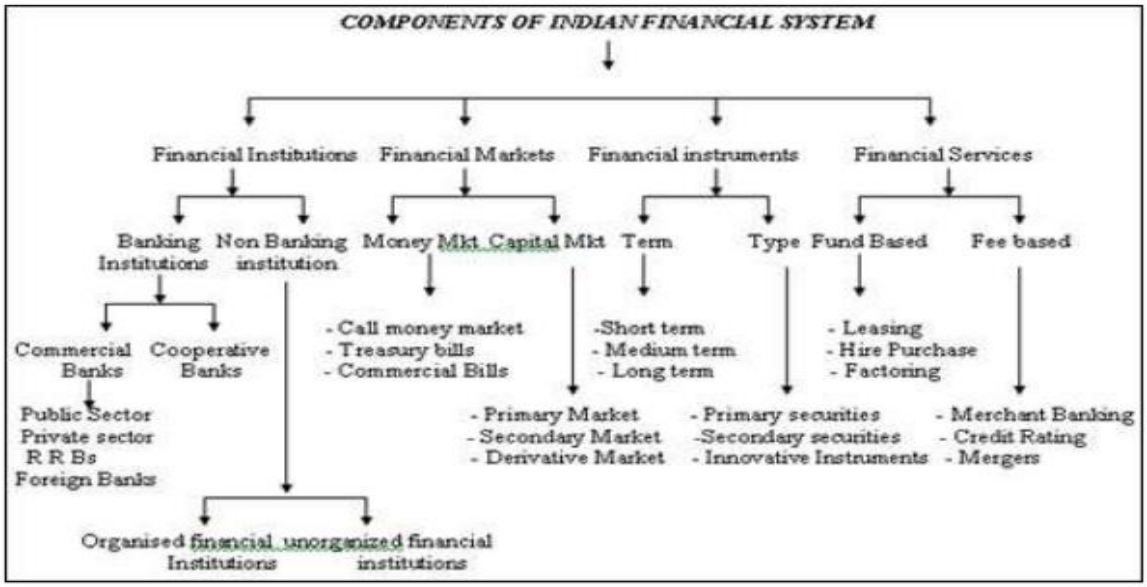


Figure 2. 4: Financial System Structure (Block, 2002)

This study focused on the innovative financial instruments for hedging weather challenges of the farmers through the use of WII product.

2.7 Financial Instruments

Several definitions exist of finance instruments: A financial instrument is an asset or liability that gives a right to receive or an obligation to pay cash (Peters & Vishnia, 2018). Financial instruments are contracts for monetary assets that can be purchased, traded, created, modified, or settled for. In terms of contracts, there is a contractual obligation between involved parties during a financial instrument transaction (Kenton, 2023). The figure below shows types of financial instruments.

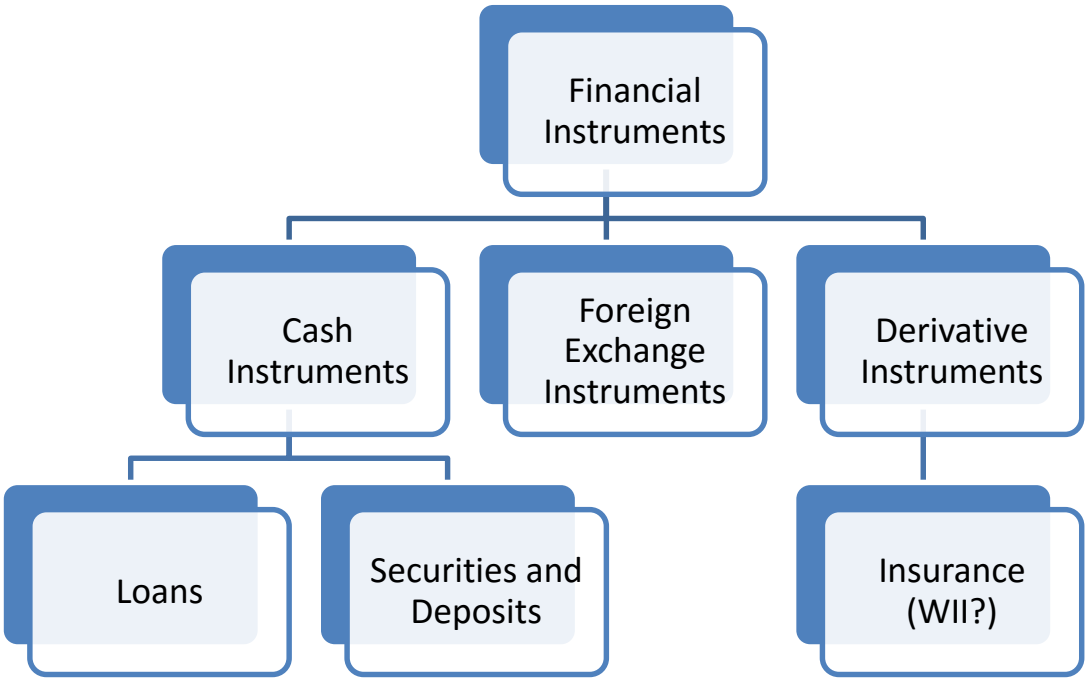


Figure 2. 5: Types of financial Instruments (Source: Kenton,2023)

Index-based insurance (or index insurance) is a contract that pays for losses based on an index, an independent and objective (Mulangu, 2015). Insurance policies are not considered securities, but one could possibly view them as an alternative type of financial instrument because they confer a claim and certain rights to the policyholder and obligations to the insurer (Kenton,2023).

There are a number of insurance-based instruments, the study assessed the diffusion levels of weather insurance index product among the small holders' farmers in the districts of Mumbwa, Choma, Chongwe and Petauke.

2.8 Insurance

Insurance is a way to manage risk – it reduces financial risk of the policy holder. An insurance policy is a written contract between the policyholder (the person or company that gets the policy) and the insurer (the insurance company) (Building blocks student handout,2022). Agricultural insurance is a valuable financial instrument for smallholder farmers. It increases their resilience by avoiding or limiting potentially devastating financial losses. This prevents them from falling into poverty. Insurance also eases access to finance and increases smallholders' productivity. They can confidently invest in their farms and adopt new

technologies that enable economic prosperity and eventual graduation from poverty (Sygenta Foundation for sustainable agriculture ,2023).

2.8.1 Classification of Agricultural Insurance

Agriculture based insurance is classified in various categories based on the objectives.

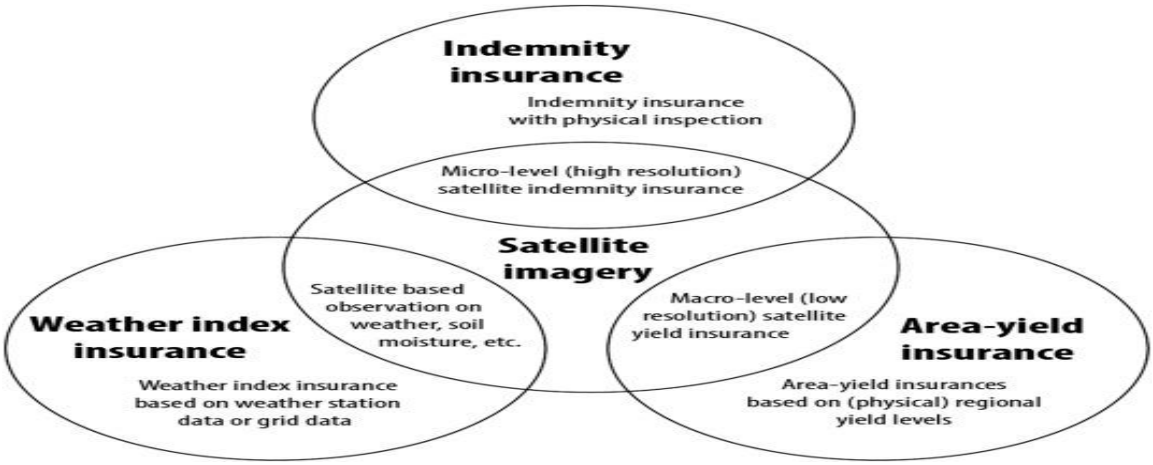


Figure 2. 6: Classification of agriculture insurance. Adopted (Leblois and Quirion., 2013).

The spectrum of agricultural insurance solutions is broad, from traditional indemnity-based products (e.g. multi-peril crop insurance) to different forms of index insurance (weather, satellite-based vegetation indices, area yield-index) (Syroka & Reineck,2015). Index insurance is a relatively new but innovative approach to insurance provision that pays out benefits on the basis of a predetermined index (e.g. rainfall level) for loss of assets and investments, primarily working capital, resulting from weather and catastrophic events (Building blocks student handout,2022).

2.9 Weather Index Insurance

Weather index-based insurance products use an underlying index to determine losses due to a specified event (Weather Index Insurance and Transforming Agriculture in Africa.pdf (afdb.org). It aims to 'reduce the impact of harmful weather on farms whose [economic] margins widely depend on climate' [(Leblois & Quirion (2013)]. All sorts of weather phenomena can be used as the underlying index. Precipitation, temperature, wind, solar radiation or combinations thereof, and also water capacity-based indices (e.g. soil moisture indices) have been considered [(Leblois & Quirion (2013)].

WII is a relatively new type of financial risk transfer product, which could help to overcome some of the problems with traditional insurance schemes. Unlike indemnity-based crop

insurance, where an insured farmer receives compensation for the verifiable loss at the end of the growing season, WII makes claim payments based on the realization of an objectively measured weather variable (e.g., rainfall) that is correlated with production losses. Neither the insured farmer nor the insurer can easily manipulate rainfall measurements, which reduces issues of information asymmetry. Moreover, instead of reducing effort to increase chances of compensation, farmers with WII have an incentive to make the best farming decisions. In comparison with traditional insurance, WII is less expensive to administer, which can lead to more affordable contracts and faster payments to farmers, who often need the funds for timely planting in the subsequent season (Kenneth, 2018).

The most attractive technical characteristic of the WII product is that it relies on a model that predicts the changes in yields of specific crops (or livestock enterprises) resulting from changes in weather parameters. The insurance industry needs to monitor only key weather parameters near the farmer's crop, not the crop itself. Indemnities can be paid based on remote observations of weather conditions, without having to assess damages in farmers' fields (Carlos, 2016).

This innovation carries the potential to avoid several key shortcomings of traditional agricultural insurance in developing countries. There is no moral hazard and low adverse selection because the trigger for pay-outs is based on objective weather observations. Equally important, the elimination of field assessments means that administrative costs can be drastically reduced. These factors increase the possibility that WII may be commercially sustainable (Carlos, 2016).

WII became feasible when FAO developed the water requirement satisfaction index (WRSI), which estimates yields based on rainfall patterns. An early programme in India tested WII's potential for protecting the rural poor. The World Bank then promoted a series of pilot projects intended to provide low-cost, commercially sustainable, individual protection for small farmers in several other developing economies (World Bank, 2005). In large part due to World Bank support, more than 15 developing countries introduced experimental WII pilot programmes for individual farmers (Carlos, 2016).

2.9.1 Brief History of Weather Insurance Index and Development Process of Weather Index Crop Insurance

WII originated from the international weather derivative market which corporations used to hedge weather risks. In 1997, the first weather derivative transaction related to temperature variation was conducted in the US (Matei & Voica (2011). By 1999, WII was being discussed in academic papers as an alternative solution for developing agricultural economies. In 2002, the World Bank embarked on a WII agenda and disbursed substantial loans and a component of technical support for crop specific insurance in India (Ankara,2021). The contracts involved an index based on one or more weather conditions (such as temperature, precipitation, wind speed, etc.) that are implicitly related to a level of crop damage or income loss. When the index reaches a certain level, the insured can obtain the corresponding compensation according to the set contract Sadler & Mahu (2009). The interest in WII for crop production came from an observation that the old crop insurance products were not viable for many countries where small average farm sizes and lack of commercialization are major obstacles to the sustainable development of crop insurance products.

Weather index insurance principles were initiated by Halcrow (1948) and further developed by Dandekar (1977). Skees *et al.,* (1999) theoretically proposed these principles for developing countries and later on empirically tested in Morocco (Skees *et al.,* 2001 & Wamuyu,2017) provided a more formal framework for WII in agriculture. Using historical rainfall and temperature data, Turvey (2001) illustrated how WII could be used to address specific-event risks measured at the local level and how rainfall and heat insurance could be priced in practice (Tadesse *et al.,* 2015). Further, the evolution of WII is traced as indicated by Bagazonzya and Kloeppinger-Todd (2007) divided the development period for WII into two phases as indicated below.

First Stage 1997-2001

i. First weather derivative insurance transaction in U.S. in 1997.
ii. Incorporated into research agenda of the World Bank in 1999.
iii. Academic focus on designing generic applications for the rural sectors of developing countries.

Second Stage, 2002 Onwards

i. First involvement by diverse donors in financing project development costs.
ii. Focus on design and implementation of pilot-scale WII projects.

iii. Activities being prepared in Central America, Vietnam, Kenya, and Tanzania.

Conversely, Syroka (2007) argued that WII has experienced three stages. The first stage from 1997 to 2001 was mainly concerned with feasibility studies from a theoretical angle. Most academics focused on the design of generic applications for the rural sectors of developing countries. The second stage lasted from 2002-2005 and involved diverse donors financing project developments, and some pilot-scale testing. The research moved to project design and implementation, collecting interesting experiences at national and farmer level, from Mexico (2001), India (2003), Ukraine (2005), Malawi (2005), and Ethiopia (2006). From 2006, there has been a dramatic increase in investments related to index-based insurance programs from the international community, World Bank, IFC, European Investment Bank, Asian Development Bank, Caribbean Development Bank, and World Food Program [(Barnett & Mahul (2007)] investment is also more diversified, focusing on new risks and more countries, innovative distribution channels, new risk assessment technologies, capacity building, design of new applications, systematic project evaluation, and developmental impact. The research extended to the deployment of a sustainable, scalable, standardized project.

2.9.2. Vulnerability Assessment and Theoretical Appeal for Weather Index Insurance

We begin by looking at the vulnerability appeal of agriculture, in which most marginalized smallholder farmers are engaged. It is well-known that agriculture faces numerous risks directly impacting crop production and food security challenges for poor rural farmers. Hence, changes in the climate have direct effects on those who do not have irrigation facilities. Climatic stresses and many other factors can cause sudden losses in farmer production and production capacity, resulting in highly volatile returns coupled with inferior market opportunities, predominantly in the rain fed dependent areas, of which most farmers are part. Indeed, growing evidence suggests historical food insecurity globally because of climatic influence [(Niles & Salerno, 2018; Ray et al., 2015]; Ngoma *et al.*, 2021). Chinseu *et al.*, (2019); Rosen *et al.*, (2021), submitted that extensive climatic and socio-economic vulnerability challenges the wellbeing and livelihoods of low-income agriculturalists that make up the majority of rural populations in developing nations (Duwenu *et al.*, 2020,De Javry,2014). For many years now, most countries and regions in Africa have had recurrent droughts worsened by socio-economic and political unpredictability, causing most lives to be lost from natural disasters between 1980 and the present (Rasmussen, 2018; White 2021). A

changing climate is predicted to exacerbate variability and lower agricultural production and productivity per unit area, hurting rural livelihoods worldwide today and in the future (Arnell *et al.,* 2016). As a result, risk management tactics, inexpensive technology, and policy packages from changing climate programs that encourage rural community development are critical (Vidal-González & Nahhass, 2018).

As a risk-management method, smallholder farmers frequently use limited external inputs in their production systems (Moder *et al.,* 2019). Low productivity and production concerns may have implications for everyone. Keeping the cost of purchased inputs low, on the other hand, helps to minimize financial loss in years with bad weather when crop yields are already poor. Nevertheless, everyday input use also constrains results in good years and thus hampers average farm productivity and income growth (Williams *et al.,* 2021). It, therefore, seems that crop insurance that compensates farmers for low yields in bad years could promote higher input use (Hansen *et al.,* 2019). However, traditional indemnity-based crop insurance barely exists in developing countries due to high transaction costs (Ghosh, 2020). Nevertheless, today, across the globe, weather index -based crop insurance has been acknowledged as an efficient hedging strategy against extreme weather events and is often used to mitigate unexpected losses (Panda, 2013, Platteau *et al*., 2017; Arun Khatri-Chhetri *et al.,* 2021).

Weather index insurance (WII) may be an appropriate option for reducing transaction costs due to its attractiveness, potential, and affordability. The fundamental difference that would benefit farmers is that, unlike indemnity-based insurance, WII pays out to farmers based on a transparent and objectively observable weather variable with less human influence, such as rainfall, rather than real crop damage (Yiran & Stringer, 2016). WII aids in the reduction of moral hazards and adverse selection issues that are typical in traditional insurance systems (Barnett and Mahul, 2007). As a result of the farmers' central trust, WII may incentivize higher input use by decreasing risk and relieving financial limitations (Farrin & Miranda, 2015). However, there is a scarcity of scientific proof about the real effects, making it less appealing for farmers to embrace (Williams *et al.,* 2021; Singh *et al.,* 2018; Farrin & Murray, 2014; Carter *et al.,* 2016). However, many households may not be aware of the monetary cost of their production risk, making the appeal of WII unappealing to them—it appears that many families have never been exposed to this way of thinking (Wigwe *et al.*,2021).

Agreeing with the current appeal of WII, the World Bank report of (2007) also asserted that risks are high in agriculture, especially among the smallholder farmers. Exposure to uninsured risks is a significant cause of low yields, slow growth, and persistent poverty (Gupta *et al.,* 2017). Moreover, weather-related risks are enormously significant for poor people in developing countries as an estimated two-thirds of them depend on agriculture and natural resources for their wellbeing (FAO, 2021). Apart from farmers, uninsured weather shocks thus affect both the demand and the supply side that includes; farmworkers, input suppliers, entrepreneurs and workers in agribusiness, and providers of non-tradable goods and services in the rural non-farm economy (Cabot, 2017; Mclntosh *et al*., 2013). Therefore, understanding current risks facing different stakeholders and finding vulnerable populations can be extremely important as a starting point for local decision-makers, systems designers, and policymakers and will likely contribute to economic development through improved risk management (Unterberger & Olschewski, 2021;Sivuka *et al.,* 2021).

As obtained in the introduction, it is estimated that about 2.5 billion people in lower-income countries are "in households involved in agriculture" (Haanyika et al., 2021; World development report,2008, Barnnet *et al.* 2009; Collier et al., 2009). In the case of Zambia, 69% of the rural Zambian population depends on agriculture for their incomes and consumption (Chapoto & Subakanya, 2019). Roughly 70% of the labour force in Zambia works in agriculture, where there are approximately 1.6 million small-scale farmers and about 1,000 large scale commercial farmers (IAPRI, 2012). Thus, weather-related shocks have a broader impact than agriculture because they tend to covariate across vast geographic areas, particularly among rural populations, which house most smallholder farmers.

Nevertheless, the insurance markets are underdeveloped or non-existent. The introduction of WII was triggered by the weaknesses demonstrated by traditional agricultural insurance(Genesis analytics, 2018), which based indemnity payments on verifiable losses and appeared not to offer opportunities for smallholder farmers to understand it clearly (Helder & João A., 2018; WFP, 2021). Two significant critical problems with such traditional agriculture insurance policies are the potential for fraud and the high operational costs of issuing contracts to large numbers of distributed smallholders in remote rural areas. Moreover, non-existence of farmer aggregation present design challenges in the correct models, especially in countries with low-density populations per unit area. If this is coupled with low or non-existence uptake by

farmers, there seems to be an agreement that traditional insurance products do not work in such circumstances (Carlos, 2016; Syroka & Reinecke, 2015).

2.9.3. How Does Weather Index Insurance Work?

Weather index insurance, which is gaining popularity in lower-income nations, ensures a weather risk that is often significantly connected with agricultural production losses as a surrogate for economic loss. This instrument should save money over standard farm insurance despite the high start-up expenses and absolute risk. (Barnett *et al.,* 2009).

The farmers must pay a pre-determined amount to the insurance firm to obtain the product. These are known as "premiums," They are not refunded if there is a payout. If the weather has been terrible enough to trigger a payout as per the product criteria, a payout is expected with weather index insurance. In the event of drought or excessive rain, insured farmers can replant due to the early payout long before the conclusion of the growing season (Greatrex *et al.,* 2015).

The WII captures weather events and is measured throughout the season using satellite technology. Current weather index-based insurance services use technology to automate and digitize key steps in service formation and provision, such as satellites and automated weather stations (AWS) to collect the weather data needed to calculate indices (GSMA, 2020; Aditya *et al.,* 2020).

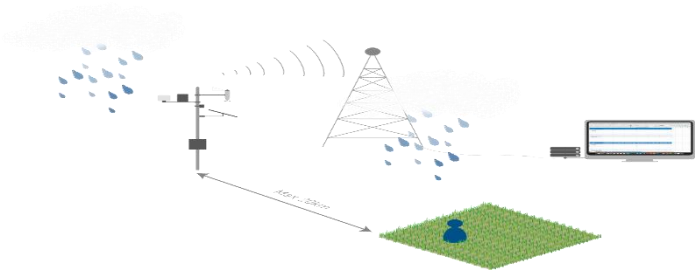


Figure 2. 7: showing insurance set up ***Source:*** *(Musika, 2017)*

Satellite estimation of rainfall over farmers' fields (aggregated) for different locations in Zambia, based on GPS coordinates of reference points. The information collected by the satellite is used to compute the insurance pay-out. Index insurance payments are made in this scenario grounded on an indirect indicator that functions as a representation for loss or damage. The index is based on historical data, and it verifies when payment is triggered using current season data. When the index starts, all farmers in a particular area typically acquire the exact insurance for the same price and get the same rewards (1FAD, 2017).

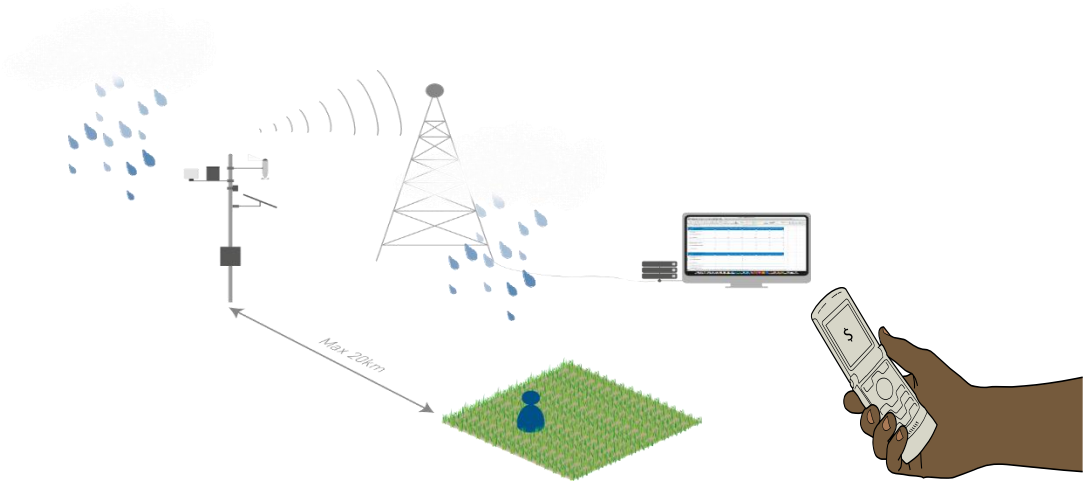


Figure 2. 8: showing illustration of how WII works Source: (Musika, 2017).

The insurer is alerted of the claim event, and the claim is processed after the trigger levels are met. Insurers, reinsurers, input suppliers, and farmers regularly receive weather reports. As a result, everyone is on an identical sheet regarding weather data. A payout is provided automatically based on the weather events (e.g., droughts, dry spells). Typically, a payout is provided through distribution channels. The insurance firm will award pay-outs accordingly in the case of some pilots in India, crediting the money directly to each qualifying farmer's bank account. The farmer receives a final SMS communication stating that the settled insurance claim. Farmers can rest assured that they will be reimbursed if they wake up to discover whirling floodwaters threatening their livelihoods (Giriraj, 2017).

If satellite rainfall data indicates that a pay-out is required in the area, the same percentage pay-out is paid to all farmers registered at that weather station, and no field visit or assessment is required (Matt & Mehta, 2018; FAO, 2021). The weather insurance index occurs based on historical data, which is verified when payment is triggered using current season data. When the index triggers, all farmers in a particular area typically acquire the exact insurance for the same price and obtain the same rewards (1FAD, 2017).

The rewards are provided automatically when an index goes above or below a pre-determined threshold. (GSMA, 2020). The farmer does not need to fill in any documentations to get payments (CNAAS, 2020).

The higher the payoff, the more complex the weather; however, the pay-out is consistent throughout the area. Instead of providing coverage at the farm level, index insurance offers a range against specific dangers across a defined area (GSMA, 2020).

2.9.3.1 Insurance Contract Components

Index insurance payouts are determined by a "formula". This formula is based on the agronomic characteristics of the crop insured. Most crops follow a particular crop growth cycle and have different risks at the different phases in their growth cycle. The formula takes into account these differences by setting triggers accordingly. The below illustration provides an example of a crop growth cycle for maize.

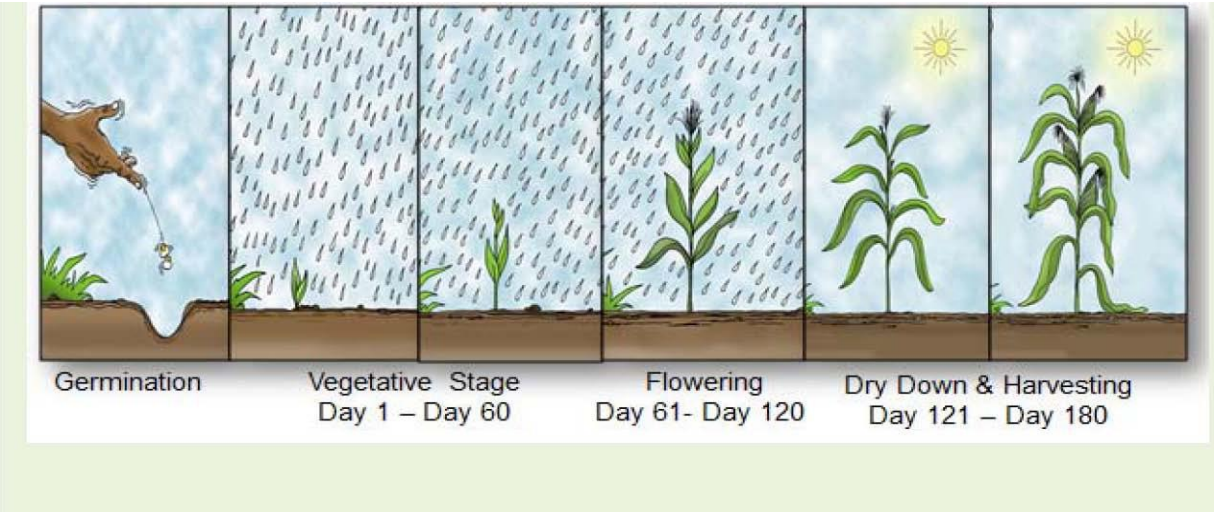


Figure 2. 9: Crop Growth Cycle (Musika,2017).

Crop Growth Cycle- cycle of events through which a crop develops from planting to harvest.

Risk Period or Contract Period-the particular duration when the crop is most susceptible to a specified insured event occurring. A contract period is often divided into different phases.

Contract Phases - these are identified critical periods in the growing season in which a crop is vulnerable to risk.

Triggers - used to determine payouts. During the contract period, we use satellite to estimate the amount of rainfall received. Each contract phase has what is called a 'trigger'; for the case of a drought index if the total rainfall amount is more than the trigger, there is no payment.

Any rainfall total below the trigger will result in a payout. Payments will increase for each millimeter (mm) of rainfall below the trigger, until a maximum payment is reached.

Index Exit – is the maximum payout point. Depending on the terms of the contract it could either be the maximum probable loss or the sum insured.

2.9. 3.2 Methods of Compensation.

In index insurance, compensation is determined by data recorded by the satellite. If the results show that there is a payout, all farmers insured under the same reference point are paid regardless of the situation on individual farms.

Methods of paying compensation vary with insurance company. Compensation methods available are direct bank transfer and cheque. They are also studying to see if payment can be done through the e-voucher.

2.9. 3.3 How is the payout calculated? An example of a payout structure.

Maximum payout of a product is K 600 per unit. Maximum of 50% is paid out for Early Dry Spells (15 Dec- 31 Jan), so maximum payout is K 300 per unit.

If the Normal level over 20 days (1^{st}- 20^{th} January) is 100 mm and the Trigger is 60% of Normal, then the Trigger level is 100 mm x 60% = 60 mm.

Payouts start when rainfall is less than 60 mm, with maximum payout of K 300 being made when rainfall is 0 mm over the 20-day period (1^{st}-20^{th} January). Hence for every 1 mm deficit K 5 (K 300/60) is paid out.

If the actual rainfall is 20 mm over the 20-day period, then this is 40 mm (60-20 mm) less than the trigger level. Hence Payout = K 5 x 40 = K 200 per unit.

2.9.4 Critical Points for Weather-based Index Insurance.

The weather is not easy to be observed and objectively measure (Nick Miller, 2020). the insurance payout. Hence , the weather variables that can form an index must satisfy the following properties: observable and easily measured Objective, Transparent Independently verifiable , Reported promptly ,Consistent over time experienced and over a wide area (World Bank, 2011; (https://www.climateinvestmentfunds.org; Swiss Re Corporate Solutions, 2019).

Weather insurance protects against losses caused by a specific weather index, such as too much or too little rain. However, other non-weather threats, such as pests and diseases, are not covered (Balafoutis *et al.,* 2017) Barrett (2016) agrees, stating that index insurance products are typically limited to a particular risk linked with a specific type of output (e.g., crop drought risk) (Barret *et al.,* 2016).

Payouts are based on the local weather station's weather, not the farm (Perrone, *et al.* 2020). Therefore, if rainfall is different at the farm than measured by the satellite, the farmer may not receive a payout even if he experienced a drought or excess rain that damaged his crop (FAO,

2021). However, if approved, payouts come quickly to provide compensation when the farmers need it most in a particular season, allowing them to use resources for alternative opportunities to help increase resilience (Fanconi & Scheurle, 2017;) Insurance has also been shown to increase average overall farm revenue (net of insurance premiums and indemnity payments) among Ghanaian farmers (Delay *et al.*, 2022, Karlan *et al.*, 2014, GSMA, 2020., He *et al.*, 2019) and to develop livestock productivity and child health for pastoralists in Kenya (Karlan *et al.*, 2014), Jensen *et al.*, 2016a). Premiums are non-refundable and must be paid in advance (Greatrex *et al.*, 2015). A premium is usually only valid for one season and is not carried over to the next season without payout.

However, if approved, pay-outs come quickly to provide compensation when the farmers need it most in a particular season, allowing them to use resources for alternative opportunities to help increase resilience (Fanconi & Scheurle, 2017).

2.9.5 Applications of Insurance (WII) at the Different Levels Micro, Meso and Macro

While there is no single way to categories the variety of applications of index-based weather insurance on the continent, one can loosely group the different approaches being used into macro, micro-, and meso-level weather insurance.

2.5.5.1 Insurance for Individuals: Micro.

In this broad categorization, index-based weather insurance at the micro level is the use of index-based products for direct sale to individuals i.e., farmers. These farmers can be commercial farmers or smallholders that can transform into commercial farmers, but insurance to poorer farmers has also been considered. The products essentially mean that the individual clients are the direct policyholder. This requires that the product being sold matches the specific risk profile of the policyholder since that policyholder would likely both pay for the insurance and be compensated directly in case of losses. Micro-level index-based weather insurance policies are therefore often sold at the local level and the product design requires significant ground-truthing with policyholders to ensure that the policy being sold adequately predicts losses on the ground (the potential mismatch between the index and what has happened on the ground is known as “basis risk”). These policies can be, and have been, retailed through a wide variety of channels including direct sales from insurance companies, agribusinesses, input suppliers, and banks among others. There have been many small pilot programmes in Africa to test these products and determine how to best utilize these products to the benefits of policy

holders. In most cases these programmes are yet to reach scale although some are showing promising results as they work to overcome some of the key constraints in designing and implementing these products. These include the quality of the index as a representation of losses, the need for significant investment for product design along with the willingness and ability of clients to pay.

2.9.5.2 Insurance for Businesses and Financial Institutions: Meso.

Weather index insurance at the meso-level includes the use of institutions and businesses to protect their own investments. Just as farmers are exposed to the weather, banks, services providers, and traders that deal with farmers also face this same exposure. Their ability to manage risk allows them to stay in business in the face of defaults and volatility in volumes of agricultural goods delivered, loans repaid, and services utilised. These clients are often looking at policies that cover a larger geographical spread and more extreme events then direct buyers. While there are still challenges to implementation at the meso-level, some of the technical challenges are diminished and the costs of retailing significantly reduced as clients are companies rather than individuals. Policies can be sold to larger entities and these clients can often better absorb potential basis risk due to their greater financial capacity.

2.9.5.3 Insurance for Governments: Macro.

Macro or sovereign-level index insurance is the use of index- based products by governments – local, national, and sub-national – to allow them to manage liquidity constraints in times of disaster or to respond to the needs of their constituents, which increase due to weather variability and its impacts on their food security, lives, and livelihoods. In Africa, in most cases, work on weather index insurance at the sovereign level has focused on assisting governments in responding to humanitarian needs because of extreme weather variability. This type of insurance was first tested for drought in 2006 and 2008 by the Governments of Ethiopia and Malawi through facilitation by the United Nations World Food Programme and the World Bank respectively. More recently, the African Risk Capacity (ARC) was established as a Specialized Agency of the African Union in 2012 and since 2014 has been working with African Member States to insure their drought risk through ARC's financial affiliate ARC Ltd. These macro products directly insure governments, but a significant amount of upfront work is required to make them effective. To be able to access ARC's insurance, for example, governments must

integrate these products into their disaster operations by developing contingency plans as to how pay-outs will be used, conduct technical work to design an index that accurately predicts governments' needs, and, finally, pay a premium to enter the contract. The ARC Agency provides capacity building to countries to help them complete these requirements and join the ARC Ltd insurance pool.

2.9.5.4 Weather Index Insurance and Transforming Agriculture in Africa

At the micro-level, it is widely hypothesized that farmers who are protected by insurance will have better access to finance, greater resilience to shocks, and access to higher cost, higher yielding inputs that will increase incomes. At the meso-level, the belief is that these products will allow banks to operate more efficiently and service providers to extend their reach and reduce rates. While much of the academic literature has explored these hypotheses, the ability of these products to deliver these outcomes will be based both on increasing the scale at which they are used but also through robust research and analysis of the use of these products on households and the agricultural sector. With significant innovation currently in the micro and meso field both the number and scope of products being tested is also growing.

In the case of sovereign-level index insurance the African Risk Capacity – the only sovereign programme that is current operational on the continent – insured four governments (Kenya, Mauritania, Niger and Senegal) against drought in its first year of operation and nine (Burkina Faso, Kenya, Mali, Malawi, Mauritania, Niger, Senegal, The Gambia and Zimbabwe) in its second. In its first year of operations three of these four governments received pay-outs from ARC due to poor rainfall in the Sahel which have been used to assist 1.3 million drought affected people. ARC is actively working to expand its risk pool and by 2020 hopes to insure up to 30 countries with USD 1.5 billion in insurance coverage against drought, floods and cyclones.

While ARC's insurance pays out directly to governments, the use of these pay-outs is almost always targeted at the poorest of the poor in rural areas. The premise of ARC's value proposition to Member States is that assisting countries in reaching those vulnerable and affected – usually poor or subsistence farmers – quickly and effectively ahead of traditional humanitarian aid can help prevent asset depletion and protect livelihoods. In turn this means they can continue investing in their agricultural activities and increase their chances of joining or remaining productively involved in the economic sector. Budgeted, planned and timely

responses at the national level, like those facilitated by ARC, could also help mitigate the larger-scale macro-economic impacts of disasters such as drought as identified above.

2.9.7 Benefits of Insurance

Insurance enabling linkages to markets - Traders buying produce, supermarkets stocking food and exporters buying food for the international markets are all interested in a stable supply of crops. If such a stable supply can be guaranteed, traders, supermarkets and exporters are willing to set up long-term agreements with farmers that allow farmers to know their market price and income in advance. Some agribusinesses are willing to provide farmers with farm inputs in situations when farmers have supply contracts in place.

Farm risks can disrupt this continuity and will threaten long-term price contracts made with buyers. Buyers may decide to buy from other regions and will find that inputs forwarded were not repaid following the occurrence of farm risks.

Insurance enabling access to credit - Agricultural insurance and rural finance are linked. Farmers who borrow from formal financial institutions have more incentives to purchase agricultural insurance, either because the banks require their loans to be protected against climatic risks or because these products allow them to access credit at better terms.

Insurance gives farmers peace of mind to invest in their farm and treat it as a business. As farmers learn that insurance companies can cover certain risks that they face, they can make investments in their farm that they previously might have avoided because of the risks. This means that farmers can make the most productive use of their scarce resources and can make their farm as profitable as possible.

2.9.7.1 Benefits of Insurance and Weather Index for a Farmer.

i. Peace of mind; when individuals have insurance in place to deal with the financial burden of losses from insured risks, they are encouraged to invest more in their farms.
ii. Risk transfer: Insurance does not prevent losses from occurring. The primary function of insurance is to transfer the financial consequences of an insured risk to an insurance company.
iii. Risk pooling: Insurance gathers together people who want insurance protection and creates a pool from which contributions of the entire pool compensate the unfortunate few who suffer from loss.

iv. Objective measure of loss; In Index insurance the weather is easy to observe and provides an objective trigger for the insurance payout. Since weather events mainly affect large areas simultaneously, index insurance is a good tool for helping small holder farmers farming in similar crops in a region.

v. Fast claims process: Payouts are calculated automatically for all insured farmers under the same reference location – there are no claims to file.

vi. Preservation of source of income; Payouts come quickly to provide compensation when you need it hence improving sustainability of crop production.

vii. Boost access to credit; Financiers are more willing to offer credit because with weather index insurance their risk has reduced. Insurance may also enable contract farming. An agricultural marketing company contracting farmers would be interested in securing continuity of production for their farmers. They identify the crops key risks and would encourage their farmers to protect their inputs and potential harvests against the identified risks.

2.9.8 Common Challenges for WII

2.9.8.1 Consumer Related

i. Limited Demand for Insurance.

Household demand for insurance against catastrophic risk is low.

ii. Insurance Literacy

In most developing countries where WII have been piloted, the primary target beneficiaries are the stallholder farmers and many lack experience with insurance products.

iii. Lack of Consumer Confidence

A well-defined legal and regulatory framework will give consumers the necessary sense of protection and confidence on WII products. Experience has also shown that when insurance is liked to index products that farmers trust, and sold by trusted distributors, many are willing to give it a try.

2.9.8.2 Institutional Related Challenges

For most insurance firms index insurance is a new phenomenon of which they have no experience. To compound the situation, there is no historical data to allow proper determination of insurance prices.

i. Distinguish Between Social Versus Development Insurance.

Social promotion of insurance aims to protect assets and livelihoods of poor people from catastrophic loses and may entail subsidies. Development insurance aims to promote agriculture development and should be channeled through private intermediaries and subsidy free.

ii. Lack of a Leading Champion Institution

In the past the design and technical support for WII has been largely provided by donors. The rationale is to pilot to allow for commercial player scale up the projects.

2.9.8.3 Infrastructural -related Challenges

i. Sparsely Distributed Weather Station Network

Not many countries in Africa (except south Africa) have a well -developed weather stations network that covers the expansion of rural areas. besides physical presence of weather stations, there is also the need to collect, maintain and archive data as well as making the data readily available for insurance rating purposes.

ii. Non-Homogenous Microclimate

The fundamental assumption with weather stations is that farmers within the vicinity of the station (approximate 20km radius) are likely to experience similar weather patterns. however, in some cases it turns out that even within 20km radius rainfall patterns can differ as areas experience dissimilar microclimate and hence Basis Risk Becomes an Issue (Makaudze, 2012).

2.9.9 Global Perspectives of Agriculture Insurance

In recent years, there has been excitement among academia as well as practitioners about the prospects of introducing weather index insurance to manage smallholder farmers' risks in developing countries (Awel & Azomahou, 2014). Within a decade, there has been numerous weather index insurance pilot programs in Ethiopia, Kenya, India, and China (Janzen & Carter, 2013; Cole & Vickery, 2014).

We begin by appreciating the background of weather index insurance. as obtaining, it seems the weather insurance index originated from the international weather derivative market, which corporations used to hedge weather risks. According to Matei & Voica (2011), the first weather derivative transaction related to temperature variation was conducted in the US way back in 1997. By 1999, weather index insurance was discussed in academic papers as an alternative solution for developing agricultural economies. In 2002, the World Bank embarked on a weather index insurance agenda and disbursed substantial loans and a component of technical

support for crop-specific insurance in India (USAID, 2007). The contracts involved an index based on one or more weather conditions (such as temperature, precipitation, and wind speed) that are implicitly related to a level of crop damage or income loss. According to the set contract, the insured can obtain the corresponding compensation (Sadler & Mahul, 2009). The interest in weather index insurance for crop production came from an observation that the old crop insurance products were not viable for many countries. Small average farm sizes and lack of commercialization were significant obstacles to the sustainable development of crop insurance products.

Figure 2. 10*: shows agriculture insurance coverage for smallholder farmers across developing and middle-income countries.* Source: Adopted Number of Farms (Lowder et al., 2016; Nshakira-Rukundo et al., 2021) The data does not include Somalia, Sudan, Eritrea, Mauritius, or Burundi. Number of insurance policies (Hess & Hazell, 2016; Kaunda & Chowa, 2023), current coverage—authors' estimates from several sources.

Table 2.1: Global Number of Insurance Policy's View

	Latin America & Caribbean	Asia	Africa
No of small farms	21,005,083	420,078,903	59,056,107
No of insurance policies	3,315,626	194,185,463	600,975
% of insured smallholder farmers	15.8%	46.2%	1.0%
Current coverage			2,039,506
% of farmer currently insured			3.5%

Sources*:* Adopted Number of Farms (Lowder *et al*., 2016., Nshakira-Rukundo *et al.*, (2021) Data does not include Somalia, Sudan, Eritrea, Mauritius and Burundi. Number of insurance

policies (Hess & Hazell, 2016; Kaunda & Chowa, 2023), Current coverage – authors' estimates from several sources.

2.9.10 Agricultural Insurance in Africa: An Overview

Agricultural insurance has been present in some African countries since the early 20th century (Adesimi and Alli, 1980; Alli, 1980; Atlas Magazine, 2017), however, the market remains very small. As of 2008, four out of 47 countries in the region had a functioning agricultural insurance program and an additional six were implementing pilot projects (Mahul and Stutley, 2010). The last decade has observed gradual improvement ranging from agriculture micro-insurance (Di Marcantonio and Kayitakire, 2017) with several countries piloting index insurance (Sandmark et al., 2013). Hess and Hazell (2016) found that about 653,000 farmers had some form of insurance coverage and our updated program coverage suggests over 2 million smallholder farmers have insurance in Africa . At the continental level, the African Risk Capacity (ARC), set up in 2012, has facilitated the entry of countries into regional risk pools (Vincent et al., 2018). Currently, the ARC comprises 34 member states of which 11 took part in the 2019–2020 risk pool. While countries' participation has increased, there is a need for more political support. In 2016, both Kenya and Malawi dropped out of the risk pool due to internal politics and have not been able to re-join ever since (Hohl, 2019). Moreover, for the risk pool to be more effective, more countries need to enroll. In general, while agricultural insurance in Africa has grown, coverage is still very small especially in comparison to other regions and the number of smallholder farmers and pastoralists in the region. While several countries have started pilot programmes and a few like Zambia are scaling up, climate shocks tend to be cross-country and covariate in nature; hence the necessity for regional and continental risk pools remains critical.

Further, the insurance industry in Africa is still in its infancy and is relatively underdeveloped compared to other emerging economies and developed countries. The insurance companies in this region offer property, auto, health, life, casualty, and other types of insurance; however, in most countries the auto insurance sector holds the largest portion of the market share. The insurance market in some countries is dominated by nonlife insurance which represents about 85% of the industry premium. Life insurance is not a significant portion of the market, albeit the sector has been the fastest growing sector in the insurance industry. The insurance sector in Africa varies from a monopoly to a very competitive market. Nigeria has a large insurance

market with 48 insurance companies operating in the country as of 2008.Although the insurance companies in this area are mostly privatized, the governments in some of these countries still hold significant stakes in the firms.

2.9.11 Agriculture Insurance Sub -Sahara Africa Overview

First, the review exclusively focuses on Sub-Saharan Africa (SSA) due to its higher vulnerability to weather shocks than other regions (Coe & Stern, 2011). In the region, droughts between 1980 and 2013 are said to have affected more than 360 million people and caused more than US$31 billion in losses (FAO, 2015). The 2008–2011 drought in Kenya alone led to US$11 billion in losses (FAO, 2015) and the 2016 drought in Malawi dented the country's economy by US$400 million (Reeves, 2017). The trend of losses is not likely to decrease (Haile *et al.*, 2020a); Spinoni *et al.*, 2020). Despite these losses, insurance take-up remains the lowest in the world. Accordingly, of the 51 million smallholder farmers in Africa (Lowder *et al.*, 2016), only about 1.3 per cent have agricultural insurance (Hess and Hazell, 2016). Our more updated estimate suggests current take-up around 3.5 per cent but this remains far below rates in Asia and Latin America. The low insurance coverage situation in SSA therefore raises questions possibly specific to the region and requires closer assessment.

2.10 Agriculture Insurance Country Specific Cases

Case of India

The weather index insurance market in India is the world's largest, having transitioned from small-scale and scattered pilots to a large-scale weather-based crop insurance program covering more than 9 million farmers. India is one of the largest countries in agricultural insurance after the United States and China. The national crop insurance scheme (known as Pradhan Mantri Fasal Bima Yojana) is an area-based yield insurance scheme launched in 2016. Although it covers most of the area under crop insurance, weather-based index insurance scheme had an area coverage of 1.7 million hectares in the country in 2016. Under this scheme, claim payments to farmers are linked directly to weather parameters like rainfall, humidity, and temperature (Rao, *et al*., 2019).

India has a strong claim to have been the birthplace of the idea of weather indexed insurance, with Chakravarti having outlined a detailed proposal for rainfall indexed insurance to be sold across India as early as 1920 (Chakravarti, 1920, Pramod, 1995; Clarke *et al*., 2012). Although Chakravarti’s proposal was never implemented, it is somehow fitting that India was the first

developing country to pilot weather indexed insurance and, despite the recent spread of weather indexed insurance programs across the world, at the time of writing more farmers purchase weather indexed insurance in India than in any other country (Mahul & Stutley 2010).

2.10.1 Case of Ghana

In Ghana, weather-index insurance was introduced by the Ghana Agricultural Insurance Pool (GAIP) in 2011, to reduce the financial risk of crop failure and to also encourage farmers to invest more on their farms to increase production. The weather insurance product is targeted at only smallholder farmers with farm sizes less than 20 ha. At its introduction in 2011, it covered 3000 farmers in the three northern regions and was scaled up to six regions during the 2012 cropping season.

2.10.2 Case of Malawi

The weather index insurance programs in Malawi often bundled credit with mandatory weather index insurance to assure worried lenders (Suarez and Linnerooth-Bayer, 2010). With technical support from the World Bank, weather index insurance was offered in 2005 by the Opportunity International Bank of Malawi (OIBM) and the Malawi Rural Finance Corporation (MRFC) to 892 groundnut and maize farmers (Hess & Syroka 2005). A total of a US$40,000 pay out was made based on nearby weather station records. In 2006, the World Bank provided insurance for the purchase of improved seeds covering a total of 1700 households. For this pilot, farmers were required to pay 4.9 Euros per hectare premium to get a 25 Euro pay out for their input cost if drought occurred. In 2010/11, program participation expanded and a total of 10,500 households were covered for their cash crop, tobacco. Besides tobacco and groundnuts, maize is an important staple crop being piloted by various programs in Malawi. For instance, in 2012/2013 a Dutch-based re-insurance company called COIN-Re along with local insurance companies insured 1282 maize growers in Central and Northern parts of Malawi using relative evapotranspiration (RE) as an index instead of using the rainfall index (FESA, 2014). Similar pilot projects are on-going in other African countries such as Mozambique, Tanzania and Burkina Faso using RE as index (FESA, 2014).

Since 2008, the government of Malawi and the World Bank along with Swiss-Re actively engaged in a weather derivative market to price drought risk (Syroka & Nucifora, 2010). This is a typical macro-level application of weather index insurance similar to the WFP/World Bank

and Ethiopian government pilot program in 2005/2006. With the establishment of the African Risk Capacity Program, the Government of Malawi became one of the African member states which established a common risk management strategy (ARC 2014a).This may imply African countries are in a better position to manage disaster risks (e.g. drought, flood and related catastrophic events) without having to look for significant financial support from the World Bank and other donor agencies.

2.10.3 Case of Kenya

Kenya is one of the countries where both index-based crop insurance (IBCI) and Index-based Livestock Insurance (IBLI) pilots have been tested. A recent review of the Financial Sector Deepening (FSD) supported by several donors in Kenya provided important lessons and recommendations based on the performance of weather index insurance pilots in the country (FSD, 2014). The FSD review recommends that FSD scale down the retail pilots and take a longer-term view by concentrating on meso- and macro- level cover, such as an agricultural lending portfolio or area drought cover for government agencies and others responsible for drought response (FSD, 2014) which is quite interesting and pragmatic given the challenges of micro-level commercialization of the product using the existing delivery mechanisms and weather data for computing locally relevant indices to trigger pay-out.

In 2010/11, an innovative index-based livestock insurance (IBLI) was introduced in Northern Kenya through the joint effort of the International Livestock Research Centre (ILRI), Cornell University in USA, a private insurance company in Ethiopia and Swiss Re. Initial results from this initiative indicate that high premium, basis risk and risk preferences have strong effects on the uptake of insurance, similar to earlier findings (Mude & Barrett 2012). Using the NDVI index for vegetative cover on rangeland, Chantarat *et al., (*2012) found that risk preference, perceived basis risk and the subjective expectation of loss were important factors affecting Northern Kenyan pastoralists' willingness to pay for index-based livestock insurance. Besides index-based livestock insurance pilots, index-based crop insurance schemes (Kilimo Salama, meaning safe farming) are being tested. In an effort to reduce delivery costs, mobile phones are in use to pay premiums, receive pay-outs and weather information (Syngenta, 2012). The delivery mechanism is based on linking insurance with input marketing. When farmers buy seeds, fertilizer, or other agricultural inputs, they can also buy insurance for their inputs by

paying 5 % of the input cost. Covered farmers need to register in one of the weather stations close to their farm.

By the end of 2011, these innovations covered 23,000 households in five regions of Kenya and expansion to the remaining regions and other countries in Africa is expected (Syngenta, 2012; ASN, 2012). By the end of 2013, the program reached over 185,000 farmers in Kenya and Rwanda (Syngenta, 2014). However, part of the success/expansion may be related with the 50 % premium subsidy offered by this scheme although the program plans to achieve operational sustainability by the end of 2016 (Syngenta, 2014). Timely delivery of agricultural inputs (fertilizer and improved seeds) interlinked with insurance services through mobile banking could bring a breakthrough in transforming the rural economy in Kenya. If the index is properly developed, this approach has the potential to further reduce administrative costs in reaching the clients with specific information and affecting pay-outs in the event of shocks. Use of automated weather stations also overcomes the problem of manipulation of weather records. Syngenta claims that insured farmers earned 16 % more income compared to their uninsured neighbours (Syngenta, 2014).

2.11 Brief Background to Agriculture Evolution in Zambia

2.11.1 Pre -Independence Agriculture Practices

Subsistence Agriculture

The pre-independence error agriculture production was driven by the traditional ways of production and mainly for survival. Resilience strategies was around the traditional ways of production which was different from tribe or regions to regions for example the bemba, Tonga and Lozi people all had their different ways of production. In terms of production, individuals as members of specific households, were free to cultivate the land that they had cleared, hunt, catch fish, extract timber for constructing their huts, harvest honey, trap rodents, graze their animals and gather wild fruits, mushrooms, and other non-timber forest products. These activities were undertaken by individuals in order to meet the needs of subsistence or livelihoods and reproduce the groups. During that time, it was assumed as Yudelman (1964) argues that nobody in the community was to be without land, and land did not naturally have a market value since these were pre-industrial societies. The abundance of virgin land and low population densities ensured that the land resources could be accessed by individuals without any or much restriction. Each household was responsible to meet its own needs of subsistence

or livelihood, but weaker members of society, the infirm, widows, orphans and visitors benefited from the operation of social capital in terms of redistribution and sharing of food, and game meat, fish, beer and food between relative. The food production systems were based on the different traditional beliefs and set up. To date some of the systems are still practiced in some provinces.

2.11.2 Post-Independence Agriculture Production -UNIP Error 1964 -1991

Ncube (1983) stated that agricultural policies in Zambia since independence had emphasised among other things the following:

i. The improvement of the standard of living of the rural population.
ii. The creation of a self-reliant and progressive rural Zambia.
iii. The attainment of self-sufficiency in food grains; and.

The provision of infrastructure for the economic development and social stability of rural areas (Ncube, 1983). In order to achieve these noble objectives, the UNIP government undertook a number of agricultural/rural development programmes such as settlement schemes (to resettle people from overcrowded reserves and areas with tsetse fly); Producer Cooperatives (that attempted to promote socialist oriented production); Intensive Development Zones or IDZs (based on the growth pole theory of concentrating development efforts at specific nodes from which development could spread outwards); Integrated Rural Development Programmes or IRDPs, (with the aim of integrating planning, monitoring and evaluation of development projects to be run by local government institutions); Rural Reconstruction Centres (aimed at resettling unemployed school leavers under military discipline) ; Operation Food Production Programme (aimed at establishing state farms in the country) and the Lima Programme.

The Lima programme that was launched in 1980, was perhaps the one programme that was most popularized by the politicians. Its aim was to improve the productivity of small-scale village farmers, who were encouraged to apply chemical fertilizers on at least one quarter of a hectare, called a" Lima" which means – "*learning improved methods of agriculture"*. This programme was donor funded, but the Zambian government was expected to provide counterpart funding. Politicians and government extension workers from the Ministry of Agriculture persuaded village farmers to stop shifting cultivation or Chitemene by providing them with free inputs under the National Lima Fertilizer Programme (Eklund, 1985). The Lima programme promoted the cultivation of maize (to the exclusion of other traditional cereals) as

a cash and food crop. In the Northern Province maize production between 1975-1988 increased by 850 % (Moore & Vaughen, 1994 p. 206). It may be argued that these rural development programmes, with the exception of Producer Cooperatives, Rural Reconstruction Centres, and the Operation Food Production Programme, which failed to achieve their objectives (Siddle, 1971; Bwalya, 1984; Kalapula, 1984), were successful to a large extent because they made it possible for rural society to access infrastructure like passable feeder roads, schools, rural health centres, clean drinking water and marketing depots.

2.11.3 Liberalised Economy Agriculture Production 1991 -2023

Zambia agriculture markets development have taken a total shift from the area development goals in the sociality economy. The shift has been mainly due to policy changes as the country moved from the one party to multi democratic and market economy lead economy.

2.11.3.1 MMD under Frederick Chiluba

According to Chabala and Sakufiwa (1993), the government of the Movement for Multiparty Democracy (MMD) and Dr. Frederick Chiluba, introduced the Structural Adjustment Programme (SAP), with the support of the International Monetary Fund (IMF) and the World Bank, in order to remove all monopolistic and excessive government involvement in the running of the economy. The new government wanted to encourage free enterprise and the operation of market forces of supply and demand, instead of a state-controlled economy as was the case under UNIP and Dr. Kaunda's government. Within the agricultural sector, structural adjustment entailed the introduction of market liberalization by which the government removed subsidies on fertilizers and other inputs, decontrolled prices of commodities including maize, and opened up marketing so as to attract competing marketing organizations.

Because of liberalization, the government began to privatize all agricultural parastatal companies so that new private sector-based marketing agencies could enter the market. These changes saw the collapse of NAMBOARD, the liquidation of LIMA Bank, and collapse of CUSA and the Zambia Cooperative Finance Services, which had been responsible for providing agricultural credit to small-scale farmers. The MMD government also eliminated exchange rate restrictions to encourage the establishment of' Bureau de charge', although the state continued to monitor the foreign exchange market, and also liberalized export and import trade, while providing export incentives. On the whole, the MMD government aimed at completely liberalizing the agricultural sector involving production, marketing and input

supply, but still hoped that the new framework could facilitate increased agricultural production to ensure national, regional and household food security (Chabala & Sakufiwa, 1993). These changes in maize and fertilizer marketing policy were so radical that they created policy shocks or shifts that resulted in some very serious short-term effects on production, marketing and storage of Zambia's major staple crop, maize (Chabala & Sakufiwa, 1993). Furthermore, these policy shifts had implications on household food production and undermined the resilience of rural society as a whole.

2.11.3.2 MMD Under Mwanawasa New Deal

When President Levy Patrick Mwanawasa won elections in 2001, but on an MMD ticket, he called his administration, a New Deal. The government continued to promote private sector led developments in order to achieve growth in the economy. However, as part of the New Deal, the government undertook deliberate measures aimed at rebuilding the resilience of small-scale farmers who had experienced both policy (SAPs) and environmental shocks (droughts and floods), in the past ten years. This rebuilding aimed at reducing poverty by increasing food production, as well as ensuring national and household food security through the promotion of the production by small-scale farmers of cereals, legumes, roots and tubers, tree, and plantation crops (GRZ, 2004), as well as livestock restocking. To achieve these objectives, the New Deal administration undertook to implement two programmes. Firstly, a partial 50% subsidy for fertilizers was re-introduced in 2002 as part of the Fertilizer Support Programme. The subsidy was increased to 60% by 2007. It was meant to help small-scale farmers (both men and women), that had lost income as a result of the shocks, especially the 2000/2001 drought.

In the Fertilizer Support Programme, a total of 120,000 farmers were targeted by providing them with a total of 24,000 tonnes of D- Compound and 24,000 tonnes of Urea fertilizer. This deliberate intervention led to an increase in production of over 360,000 metric tonnes of maize valued at K200 billion between 2002 and 2004 (GRZ/PRSP, 2004). Secondly, the government introduced the Food Security Pack that was targeted at the vulnerable but viable small-scale farmers. This programme was to be administered by a government-supported NGO, the Programme Against Malnutrition (PAM). Under this programme, 3,140 tonnes of basal and 3, 217 tonnes of Urea fertilizer were distributed, together with 50 tonnes of maize seed, and 23 tonnes of sunflower seed (GRZ/PRSP, 2004). A total of 125, 000 beneficiaries per year were reached, from a targeted number of 200,000 vulnerable but potentially viable farmers

(GRZ/PRSP, 2004). The Rupiah Banda lead under the continued strategy of the new deal governments.

The private sector lead development strategy has continued with the patriotic government programs allowing the mushrooming of private sector lead development programs that all focusing on all-inclusive participation of the private markets to drive agriculture development. Instead of the government driven subsidy programs under the farmer input support program solely driven by government in terms of procurement, bidding process, farmer selections and engagement and distribution of inputs. The new approach is to now allow the private sector networks to distribute the agriculture inputs. The patriotic front government continued with the private sector lead development, increased the farmer support program to 1, 500,000 farmers, the electronic and direct farmer input support program but it further embraced the weather index insurance as a drought and flood mitigation measure.

2.12 Agriculture Appeal to WII

2.12.1 Climate Change Challenges to Agriculture Production

Changing climate in the future is expected to further exacerbate variability and reduction in agricultural production, affecting rural livelihoods at the global scale (Arnell et al., 2016). Risk management from changing climate is hence considered vital in protecting agriculture and promoting development (Jensen & Barrett, 2017). Climate change related losses in agriculture are expected to amount to US$ 2,200– 3,130 million over the next 10-20 years (Zambia country climate risk report, 2018).

Climate change challenges are increasingly becoming dominant with either droughts and or floods that makes the farmers to fail for their production. Though the routine of droughts of floods are sometimes historical and the local people tend to have ideas of routines of when such occurrence's take place. Beyond agriculture, climate exerts a profound influence on the lives of rural populations, particularly the rural poor, who depend on agriculture for livelihood and sustenance, who are unprotected against climate-related diseases, who lack secure access to water and food, and who are vulnerable to hydro meteorological hazard. Climate shocks such as drought and flooding lead not only to loss of life, but also long-term loss of livelihood through loss of productive assets, impaired health and destroyed infrastructure. The uncertainty associated with climate variability is a disincentive to investment and adoption of agricultural technologies and market opportunities, prompting the risk-averse farmer to favour

precautionary strategies that buffer against climatic extremes over activities that are more profitable on average. Weather index insurance is one of several promising interventions for overcoming the negative impacts of climate risk on rural livelihoods and food security.

No doubt the reality of time today is evident that not any soon will the developing countries experience reverse climate change. Hush climate weather is expected to continue in the developing countries globally and specifically in Zambia. For example, Zambia's rainfall events run from October to March with occasional rains in April and sometimes even in May (Kurji *et al*, 2003). On average the country receives about 1000 mm of rainfall per year with variations of about 1400 mm in the North and 600 mm in the South (GRZ, 2002). According to Kurji *et al*, (2003) the average amount of rain received in some parts of Southern province is often below what the farmers require. GRZ (2002) said that Zambia's climatic conditions have changed in that since early 1980s, the rainy season has been starting late and the rains have been withdrawing early, and that temperature has been observed to have increased by one degree since the 1970s. The World Bank (2006) also reported that Zambia has been experiencing an increase in floods, temperature and drought frequency and intensity, which many scientists have attributed to long term climate change. The agriculture sector, which hosts over 69 percent of the stallholder farmers, is under continuous pressure. In the recent past years, the farmers have experienced droughts and floods resulting in extreme production and productivity reductions resulting in poor incomes and household food security challenges. In Zambia, recent decades have seen an increase in intensity and frequency of floods and droughts (GRZ, 2010).

Currently, global temperatures are estimated to be about 0.8oC above the preindustrial levels (The World Bank, 2010). The farmers have continued to lose their entire investments making it difficult for continuity crop production and indeed food security. It is well known that households facing risk with few resources are likely to remain poor or to be caught in poverty traps (review by Barnett *et al, (*2007)

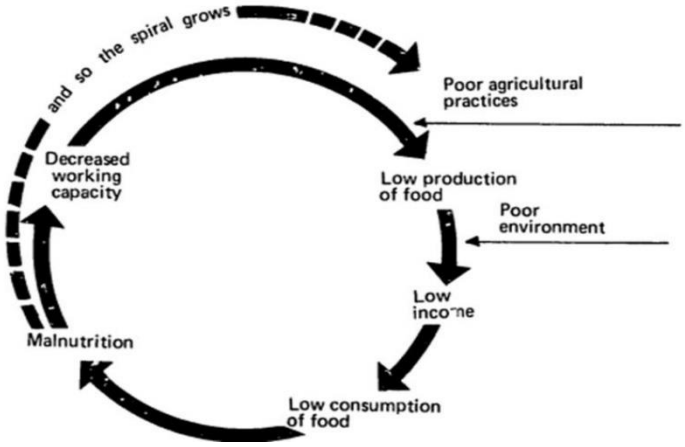


Figure 2. 11 :Poverty Cycle (Barret & Skees, 2007)

2.12.2 Weather Insurance Index Innovation Contribution Toward Solving Problems.

Climatic and socio-economic vulnerability pose significant challenges to development, often requiring large-scale solutions to overcome. Index based micro insurance for weather risk transfer is one potential element of sustainable and scalable management solutions. This type of insurance provides coverage against financial losses incurred which can be caused due to natural calamities/extreme weather conditions like storms, snow, rain, fog, wind, sudden temperature dip or rise, etc. Weather index-based micro insurance is a new instrument for managing disaster risk and has the potential to be revolutionary. By replacing costly farm visits with weather stations measuring rainfall as the indicator of drought conditions, weather index insurance is radically different from traditional agricultural insurance (Rose Gosolinga-Kenya)

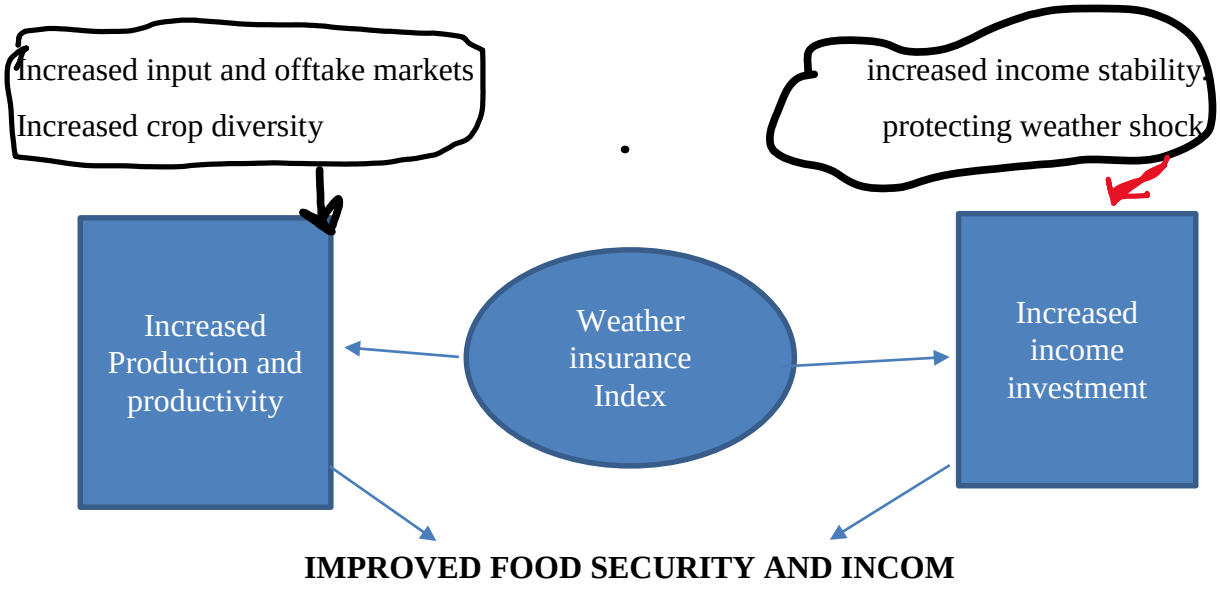


Figure 2. 12*: Food security* Source: (Author, 2020)

A multifaceted strategy that considers supply and demand dynamics may be necessary to solve the issue. For a farmer to have the chance to escape poverty, several players on the agriculture market must work together to provide the necessary services. These players include the policy environment, capacity building and extension services, regulations, innovation platforms, and traditional leadership that upholds and oversees the regional fabrics. Therefore, it will take coordinated efforts to create an equilibrium between supply and demand in the small business insurance program. When farmers purchase insurance, they tend to increase investments in inputs such as fertilizer and enterprises with higher risks (Cai, 2016; Karlan *et al.,* 2014). Taking up agricultural insurance not only led to increased incomes, but also decreases income fluctuations (de Nicola, 2015).

2.13 Understanding the Farmers and the Farming Cycle

For successful and commercially viable agriculture insurance, it is important to appreciate and understand the small holder farmers' cycle of crop production, the purpose the farmer will pay for insurance, what the farmers expectations are, what the farmer characteristics are, the farmer income cycle usually for most majority which is once per year, and the farmer social aspects/norms to do with adoption of innovations.

It appears WII not taking this into account as the mismatch between the farmers' experience and the service fail to match. If the payments systems can match the farmer's cycle of for alternative survive after weather failure this could allow the farmers trust the system. The majority smallholder farmers would want response or compensation that allows them to get into production and or hope for survival. Additionally, there is evidence from various studies in several developing countries that suggest individuals value the present more than the future, and would therefore prefer the immediate benefit of a discount to the delayed benefit of a rebate (Duflo *et al*., 2011). Along similar lines, individuals may prefer the discount because there is more certainty associated with a discount now, whereas the promise of a rebate in the future entails some uncertainty. Interestingly, however, despite the uncertainty, this promise of a future payment may be alluring for some farmers. In the context of insurance, rebates provide a certain payout in the future regardless of whether the insurance pays out, and this has been shown to be preferred in Burkina Faso (Serfilippi *et al*., 2016, Hill *et al.*, 2019).

2.13.1 The Future of Smallholder Farming

Our main focus is on understanding the future of smallholder farming in sub-Saharan Africa, despite the fact that in absolute terms the number of smallholder farmers in Asia is much larger than in Africa. This is because the predicament smallholder farmers in Africa find themselves in is of a different nature than that of their Asian counterparts. Agricultural development in Asia has been strongly guided by – smallholder-oriented – agricultural policies (Henley, 2012) and has taken place in the context of an industrialization of local economies offering alternative employment opportunities. Furthermore, overall populations in Asia, and in particular rural populations, are stabilizing or start to decline. In stark contrast, rural populations in Africa are still doubling every 20 years, against a backdrop of farm sizes which are already small. What does this mean for the future of African farming systems? it is hard to see that food production can keep pace with growing demand without expansion of the cropped area, no matter how undesirable for biodiversity conservation and other ecosystem services. Yet, so-called un(der)utilized land is often in remote areas, far from markets (Chamberlin *et al.,* 2014) and increasingly in agriculturally marginal areas, which increases the vulnerability of agricultural production to climate variability (Andersson, 2007).

It appears, analysis of the future of smallholder farming in Africa portrays a bleak picture, as alternative strategies to deal with current constraints hold relatively little promise in the short term. For instance, Headey and Jayne (2014) make the point that diversifying employment through non-farm activities, domestic and international migration, although important, will not be able to absorb sufficient numbers of farmers stepping out of agriculture. Unlike most of Asia, most of Africa is not characterized by a rapidly expanding urban manufacturing sector that can absorb rural-urban migrants. Relative high wages in comparison to Asia are probably an important factor in this sluggish industrial development, partly because food prices are relatively high (Breman *et al.,* 2019). In Africa, ‘consumption cities’ predominate over ‘production cities. At the heart of the problem lies what has been termed the ‘Food Security Conundrum’ (Giller, 2020a) which is the nexus of three factors. First, African countries need an abundant supply of affordable and nutritious food for their burgeoning rural and urban populations. Second, agriculture is a major contributor to the balance of payments for African economies, meaning that much of the focus of governments is on produce for export rather than food security. Third, most rural households lack sufficient land, labour or economic incentives to invest in food production. A significant proportion of smallholders does not

benefit from productivity increasing technologies, and just ‘hang-in’ (Thornton *et al*., 2018; Dorward, 2009) in absence of economic alternatives.

To make farming more profitable and attractive, substantial improvements in the enabling conditions are needed. The list of potential interventions is long and well-established. Reducing transport costs by investment in infrastructure, more effective extension services based on tailored agronomic research, an enhanced role of the private sector to name a few. Input subsidy programmes implemented in many countries of sub-Saharan Africa over the past 10 years have increased the use of fertilizer, but with insufficient attention to ensuring they are used efficiently (Jayne *et al.*, 2018). Other good agronomic practices, including improved cultivars and seed, plant density and weed, pest and disease management are needed for this. Crop insurance and other policies to buffer smallholders against climate and market risks are essential, particularly in the face of increased climate variability resulting from climate change.

Yet, without a fundamental transformation of African agriculture that allows for the consolidation of small farms into larger and more economically viable units, it is unlikely that substantial intensification of farming will occur. Given a lack of livelihood security outside agriculture and the significant non-productive meanings of land in many African cultures, for example as the rural home, a place of belonging, where ancestors are buried (Andersson, 2002), the consolidation of land through purchase seems unlikely, at least in the short term. Land rental or sharecropping appear much more likely options which can provide the economies of scale to allow investment in inputs and mechanization to enhance both labour and land productivity. No doubt production of commodities such as cocoa, coffee, cotton and tea will continue to be important agricultural exports as well as important income streams for smallholders and the national economies. Boosting production for national markets could also contribute strongly to national economies by reducing the need for imports. A good example is soybean; there is increasing demand throughout SSA for soy cake as feed for poultry and aquaculture which is largely met by import of processed cake from South America. The use of temporary tariffs to stabilize prices, or price guarantees for farmers to de-risk their investment are means to expand the fledgling local feed industries until the production volumes increase to become competitive with imports. The moves to create free trade zones within the African continent could also enhance production for national and regional markets.

History has taught us that agricultural development is conditional for economic development – but how can the conditions be created to foster development of the agricultural sector? Perhaps the greatest challenge lies in creating the employment needed outside agriculture to provide alternatives to farming (Christiaensen, 2020). One promising trend is the development of smaller urban centres in otherwise rural areas (United Nations, 2018). This may create incentives for more local market-oriented production and opportunities for value addition in processing resulting in a virtuous cycle of farm and non-farm activities supporting each other (Agergaard *et al.*, 2018). The improvement in infrastructure associated with urban development may foster these developments. Analysis of past developments in Asia shows that a multi-layered and diverse range of pro-poor policies and investments are needed to stimulate rural development, including agriculture (Henley, 2015).

A crucial question that remains concerns the provision of social safety nets for rural households who lack resources to make a living income from farming and lack alternative employment. Banerjee and Duflo (2019) argue for an ultra-basic, universal basic income for all. Such an approach of direct cash payments to farmers is already being tried in India, as an alternative to direct provision of food support. Such a universal basic income would also provide a buffer against the risk of crop failure – and help to prepare smallholders for impacts of climate change. Investment in health and education for all, and especially for girls, will be critical to slow rates of population growth in Africa and equip the future labour force (United Nations, 2019).

Farming will remain an important component of rural livelihoods but cannot deliver economic growth as currently assumed by many policy initiatives in Africa. Currently, all problems of rural development appear to be placed on farming – whereas agriculture should be seen as one component of rural life, albeit a central component of rural livelihoods. Agronomic research continues to focus on technologies for yield improvement, but against a backdrop of farm structures and farmer livelihoods which prevent farmers to 'step-up' their operations. Yield-improving technologies remain nevertheless crucial for their contribution to rural households' food and nutrition security. A broader dialogue is needed on how to transform and harness the potential of smallholder agriculture, whilst addressing other opportunities for employment in rural and urban areas and – at the very least – avoiding further environmental degradation and limiting expansion of the land area under agriculture (Giller *et al*, 2021).

2.14 Commodity and Derivative Markets as Key Drivers

Functional and futures markets are not well developed in most of the African countries and Zambia is not an exception to this market. For the pull and push effects for market innovation development the markets are key just as highlighted on the market systems (Amadou,2021). The farmer participation onto the agriculture markets requires confidence building because of available platforms that gives the farmer information about commodity trade for immediate as well as futures and predictable markets. The commodity and derivative markets gives confidence to the farmers but also to a wider range of stakeholders that include the financial institutions that are very avers of investing into smallholder agriculture production systems, the private sector companies that are able to provide extension service, inputs and technologies but most importantly this will give confidence for the insurance institutions at different levels that include the insurers , and the agriculture insurance focus on the smallholder farmers (Karuho,2020).

2.15 Market Systems Helping to Solve the Uptake Puzzle

Many donors and development agencies that defined a “market system as a multi-function, the multiplayer arrangement comprising the core function of exchange by which goods and services are delivered and the supporting functions and rules which are performed and shaped by a variety of market players" (Garloch, 2015). Market systems include households and communities that thrive to operate and benefit from the operations of the market system. Decisions about resource allocation are negotiated among household and community members, influenced by individuals’ incentives and expectations, status and decision- making power, a range of socio- cultural norms and traditions, and physical factors that constrain available options. Understanding household and community systems and how they interact with each other and other systems can be important for achieving development objectives (Dean Hunter, 2018; Fogelberg & Psi, 2020). The low expansion and uptake depicted above could be seen as a snapshot of past market development trends which are not well functional. Studies also show that non-functional markets lack coordination and organization among market participants, which results in a lack of grading systems and standards, which is made worse by a lack of accountability and transparency (Hasin *et al*., 2014; Mutambara, 2015; Raj & Hall, 2020). The figure 2.13 below also demonstrates how the non-function market's core has a crack, which is exacerbated by a lack of systems that perform support functions, such as inadequate infrastructure, inadequate information systems, and inadequate systems for developing and

delivering business services, which are exacerbated by a lack of standards, rules, and regulations.

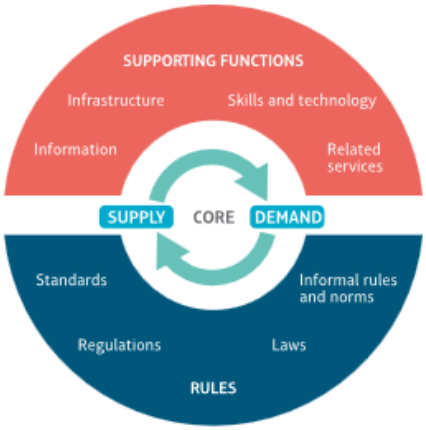


Figure 2. 13: Shows the Market Systems Framework with Three Interconnected Interfaces (the core function, support functions and rules and regulation systems) (Garloch, 2015).

According to the market systems development framework, the interconnectedness of the three functions—the core, support systems, and rules and regulations—defines how the weather index insurance market goes from nonfunctional to functional. Technical extension, business development services, infrastructure systems that support the development of information and communication, and an environment that allows for both formal and informal rules and regulations all play a big part. For farmers and providers of weather index products to be able to trade with each other in a sustainable way, the framework calls for financial, social, and environmental incentives to be in place. Studies have found that for this framework to function, it demands the defining the roles and functions of each multiple agribusiness players within commercial business functionality for the benefit of the sector (Lenaghan & Heffern, 2021; an der Lee *et al.*, 2020).The farmer uptake of WII has surprisingly remained low regardless of the appeal due to number of reasons, but a functional insurance market is one such a big issue.

2.16 Distribution Channels and Capturing the Full Value Chain Commodity and Input Markets as Key Drivers of Uptake

It is importance to market insurance through existing distribution channels that farmers use and trust, such as microfinance or input suppliers. And while insurance is typically offered to farmers, there are opportunities to market it to actors engaged in non-farm activities such as input suppliers and traders (Garloch, 2015). The market structure is very important if farmers

are to gain confidence to invest into commercial insurance products not the donor driven programs. The push and pull effects are necessary to help the farmers decide to invest into a futuristic product.

2.16.1 Structured Markets

These markets can provide both the inputs confidences and the outtake confidence to the farmers including extension services that builds up good commercial relationships with the farmers and hence could allow farmers easily add on products such the WII (Danso-Abbeam,2018).

2.16.2 Derivative Markets

This allows for financial instruments that derives its performance from the performance of an asset, called the underlying asset which would allow for spot or cash markets with spot prices allowing the farmers to have confidence to invest into the WII (Loo,2023; Kahan,2013).

2.16.3 Futures Markets

Agriculture is a business and such it must be predictable. it is important that farmers have the ideas of how the future in terms commodity prices looks like for them to invest into technologies such WII as a mitigation strategy (Kahan,2013).

2.16.4 Warehouse Receipt Markets

Farmers should have options of trading their crop with systems and or trading mechanisms that provide a chance for good prices such as the warehousing system. This though requires well certified storage shades including enough capacity in the rural areas for the farmers to deposit the crop (Farm radio international ,2021).

2.16.5 Do Farmers Have Enough Appetite for Crop Insurance / How do we Stimulate Demand?

The farmer appetite for insurance could be very confusing as it may have a wider diverse of issues that maybe political, cultural orientation, economical and the real need for it looking at the production base for majority smallholder producers in the country. In comparison terms, the commercial has increased appetite yearly to ensure their production which is never the case for the farmers. The farmers continue to face climate challenges but with reduced uptake of WII the puzzle that has continued regardless of millions of dollars from donor agencies subsidizing the farmers. A clear pull and push relationship between the farmer appetite for WII and the insurance companies should exist if this must proceed sustainably.

Boosting take-up and payment of insurance premiums requires innovative approaches to improve the face value of insurance to smallholder farmers and other food systems actors at risk from extreme weather. This includes, for instance, linking insurance with loans, so that the premium can be deducted from the loan whilst the lender can reduce interest rates to reflect insured farmers' lower default risk or providing free insurance or replanting guarantees when selling seeds as a marketing strategy for seed companies.

2.16.5 Bundling with Climate Smart Agriculture and Risk Layering.

Bundling index insurance with credit, climate smart technologies, and/or life insurance can make it a real value-adding proposition for farmers and increase demand (Shumba,2020).

Experience from farmers that grow crops such as tobacco, sugar cane, cotton as some point demonstrated the real uptake of WII with good based on values of money invested (indemnity proper) and the relationships created between the farmers, input suppliers, off takers and insurers companies demonstrated a more sustainable business case of WII and crop insurance (Stoeffler et.al.,2022) in general although these are isolated cases with the majority famers not demonstrating uptake of WII in the country in the case of Zambia. Would we say that targeting the maize crop in the case of Zambia is a wrong crop for WII? What are the risk profiles for maize? (100% loss no partial losses)? These are key questions if we are to establish the risk appetite landscape for the smallholder farmers. What crops should be targeted to stimulate real and proper demand, justify the appetite, volumes, proper indemnity?

For farmers to increase demand for the WII, it is important to look at the private sector and government involvement in coming up with commercially viable packages (Pelser & Meintjes,2023) that should include but not limited to:

2.16.6 Micro Finance

Is there affordable finance available for the farmers to utilize for their increased production and productivity? The farmer will invest in insurers products with an increased chance of increase in production. The current FISP supported program for formers only insures a space of 1 lima (quarter of 1 Hac.). This is not enough investment that would push farmers to increase investment on WII.

Microfinance remains key and strategic for the growth of the agriculture sector, smallholder farmers and the SMEs who are a key interphase between the financial institutions and the

farming communities. This is a multi-function and multi-player system that should work and create opportunities for all parties in the sector. The need to develop all-inclusive models and broad systems-based market relationships that respond to a range of farmers challenges could be the most ideal today that may include imbed extensions service, financial literacy, out grower scheme arrangements that have guaranteed contracts for both input and offtake and risk edging/mitigation facilities such as weather index insurance. The microfinance sector is though surrounded by a lot of challenges that both limit the participation of the financial institutions as well as the farmers and the SMEs. Thus, the use of microfinance in the development and rapid progress of the agriculture sector, in both the rural and urban sectors has seen a steady increase over the past years (Eliasu, 2014).

According to Ledgerwood (1999) and UKEssays, (2018), "microfinance is defined as the provision of a broad range of financial services such as deposits, loans, savings, payment services, money transfers, and insurance to the poor and low-income households and their micro-enterprises who are excluded from the formal financial systems Hence, it is important to consider the different vehicles that can unlock the low production and productivity puzzle for the farmers in past decades. Microfinance plays key roles in accelerating farmer active participation in the agriculture value chain through access to financial literacy and services, inputs, extension knowledge as most of the financial products are imbedded with extension support and facilitating offtake and guarantied market opportunities. In fact, microfinance is considered as an effective strategy for development as it has played a major role in reducing poverty, income distribution and achieving development goals. Past precedence revealed that rural financial inclusion and participation in microfinance helped the rural poor boost their income and develop their productivity potential in agriculture terms (Umara *et al*, 2011).

2.16.7 Risk Mitigation

What other mitigation systems is government putting in place for the farmers in cases of failure that should build confidence for farmers to buy into WII. Inputs and output market linkages – what is the package for the insurance product to the farmers? is this bundled with the opportunity for access to inputs as well as offtake markets.

2.16.8 Credit

The sector has remained behind in terms of the availability of credit on the markets to allow the farmers to participate in the markets with new technologies that would allow for improved production and productivity. The key drivers for agriculture revolutionization are the adoption of agriculture technologies backed up with extension services but with lack of liquidity on the farmer side Africa will has many more years to actualize the dream of increased productivity per unity area and incomes. Agreeing with this, many empirical studies have revealed cases of credit insufficiency among rural farmers in developing countries (Deaton 1997; Girabi & Mwakaje, 2013; Suleman & Adjei, 2015; Abbas, 2005). It is clear that one of the main reasons for low smallholder productivity is a traditional lack of access to affordable, productivity enhancing technologies, particularly seeds, chemicals and mechanization and, equally as critically, the knowledge to utilize these technologies microfinance is the facilitating delivery vehicle.

However, Agricultural finance in Zambia is fundamentally dysfunctional with, credit and financial services been considered as scarce, expensive, and heavily skewed towards the larger, corporate sector. These Inadequacies to access credit and financial services have remained a central concern for farmers and a key constraint to the modernization and diversification of the economy. Many studies that have focused on the constraints of agriculture credit in Zambia and its importance on the wellbeing of farm households have been undertaken (Gunther, Kelsey, and Masiye, 2014; Mike *et al,* 2009). Thus, microfinance has been widely praised for being an innovative tool for fighting against poverty and enhancing economic development across African nations. However, despite its popularity, a growing body of literature still points to the limited impact on people's livelihoods (Alana Stewart, 2020).

2.17 Africa Risk Capacity -A Disconnect with Reality – (Continuity of Business)

Many African nations' risk management capacities don't correspond to the reality on the ground, particularly in the case of smallholder farmers. Direct recommendations for insurance products to farmers do not address the ongoing poor penetration of general insurance, including WII, in many African nations. Every country has completely diverse weather cycles and patterns. The smallholder landscapes in the various nations differ in terms of agricultural production plans, but the underlying concepts are the same. Even within the same nation, direct advice, or proclamations that WII should be applied nationally to all farmers might not be the

answer. Why include all nations into one basket in the case of countries, for instance? What is Zimbabwe's risk environment? Can WII be pushed throughout Zambia, for instance, and what information may be provided to farmers while upholding the systems' fundamental tenets? What happens when farmers make rain patterns that seem to follow a pattern in terms of occurrences? Which years and regions should we avoid at all costs? Are the demands of farmers in the northern and southern provinces the same? There are no general guidelines. What proof do we have that WII has had an impact on smallholder farmers? Are these effects truly transformative? As it seems, it appears, we often see impacts of insurance and financial inclusion more generally on behavioural outcomes, but no rigorous evidence of impacts on agricultural profitability. How can consumers be nudged towards truly profitable and resilient investments?

One thing that we are testing is whether insurance has stronger impacts when advice or training is provided on how to invest along with insurance; another question is whether impacts are stronger when accompanied by interventions that link producers to better marketing channels. Reality with the status core, many obstacles remain to understanding the long-term resilience impacts of weather index insurance and other products. Future research is sorely needed in these areas. Bridging these knowledge gaps will require more partnerships between various stakeholders to build evidence, encourage innovation, and scale promising solutions to strengthen the use of financial inclusion in building resilience (Berber Kramer, 2019).

Therefore, for index insurance to be effective, it must target the right risk and the index must capture a sufficient portion of that risk. Pricing depends on quantifying that risk. Risk for agriculture is often classified as production risk (i.e., uncertain crop yields or livestock production), market or price risk (i.e., uncertainty in commodity and input prices, including influence from currency exchange rates), institutional risk (i.e., risk of unfavourable changes in institutional services and policy at various levels), business or income risk (which aggregates production, market and institutional risk), and financial risk (resulting from the degree and terms of borrowing). This classification overlooks consumption risk – a more important measure in subsistence-oriented agriculture (Baethgen *et al.,* 2008).

2.18 Government Involvement – Enabling Environment.

Macro and miso fundamentals are key for the sector to develop. The rightful business environment is required for the sector to develop. It appears the public sector, despite high

levels of subsidy directed at both agricultural markets, has failed to drive productivity gains and access to information through an under-resourced and over-stretched public extension system has yielded few benefits. However, The Government of the Republic of Zambia (GRZ) is responsible for providing a supportive macro- and micro-level enabling environment for the economy. The Government has adopted an integrated approach to sectoral development as outlined in its Seventh National Development Plan (7NDP) of 2017-2021. This is to ensure that sector interventions are coherent and support the attainment of prioritized national policy objectives. To this end, sectoral clusters have been established to promote multi-sectoral planning, implementation and monitoring impact and results. Trade, agriculture, energy, tourism, and sustainable natural resource management are part of pillar 1 whose focus is on economic diversification and job creation. (USAID, 2021).

It is then not arguably that with right micro finance models backed with the good government support systems should be able to work and engage both the demand and supply side of the agriculture markets (Madan,2020). If the Government creates an enabling environment for business which is informed regularly with input from key stakeholders, then private sector companies will be supported to grow their businesses, expand trade, and attract increased investment in agriculture, energy, eco-tourism, and natural resource management, resulting in broad-based gender-equitable economic growth that transforms rural areas and pulls people out of poverty (Stringer et.al,.2020).

Thus, it's crucial that the government has a clear position on supporting insurance for small-scale farmers. The government's position must be clearly stated and not merely empty platitudes devoid of any supporting regulations. What specific policies or initiatives is the government putting in place to support smallholder farmers as well as the business sector? While most of the firms in the private sector provide insurance services, government initiatives and policy tools are essential if smallholder farmers are to adopt WII (Ankrah,2021).

2.18.1 Regulatory and Enabling Environment

Establishing a legal and regulatory environment for enforcing contracts that both buyer and seller can trust is fundamental to making insurance and other financial instruments work (Feyen et.al,.2021). Partnerships between government, local insurers and international reinsurers are key to this effort. In some cases, smart subsidies may be required alongside regulatory reform

to provide an enabling environment for insurance to have an impact on resilience (Ankrah,2021). Trust is particularly important in the context of insurance because, unlike for credit, the policyholder relies on the insurance company to honour its promise of a pay-out in case a pay-out is triggered. Given that index-based insurance is a relatively new product, trust may be an important determinant of participation in insurance markets (Cole *et al*, 2012).

2.18.2 The Level Infrastructure to Support Weather Data.

WII insurance innovation is largely dependent on historical rainfall data to help make transparent and evidence-based decisions that takes care of the perceived risks and inconsistences by farmers on the system.

2.18.3 Data Availability

Insurance schemes struggle with an absence of data—for instance, data on rainfall and crop yields needed to develop indices and monitor risks. Information and communications technologies (ICTs) and advances in data processing offer new opportunities to improve the quality of index insurance and reduce basis risk. Innovations could come, for instance, in the form of monitoring crop losses using high-resolution satellite imagery, drones, or ground photography. At IFPRI, we are testing picture-based insurance: Farmers send the insurer photos of their own fields, taken on the ground, to document damage. Initial findings suggest that incorporating these pictures in claims helps improve demand and reduce basis risk, and improves crop monitoring, even relative to metrics derived from high-resolution satellite imagery (Berber Kramer (2019).

2.19 The Status Quo of WII Uptake Perspectives and Reviews

Non-adoption of financial innovations or utilization is a common phenomenon in agriculture emerging markets. The financial innovation by both farmers and the SMEs utilization are poor contribute to the poor performance of the sector (Appiah-Twumasi et.al.,2022). Though theory on technology adoption such as life cycle theory indicates that technology adoption just as a life cycle cannot be adopted promptly but will grow steadily as the customers are appreciate. The adoption ladder theory also indicates that technologies are adopted takes a steadily step by step process that allows the players to appreciate and experience before adoption. Therefore, utilization of innovations on the markets won’t follow a linear fashion but will need the

customers and intermediaries to learn and appreciate the accompanied incentives (Choi & Shim,2022).

Index-based weather insurance is an innovative financial instrument, which can be used by farmers to hedge against erratic monsoons. Such a product pays farmers when rainfall exceeds or falls below pre-determined triggers, which are based on historic rainfall data as well as crop and soil considerations. Despite theoretical advantages of index-based rainfall insurance, take-up as a standalone product has remained surprisingly low among smallholder farmers (Cole *et al.*, 2013).

Agricultural production and trade are becoming riskier as a result of the higher temperatures and more variable rainfall associated with climate change. These risks raise the costs of agricultural lending and reduce the opportunity and incentives of farmers to invest in new technologies, including climate smart technologies that may improve the resilience of local farming systems (Ngoma,2020) Correspondingly, traders and agro-processors face lower incentives to invest in building value chains into drier, or riskier, agro-ecologies (Giller et.al.,2021).

Traditional agricultural insurance appears to be ill-suited to meeting these challenges. Many analysts have concluded that such traditional insurance, which bases indemnity payments on verifiable losses, simply does not work for smallholder farmers in developing countries (Sibiko,2018). The first shortcoming of this traditional model is the potential for fraud, because it is extremely difficult to monitor many small plots against false declarations. Second, in many situations only farmers with high risks buy insurance, raising costs for insurers. Finally, traditional insurance encounters high transaction costs selling contracts to large numbers of dispersed smallholders in remote rural areas (Aslam et.al.,2022).

WII was created to address these problems and to offset these agricultural investment risks. The index is designed to serve as a proxy for crop growth and harvest yield. Early efforts involved building indexes from a combination of rainfall data and crop modelling. When these models proved inadequate, a Normalised Difference Vegetation Index (NDVI), calculated through remote sensing, was applied in theory, the model can predict, for instance, how many tonnes per hectare of a crop are lost for every millimetre of rainfall excess or deficit in a specific location (Ndegwa et.al.,2022). WII promises to overcome the shortcomings of traditional

agricultural insurance because it relies on measurable, objective standards. Just as important, the elimination of field loss assessments would drastically reduce administrative costs. Despite the theoretical benefits of index-based weather insurance (farmers are paid when rain exceeds or falls below pre-determined triggers), take-up is surprisingly low (Cole et al., 2013).

2.20 Defining the Five Technology Characteristics as Drivers for Uptake

Technology Characteristic Definition Relative Advantage (Perceived Usefulness) ‘degree to which an innovation is perceived as better than the idea it supersedes’ Compatibility ‘degree to which an innovation is perceived as being consistent with existing values, past experiences, and needs of potential adopters’ complexity (not easy to use) ‘degree to which an innovation is difficult to understand and use’ observability (visibility) ‘the degree to which the results of the innovation are visible to others’ trialability ‘the degree to which an innovation can be experimented on a limited basis’s characteristics of a technology that influences individual’s adoption decision (Source: Rogers (2003).

Rogers (2003) indicates that any innovation which individuals perceive to have these five characteristics is likely to experience rapid uptake as compared to technologies that do not exhibit these characteristics. Some studies such as Wamuyu & Maharaj (2011) have shown that some of these attributes contribute to rapid uptake of an innovation while other attributes do not necessarily have this positive impact on adoption. Relative Advantage of an innovation is how well the new technology serves a purpose better than the past or existing technologies. Moore & Benbasat (1991) define relative advantage as the degree to which an innovation is perceived as providing more benefits than its predecessor. Relative advantage is indicated by increased efficiency, economic benefits, and enhanced status (Rogers, 2003). Moore & Benbasat (1991) found that the relative advantage of any innovation is positively related to its rate of adoption. Mobile money offers superior benefits such as security, convenience, and low cost to its users (Wamuyu & Maharaj, 2011) hence savings in money, time, and effort, which is a relative advantage over the traditional money transmittals. Rogers (2003) indicates that compatibility can propel a rapid rate of adoption of an innovation as it relates to how the technology conforms to a user’s lifestyle and is consistent with the need of its potential adopters. Chen *et al*. (2004) explains compatibility as the degree to which a service is perceived as consistent with users’ existing values, beliefs, habits, and present and previous experiences.

When users of mobile money find it compatible with how they exchange monetary value, they tend to use it.

Complexity is defined as the extent to which an innovation can be considered relatively difficult to understand and use Cheung *et al.,* (2000). Complexity is the reverse of ease of use which used to imply the users' perception of the technology as easy to understand and operate. Therefore, users are not going to use mobile money if it requires extra mental effort, is more time-consuming or frustrating to use. Rogers (2003) shows observability as the way in which innovation is visible to the members of a social system, and its benefits can easily have been observed and communicated. It is what Moore & Benbasat (1991) refers to as innovation visibility and result demonstrability. If the users of mobile money find it working in most situations that demand exchange of monetary value, then they would use it over existing methods.

Trialability refers to the opportunity to experiment with the new technology before adoption which minimises or even eliminates certain unknown fears from potential adopters. Tan & Teo (2000) suggest that if customers are given a chance to try an innovation, it minimizes certain unknown fears, and leads to adoption. With mobile money service providers offering public demonstrations on how to use mobile phones, most users were able to see and evaluate how it works. Users who witness such demonstrations tend to use and communicate how mobile money works. Any user who perceives these distinct attributes on mobile money, there is a high likelihood of use and adoption.

2.21 The Information Puzzle with the Smallholder Farmers

Information asymmetry puzzles surround the uptake of technology by smallholder farmers. This is the case with the weather insurance index for rural smallholder and emergent farmers in Zambia. Farmers' uptakes appear to be low regardless of the hard times due to climate challenges resulting in serious poverty issues. However, demand may be lacking among a population unfamiliar with this product. Furthermore, index insurance is an intangible and complex service that may not offer immediate benefits. Therefore, if farmers underestimate insurance value, their interest in this financial service will be below. Conversely, if farmers overestimate the benefits, they will most likely take too much risk and be disappointed, which may end up damaging the product's reputation. Therefore, the quality of the information offered

to farmers is an essential factor influencing their ability to make appropriate decisions about this financial service (training manual risk shield).

The most important thing for farmers to uptake technologies is information on the product services, transparent systems, benefits, access and less on the perceived costs of the technologies. The primary conditions or variables of index insurance are that the index is closely connected with insured losses, objectively and easily quantifiable, publicly verifiable, and non-manipulable by the insurer or the insured (Michael *et al.*, 2014). To achieve this requires farmers to be aware of the WII products' requirements and how they operate. The key stakeholders need to ensure that the farmers are provided with information. Hence, a functioning insurance market can facilitate more learning opportunities and a more adaptively accomplished society by substitute as an information generation and dissemination platform. For example, insurers require diverse policyholders who undertake different extreme event risk management strategies for the weather. The insurer can aggregate these experiences and see which measures are more likely to be successful and can share this information with policyholders (Michael *et al*., 2014).

Addressing the information gap with farmers may require multiplayer and multifunction approaches to ensure farmers get comprehensive information from the government, insurance companies, and other relevant stakeholders on how the technology works. Therefore, it seems that a functional insurance market can facilitate adaptive capacity as the various risk management stakeholders contribute different areas of expertise. This combination of knowledge creates a more detailed understanding of where and how the disaster impacts materialize, which would not be available if stakeholders were not encouraged to act in concert (Slavková *et al*.,2020). When we look at the WII design, farm-level verification is not needed, avoiding both moral hazard and adverse selection issues and the high costs and lengthy delays of claims verification, but this could present puzzles with farmers if not explained. For example, instead of monitoring yields or livestock mortality over thousands of dispersed small farms, a prohibitively costly enterprise involving the local rainfall gauge, or the average yield or livestock mortality rate are measured. Thus, in principle, it is a potentially highly cost-effective approach to an unresolved issue of the first order of importance, which should allow us to deliver much-needed insurance to large numbers of smallholder farmers and rural populations in developing countries (Michael *et al*. 2014). This may meet the objectives of the

operations side, including the cost reduction, but on the other hand, it indicates reduced interactions with the farmers around information extension. This may necessitate alternative methods of ensuring farmers receive product information; otherwise, uptake may remain a challenge.

Therefore, distribution channels can be strategic and well-positioned to participate in educational efforts as they interact with farmers regularly. However, aggregators' agents have little knowledge about index insurance concepts in some cases. In other cases, they may understand index insurance but fail to convey information understandably to a target audience unfamiliar with this service.

2.22 The Confusion Surrounding the Uptake of WII.

Climate change challenges continue to be a severe risk to smallholder farmers' food security and are the most involved in agriculture production (Siankwilimba, 2019). Financial risk mitigation strategies have become handier today than ever before. Nevertheless, it appears that index insurance can only reduce risk and contribute to social and economic development if there is sustained and informed demand. However, orders may be low among a population unfamiliar with this product (Cater *et al*., 2014). Notwithstanding the benefits, index insurance is an intangible and complex service that may or may not offer immediate help. Therefore, if farmers underrate insurance values, their interest in this financial service will be below. Equally, if farmers overvalue the benefits, they will most likely take too much risk and be disappointed, which may end up damaging the product's reputation (Cater *et al.*, 2014).

Considering this confusion around weather index insurance, the quality of information offered to farmers is an essential factor influencing their ability to make appropriate decisions about this financial service. Weather index technology adoption/uptake may require various information provision platforms, including extension services, monitoring and evaluation, awareness, and training, for smallholder farmers to make informed decisions to buy in. Without a doubt, the reality of today shows that developing countries will not see a reduction in climate change anytime soon. Hush climate weather is expected to continue in developing countries globally and specifically in Zambia.

For example, Zambia receives about 1000 mm of rainfall per year, with variations of about 1400 mm in the north and 600 mm in the south (Zulu, 2002). According to Kurji *et al*. (2003),

the typical amount of rain received in some parts of the southern province is often below what the farmers require. Regardless of this situation, we continue to see low technology uptake. As observed by Peter Zulu (2002), Zambia's climatic conditions have changed since the early 1980s; the rainy season has started late, the rains have been withdrawing early, and the temperature has been practical to have increased by one degree (Siankwilimba, 2019). This shift in climate conditions implies continued pressure on smallholder farmers. Though this appears not to be the case with the farmers, the business has continued. The World Bank (2006) also reported that Zambia has been experiencing an increase in floods, temperature, and drought frequency and intensity, which many scientists have attributed to long-term climate change.

As a result, the agriculture sector, which hosts over 69 percent of the country's smallholder farmers, is under continuous pressure. In recent years, farmers have experienced droughts and floods, resulting in excessive production and productivity reductions, resulting in poor incomes and household food security challenges. In addition, the country has seen an increase in the intensity and frequency of floods and droughts (Zulu, 2002). The question is, then, why has the weather index's uptake remained so low? The ideal could have been more farmers adopting the technology to hedge against these shocks. Even with these clear indications of climate change challenges, confusion on uptake continues.

Moreover, farmers have continued to lose their investments, maintaining crop production and food security challenges. In addition, it is well known that households facing risk with few resources are likely to remain poor or be caught in poverty traps (Barnett *et al*., 2007), adding further confusion to the low uptake challenge. Finally, it appears that lack of assets and risk exposure may lead households to forego activities with high returns, perpetuating their poverty. Similarly, credit constraints and nearly non-existent insurance markets are two (of many) essential factors keeping households in traps (Barret *et al.*, 2007).

2.23 Extent of WII Uptake with the Rural Smallholder Farmers Case of Zambia

The traditional role of insurance is focused upon enhancing the recovery pillar of resilience, with insurance providing financial protection against extreme weather events. Index-based weather insurance is an innovative financial instrument, which can be used by farmers to hedge against erratic rainfall. Such a product pays farmers when rainfall exceeds or falls below pre-determined triggers, which are based on historic rainfall data as well as crop and soil

considerations. Despite theoretical advantages of index-based rainfall insurance, take-up as a standalone product has remained surprisingly low among smallholder farmers (Cole et al., 2013). Unlike indemnity-based crop insurance, where an insured farmer receives compensation for the verifiable loss at the end of the growing season, WII makes claim payments based on the realization of an objectively measured weather variable (e.g., rainfall) that is correlated with production losses (Musshoff *et al.,* 2011; World Bank, 2011). Neither the insured farmer nor the insurer can easily manipulate rainfall measurements, which reduces issues of information asymmetry. Moreover, instead of reducing effort to increase chances of compensation, farmers with WII have an incentive to make the best farming decisions (IFAD, 2010). In comparison to traditional insurance, WII is less expensive to administer, which can lead to more affordable contracts and faster payments to farmers, who often need the funds for timely planting in the subsequent season (Rao, 2010).

Despite theoretical advantages of index-based rainfall insurance, take-up as a standalone product has remained surprisingly low among smallholder farmers. This point of view is agreed by Mkhize (2012) asserting that despite these potential benefits, voluntary uptake of index insurance products is much lower than was initially anticipated (Binswanger-Mkhize, 2012). Importantly, poor households, who are particularly risk-averse and could benefit most from novel micro-insurance products, were found to be hesitant in adopting WII, unless when premiums are subsidized or bundled with other benefits, such that insurance becomes quasi-compulsory (Clarke *et al*. 2012; Miranda and Farrin, 2012). WII products have not yet been adopted widely among smallholder farmers (Binswanger- Mkhize, 2012; Cole *et al.,* 2013).

The main lingering question is whether a subsidized product can offer a cost-effective safety net in risky environments. Despite pilot testing of many types of weather index insurance products in low-income countries for over a decade, its uptake has been far below expectations. Index insurance has been widely accepted only in a few cases where it was either free or heavily subsidized. In some of those cases, farmers who received subsidized insurance tended to undertake riskier agricultural activities than those uninsured.

Similarly, several field experimental studies were undertaken to better understand farmers' insurance demand and its determinants (Carter *et al*., 2008; Norton *et al*., 2014; Takahashi *et al*. 2016). Here we shall try understanding the gaps existing between the demand and the supply side failure of uptake by farmers that has rarely been investigated also the underlying causes

by the farmers to pay for insurance. It would be important to understand the real underlying issues stopping farmers from adopting WII regardless of the continuous weather challenges, economic losses, social stress, and breakdown in their actual financial loses because of crop failure resulting into poor crop production and productivity making farmers remain in the poverty trap. The ideal is that the systems will trigger payments based on the weather condition with less interactions with the farmers agreeably reducing cost of the system. Based on the ground comments from the farmers, it was clear that farmers would need some level of interaction with the system in terms of updates or information to show case real time happenings and rainfall data were the decisions are based on. Basis risk is usually a big issue with WII as farmers would want to understand the basis of decision making for either to compensate or not and or how much will the pay-outs amounts be. The rural farmers' decisions making matrix is based on trust of the systems be it technology and or social economic issues. The theory of technology adoption emphasis the points around 5 areas that include traceability, compatibility, trialability, relative advantage and complexity. Uptake of WII is a transformative issue that may require the farmers to clearly understand and appreciate the technology. These may need to understand real time farmers point views and not really the desk top analysis only.

2.24 Reasons for Low Uptake Voices from the Farmers' Perspectives -Choma District Southern Province

Generic reasons for low uptake have been documented by main scholars. Several field experimental studies were undertaken to better understand farmers' insurance demand and its determinants (Carter *et al.,* 2008; Norton *et al.,* 2014; Takahashi et al., 2016). However, listening and paying attention to farmer voices on the reasons for low uptake for technologies WII inclusive may help unlock the puzzle regardless of huge losses the smallholder farmers continue facing. Getting close to technology adoption and uptake by farmers will need considerations of what the farmers' perspectives are and why the status core is the way it is today from the economic, social and systems point of views. This requires different stakeholders taking up and actively listening from the farmers' real time, practical, theoretical underpinnings, and philosophical dimensions. The uptake puzzle is multi facet that may require a multiplayer and multifunction approach as applied in the market systems with considerations of the inner voices of the farmers. Designing products and delivery mechanisms that do not put in serious consideration the farmers' voices will not in any way answer to low uptake of the rural poor farmers to technology. Boardroom and workshop solutions to farmer challenges is

by far farmer not the solution. Many studies have been done indicating a number of factors that affect the uptake of WII amongst smallholder farmers but keep missing the inner voices that simple and require clear solutions that both consider the social and economic aspects. Acknowledging the importance of local context is important, as it shows that there is not a one-size-fits-all solution – what might be acceptable in one region may not be in another, leading to the idiosyncratic development of insurance markets (Surminski *et al.,* 2015).

The obvious reasons and factors for low uptake have been documented by a number of schoolers but attention must be considered when looking at the underlying causes or the root causes of low uptake. Harmonizing the process of information asymmetric is crucial for the farmers' uptake to WII. In as long as the message is not clear enough with the farmers' uptake is compromised and in fact jeopardised more. Some generic reasons of low uptake include but not limited to cost issues of insurance and capacity building systems.

2.24.1 Cost Issue of Insurance

Crop Weather Index Insurance, WII, is a simplified form of insurance, where payments are made based on a weather index, rather than measurement of crop loss in the field. The index is selected to represent, as closely as possible, the crop yield loss likely to be experienced by the farmer. The most common application of WII is against drought, where rainfall measurements are made at a reference weather station(s), during defined period(s), and insurance payouts are made based on a pre-established indemnity scale set out in the insurance policy. The sum insured is normally based on the production costs for the selected crop and indemnity payment are made when actual rainfall in the current cropping season as measured at the selected weather station falls below pre-defined threshold levels (World bank, 2011- Nigeria report). However, researchers have found that rainfall insurance demand is highly price-sensitive, suggesting that high insurance prices continue to contribute to low demand (Cole et al., 2013).

If the costs of the inspectors and the inspections are included in the price of the insurance. This would be very expensive for smallholder farmers that have a couple acres or less. To reduce these costs, a measurement instrument acts as a representative for many farmers with farms close to each other. These farmers all experience similar weather conditions like rainfall and temperature. The instrument should record the risk and report.

2.24.2 Capacity Building of WIIL Insurance (Extension Trainings)

Findings from a financial literacy and weather insurance marketing field experiment conducted in 2009 indicate that financial education can have a positive and significant effect on rainfall

insurance adoption (Cole-*et-al*-2013) Not only do stakeholders have to design and market products, but also, education and capacity building among local insurance staff, delivery agents, government officials and consumers are needed. These capacity-building investments likely contribute to broader financial service development; however, it is important to note that thus far, donors and/or governments have heavily supported the development of every weather index insurance market (Barry Barnett, 2014).

Further, experience with weather index insurance markets clearly shows that developing these markets involves high start-up costs. Not only do stakeholders have to design and market products, but also, education and capacity building among local insurance staff, delivery agents, government officials and consumers are needed. These capacity-building investments likely contribute to broader financial service development; however, it is important to note that thus far, donors and/or governments have heavily supported the development of every weather index insurance market. Still, interest in weather index insurance is increasing rapidly, and development efforts are expected to expand significantly (Barry Barnettk, 2014).

2.24.3 Relationships Between Stakeholders (Trust Issues)

Insurance requires an up-front payment by a customer to obtain a state-contingent—uncertain—claim that would pay out in the future. Trust in the insurer is therefore an important consideration in a customer's decision to purchase insurance. In addition, insurance is complicated, and trust also increases confidence in the fairness and usefulness of a policy (Cloe-ET-2013).

The instrument needs to be something that cannot lie or be manipulated. For index insurance, instruments like a fully automated weather station or a satellite are used (Musika, 2017). Index based agricultural insurance products pay out based on the value of index insurance, compensation is determined by data recorded by the satellite. If the results show that there is a payout, all farmers insured under the same reference point are paid regardless of the situation on individual farms.

For the Zambia situation, methods of paying compensation vary with insurance company. Compensation methods available are direct bank transfer and cheque. They are also studying to see if payment can be done through the e-voucher of a "formula", not on losses measured in the field. The index is a variable that is highly correlated with losses and that cannot be influenced by the insured.

2.25 Why is WII Diffusion Portraying as Such - (Perspectives from Experiences)?

While use of insurance products for transferring weather risks holds much promise, practical realization of sustainable and scalable products in developing country contexts is an ongoing effort. Understanding the underpinning reasons for participation and utilization of certain financial innovations becomes important. The financial innovations choices should be answering the interests of different stakeholders including customers, farmers, and GRZ or policy makers to some extent. The emerging markets have a lot of constraints including transactional challenges, price/costing, price discovery, production information and risk mitigating. Factors that would determine which mode of e-business is appropriate include types of products or services, customers and suppliers' expectations and requirements, the industry sec- tor, size, business goals, age, etc. (Fitzgerald, et.al, 2005)

Farmers face a wide variety of risks and have developed a variety of strategies for managing them. Risk during the production cycle generally arises from weather and biological factors such as disease and pests. Such production risks can be managed by a combination of strategies. First, mitigation measures (such as good agricultural practices, irrigation, and drainage) lower the losses when risks are realised. Second, risk transfer instruments (i.e., insurance) shift all or some of the risk to a third party in exchange for a fee. Finally, coping strategies (such as selling assets, reducing consumption, migrating, or accepting government assistance) reduce the impact of those realised risks that could not be mitigated or transferred. In practice, farmers tend to rely on all these strategies. The combination chosen depends on the country's risk profiles, levels of institutional and market development, and fiscal constraints (Khan, 2013, Komarek *et al.,* 2022).

Traditional weather insurance products, mostly sold in developed countries, aim at covering a wide range of production risk. Such products include named peril crop insurance (NPCI), in which the insurance claim is calculated by measuring the percentage of damage resulting from a, named weather loss in the field, soon after the damage occurs; and multiple peril crop insurance (MPCI), in which multiple sources of loss (e.g., For example, the hail, drought, floods) may be considered. Both sorts of policy tend to be yield-based. Typically, an insured yield (tonnes per hectare) is calculated as a percentage (typically 50%-70%) of the historical average yield of the farmer. If the realized yield is less than the insured yield, the insurance company pays an indemnity. Though suitable for developed countries, such traditional

agricultural insurance products have been difficult to adapt for smallholder farming in developing countries. Reasons for the difficulties include limited commercialization in the countries, small average farm sizes, geographical dispersion of farmers, fraud, adverse selection, and high transaction costs (DiMicantonio & Katyitakire, 2020).

WII has emerged as an alternative. It was first developed in the international weather derivative market, where major corporations hedge weather risks (e.g., in the energy market). In WII, indemnity payments are not based on the assessed losses of individual policyholders. Instead, payments are linked to an index, which is based on estimates of the weather requirements for the insured crop (or livestock) to develop satisfactorily. These weather requirements are summarized in a model that measures how key weather variables, particularly rainfall (but potentially also temperature, wind speed, and solar radiation) affect crop or pasture growth. The model identifies weather extremes that lead to losses in yield. An indemnity is paid whenever the realized value of the weather index exceeds a specified threshold (e.g., when protecting against excessive rainfall) or falls short of that threshold (when protecting against drought). A WII product can help a farmer transfer weather risks occurring throughout the crop growth cycle (i.e., sowing, vegetative growth, flowering, and harvesting) or during a key part of this cycle (e.g., germination) (Dalhaus *et al.,* 2018).

Climate exerts a profound influence on the lives of rural populations, particularly the rural poor, who depend on agriculture for livelihood and sustenance, who are unprotected against climate-related diseases, who lack secure access to water and food, and who are vulnerable to hydro meteorological hazard. Climate shocks such as drought and flooding lead not only to loss of life, but also long-term loss of livelihood through loss of productive assets, impaired health and destroyed infrastructure. The uncertainty associated with climate variability is a disincentive to investment and adoption of agricultural technologies and market opportunities, prompting the risk-averse farmer to favour precautionary strategies that buffer against climatic extremes over activities that are more profitable on average. Weather index insurance is one of several promising interventions for overcoming the negative impacts of climate risk on rural livelihoods and food security.

Correlation of an index with the targeted loss is crucial if index insurance is to be an effective alternative to indemnity insurance, but transparency and acceptability to the clients and other

stakeholders, vulnerability to manipulation, data requirements, and robustness in the face of sparse data are also important considerations.

For index insurance to be effective, it must target the right risk and the index must capture a sufficient portion of that risk. Pricing depends on quantifying that risk. Risk for agriculture is often classified as production risk (i.e., uncertain crop yields or livestock production), market or price risk (i.e., uncertainty in commodity and input prices, including influence from currency exchange rates), institutional risk (i.e., risk of unfavourable changes in institutional services and policy at various levels), business or income risk (which aggregates production, market and institutional risk), and financial risk (resulting from the degree and terms of borrowing). This classification overlooks consumption risk – a more important measure in subsistence-oriented agriculture (Baethgen *et al*., 2019).

2.26 What can be Done? – Do we have Alternatives?

Despite emphasis on the business logic of WII, in practice many WII schemes remain heavily subsidized by government and donor agencies, suffering from a low rate of uptake that limits commercial viability (Cole *et al*., 2013). WII programs also often fail to attract the target clients most in need of protection against weather shocks, including underrepresented women farmers (Giné *et al*., 2008, Delavallade *et al.*, 2015). Weather-based crop insurance is a powerful tool for stabilizing farmers' income by providing timely pay-outs directly linked with weather parameters. However, its performance can be marred by faulty design, leading to high basis risk and insufficient pay-outs.

Discussion with farmers, insurance companies, and the Bank of Agriculture and Agricultural Cooperatives (BAAC) in Thailand suggested low awareness among farmers about the potential benefits of weather index insurance products. Relatively low compensation is also an obstacle. Proper marketing and awareness raising campaigns should also accompany the introduction of index-based insurance products (Sinha & Tripathi, 2016). An ideal situation would be to have a market-driven competitive agricultural insurance industry offering services with regulatory oversight to protect consumers and ensure a level playing field. However, such a situation is not easy to achieve.

The introduction of WII was triggered by the shortcomings demonstrated by traditional agricultural insurance, which bases indemnity payments on verifiable losses. Two key

problems of such traditional policies are the potential for fraud and the high operational costs of issuing contracts to large numbers of dispersed smallholders in remote rural areas. There seems to be a consensus that traditional insurance products simply do not work in such circumstances. The findings of this assessment identify no examples of the commercially sustainable application of WII in support of smallholder farmers. Donor-supported experimentation with an evolving set of methods continues. Some programmes have been sustained with substantial subsidies. However, the prospects for finding a commercially sustainable solution are low (Carlos, 2016).

2.27 The Performance Outcomes of the Pilot Projects do not Motivate Insurers to Consider WII as a Profitable Line of Business.

None of the insurance companies in Sub-Saharan Africa consider WII a profitable line of business. The industry has experienced high loss ratios that do not allow them to cover even their operational and administrative costs. A few pilots have shown growth, thanks primarily to substantial funding provided by donors for insurance platforms, technical expertise, data processing, contract design, educational and awareness programmes, marketing, and contract monitoring. There is no indication that insurers will invest in independently developing the WII market. Most would consider this product only as part of their corporate social responsibility policies (Carlos, 2016). Proactive risk management is required to minimise current and future extreme weather impacts. The Sendai framework for disaster risk reduction for the period 2015–2030 prioritises developing societal resilience through the use of measures that finance recovery costs while incentivizing risk reduction (Mysiak *et al.*, 2016).

Insurance, the prime example of risk-transfer, fills these roles by providing compensation after an extreme weather event, while acting as a potential price signal of risk. The final pillar is adaptive capacity. A functioning insurance market can contribute towards creating a more adaptively capable society by acting as an information generation and dissemination platform. For example, insurers require diverse portfolios of policyholders who undertake different strategies for extreme weather event risk management. The insurer is in a position to aggregate these experiences and see which measures are more likely to be successful and can share this information with policyholders. Additionally, a functional insurance market can facilitate adaptive capacity, as the various risk management stakeholders contribute different areas of expertise. This combination of expertise creates a more detailed understanding of where and

how the disaster impacts materialise, which would not be available if stakeholders were not encouraged to act in concert.

2.28 Targeting and Design of Insurance

Insurance must be appropriately targeted, and this means recognizing heterogeneity in farmer populations and designing insurance products that best meet the needs of specific farmer groups, even at scale. Most farmers will already have informal insurance, for instance in the form of improved savings or remittances from friends and families. Formal insurance and informal insurance should not be viewed as competitors; if properly designed, the two can complement one another. In Ethiopia, for example, researchers found that they could increase take-up of formal insurance in iddirs (informal funeral societies) by promoting it as an instrument to manage aggregate risks, while highlighting the importance of the iddirs to share idiosyncratic risks among themselves.

Gender is also important in designing these programs. Very little is known around the differential preferences for insurance among men and women. Although men are generally found to be more risk-taking than women, men are typically targeted in the marketing of insurance, with the idea that they are the decision-makers in agriculture. The few studies on this theme have not found gender differences in the propensity to purchase index-based insurance (Berber Kramer, 2019).

2.28.1 Developing Insurance Instruments

The Relevance of Long-Term Yield and Weather Data

One of the key challenges in designing weather index insurance in developing countries is the lack of long term yield and weather data (Osgood *et al.* 2007; Kapphan, 2011). In some cases, the level of aggregation of yield data is also a problem. Some researchers argue that it is more accurate to include yield or input use data (for calibrating indices) derived from plot level information/surveys than taking regional or national average yield or input use. For instance, Laajaj & Carter (2009) find that basis risk could be minimized using the village level area-yield index derived from plot and household level survey data. Morduch (2006) shows the relevance of long-term data on the same households through randomized location decisions to see the benefits of weather index insurance for the poor. However, care should be taken in any form of calibrating weather index insurance to non-weather variables since this will alter natural covariate relationships between weather and loss. Instead, the more practical approach

is to allow a suite of products with different triggers that can be offered to farm households with different risk requirements and needs (Turvey & McLaurin, 2012).

The availability of long-term time series data for 25 to 30 years containing daily rainfall and temperature observations is another challenge for many low-income countries. In many cases, weather data are incomplete or missing for several seasons and weather stations do not often represent heterogeneity in agro-climatic conditions. Although the current indices consider households within a 20 to 25 km radius from a weather station (Osgood et al. 2007), these indices do not often work in mountainous or heterogeneous farming systems where local variability in weather conditions is high (Gommes & Gobel, 2013). Rainfall can vary across short distances as influenced by certain micro-climatic factors. This is another type of basis risk negatively influencing the adoption of weather index insurance in many developing countries (Clarke, 2011; Hill *et al.*, 2010). In this regard, the establishment of automatic rainfall stations that are not subject to manipulation are expected to reduce basis risk. However, new stations lack historical data to write contracts unless insurers simulate data based on nearby station records (Kapphan, 2011).

In case of serious droughts, basis risk may be less of a problem since the whole region could be affected uniformly (serious drought as covariate risk). However, the magnitude of the problem depends on how the index is structured (Barnett et al. 2008). Designing the contracts only for big shocks is another solution to reduce basis risk (Turvey, 2008; Hazell & Hess, 2010; OECD, 2011). This allows smallholders to utilize their traditional risk management schemes for smaller and more frequent risks.

2.28.2 Rainfall Indices and Satellite Imagery Data

Some researchers argue that rainfall may not be a good indicator since rain water may easily disappear as run-off or percolate into subsoil with no benefit to the plants (Rosema *et al.*, 2010). Light rain may evaporate easily before it reaches plant roots and heavy rains beyond the limit of rain gauges are inaccurately measured (Leblois & Quirion, 2011). At present, there are reasonable methods to fill in missing rainfall data (Gommes & Gobel, 2013), and to calibrate new modern weather stations with older data. However, more research is needed to improve the effectiveness of these methods considering the capacity of poor nations. As an alternative to rainfall indices, the use of relative evapo-transpiration (RE) was suggested by some service providers as an accurate measure of crop water use (Rosema *et al.*, 2010; FESA, 2014). RE

relies on the use of satellite remote sensing and is being tested in some parts of Africa. For instance, in early 2010, using RE data supported by satellite images as an index, a maize insurance pilot was launched in Burkina Faso and Mali (Rosema *et al*., 2010; FESA, 2014).

Using satellite imagery, the Normalized Difference Vegetation Index (NDVI) is an important advancement to reduce basis risk. NDVI is capable of reporting a vegetation index at various resolutions and time intervals (Laajaj & Carter, 2009). However, NDVI rarely differentiates pastures from cultivated land and availability of estimated indices can be delayed due to clouds (Leblois & Quirion, 2011). Turvey & Mclaurin (2012) found that NDVI should not be widely applied unless calibrated using location specific data (Turvey & Mclaurin, 2012). However, some of the current imperfections in satellite imagery can be improved in the near future. Hence, there could be alternative ways of addressing or minimizing the problem of basis risk in weather index insurance contracts through remote sensed relevant climate data or crop simulation models which estimate yield responses to climate shocks at the local level. This will require multi-disciplinary approaches and effective communication among different actors (crop modellers, climate scientists, underwriters, insurers, re-insurers, and end users).

2.29 Do we Have an Alternative -Donor Driven WII Subsidized? / Alternative Risk Transfer

Donor driven WII program appear to be failing, not scalable, unsustainable, and failing to draw lessons for responsive designs which was the idea with donor support pilots. Since 2005, more than $40 million has been committed to WII programmes in developing nations, including at least eight countries in Eastern and Southern Africa. USAID has funded several programmes that have been implemented by US agricultural universities. A larger share of the funding for experimental programmes in Africa has been committed through the World Bank (Carlos, 2016).

A review of these programs raises several important questions. Is WII fulfilling its goal of helping smallholder farmers manage risk? Do the farmers see a value proposition in acquiring the insurance? Are technical constraints to providing a cost-effective product being resolved? Is WII becoming commercially profitable? Are there any signs that commercial insurance companies will expand investments in WII on their own? (Berber Kramer, 2019)

The review notes that public subsidies have offset a significant share of the costs of product development, promotion, and supervision in all the pilot projects. In many of those still operational, subsidies still cover parts of the costs of premiums. This raises the question of whether WII can offer a cost-effective safety net offsetting farming risks in risky environments. However, the experience with the subsidy programs in many countries of Africa have not yielded anything the farmers continue not to uptake weather insurance index and most importantly the focus of such support appears to be once off and not considering the long-term implications of mind-set change of the smallholder farmers. Several questions remain an answered.

How can we insure agriculture? Have we gotten the best solution to ensure agriculture that is taking care of the smallholder farmers, can we look at alternative ways of compensating the insured farmers to build their confidence?

Does it really work? If the majority farmers indicate they are not benefiting in many parts of Africa, could we claim WII works, what is missing, is the design securing the smallholder farmers, could it be the farmers failing to understand WII.

Can it be sustained without donor support? Have the pilot projects done by donors yielded anything changing the insurance market systems. It appears the pilots are not addressing the root causes but just addressing the symptoms and hence the pilots not having any effects on uptake.

What is the risk landscape? Do we have evidence-based base of the smallholder risk landscape that can used as a marketing tool to encourage buy-in of the insurance companies?

How are the farmers getting compensated, are they getting the money? The ultimate goes for the famers engaging with WII is get timely compensation that allows them to utilize the money for alternative farmer enterprises, micro insurance – what are the risks farmers are facing.

2.29.1 Multi-Year Insurance Product as an Alternative

A multi-year policy, as the name suggests, will provide coverage for an extended duration of two or more years. It typically allows policyholders to pay the premium for the next two or three years in one go at the time of buying the policy, thereby relieving them of the hassle of renewing it every year (Maynard *et al.*, 2012, Maynard & Ranger, 2012).

While multi-year contracts are not unheard of in the insurance market today, particularly in commercial insurance lines and for high net-wealth individuals, they are rare in the majority of general retail insurance markets. Where they do exist in the commercial and high net-wealth markets, the policy term is typically no more than 3 years (Maynard *et al*., 2012).

2.29.2 Advantages of Multi-Year Insurance

Multi-year contract at a guaranteed price (or alternatively, a price with pre-defined ceiling and floor) provides financial certainty for the policyholder and a guarantee of insurance coverage over the policy term. Multi-year contracts could decrease the transaction or search costs to policyholders in a case where annual policies are not renewed by their insurer (though search costs may increase per policy as multi-year contracts mean more complex decisions). Multi-year contracts could reduce administrative costs for the insurer and increase certainty by reducing the turnover of customers.

Multi-year contracts could encourage a higher degree of insurance coverage across society with benefits to individuals and society. For example, in some markets, policyholders tend to cancel or not renew contracts if no losses have occurred and this can leave them, and society, more exposed when an event occurs.

This facility will allow for continuity of business with the smallholder farmers as opposed to the annual based insurance contracts. A more long-term relationship between the insurer and policyholder would help to alleviate this barrier by allowing the insurer to offset the investment costs against future reductions in losses to the property.

2.30 Sustainable Insurance Markets

2.30.1 Multi Player - Multi Function as a Strategy to Uptake

Market functioning is crucial for WII adoption. For the smooth operation of the market's mechanisms, several participants with varying functions and interests in the market work together. According to Figure 2.14 below, insurance needs infrastructure in a variety of areas, including data and pay-out systems, as well as the right and proper incentives and environment. These factors may include the policy regulatory environment, financial incentives like credit and, in some cases, subsidies, as well as distribution channels, diverse and innovative products that continue to meet the needs of smallholder farmers. Yet it will be important to spend

resources on systems development rather than on premiums for long term sustainability and lasting change.

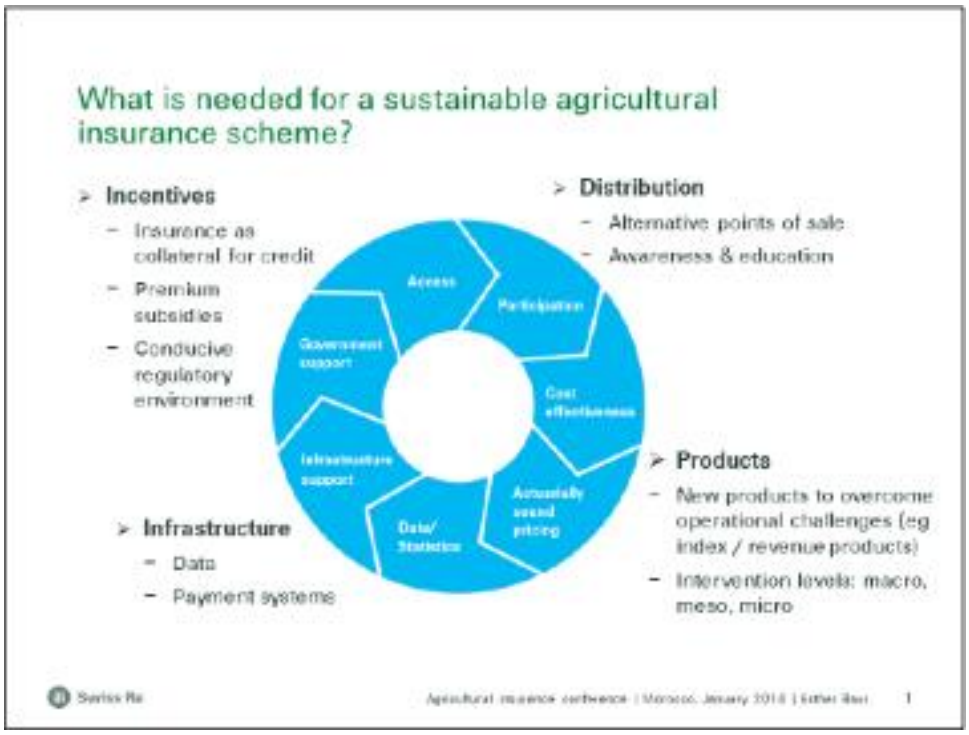


Figure 2. 14: Sustainable Insurance Scheme showing effectiveness of Index-Based Micro-Insurance in Helping Smallholders Manage Weather-Related Risks Source**:** Adopted from (Cole *et al.*,2012).

2.30.2 Need for a Collaborative Approach

For these insurance schemes in the growing agricultural markets, a collaborative and transformative strategy is essential (Timu and Kramer,2023). Figure 2.15 illustrates the various participants required for the insurance markets to be robust, sustainable, and operating. This will require participants from financial institutions like banks, commodity traders for grains to package their offers with insurance, input markets to package their products with insurance, insurers and reinsurers with proper and transparent settlement systems, and a supportive environment provided by the government through the provision of fundamental frameworks, policy frameworks, and incentives to the participants at the micro and meso levels (Kimura et.al,.2022).

Figure 2. 15: Collaboration Among Stakeholders Shows the Effectiveness of Index-Based Micro-Insurance in Helping Smallholders *Manage Weather-Related Risks (Cole et al., 2012).*

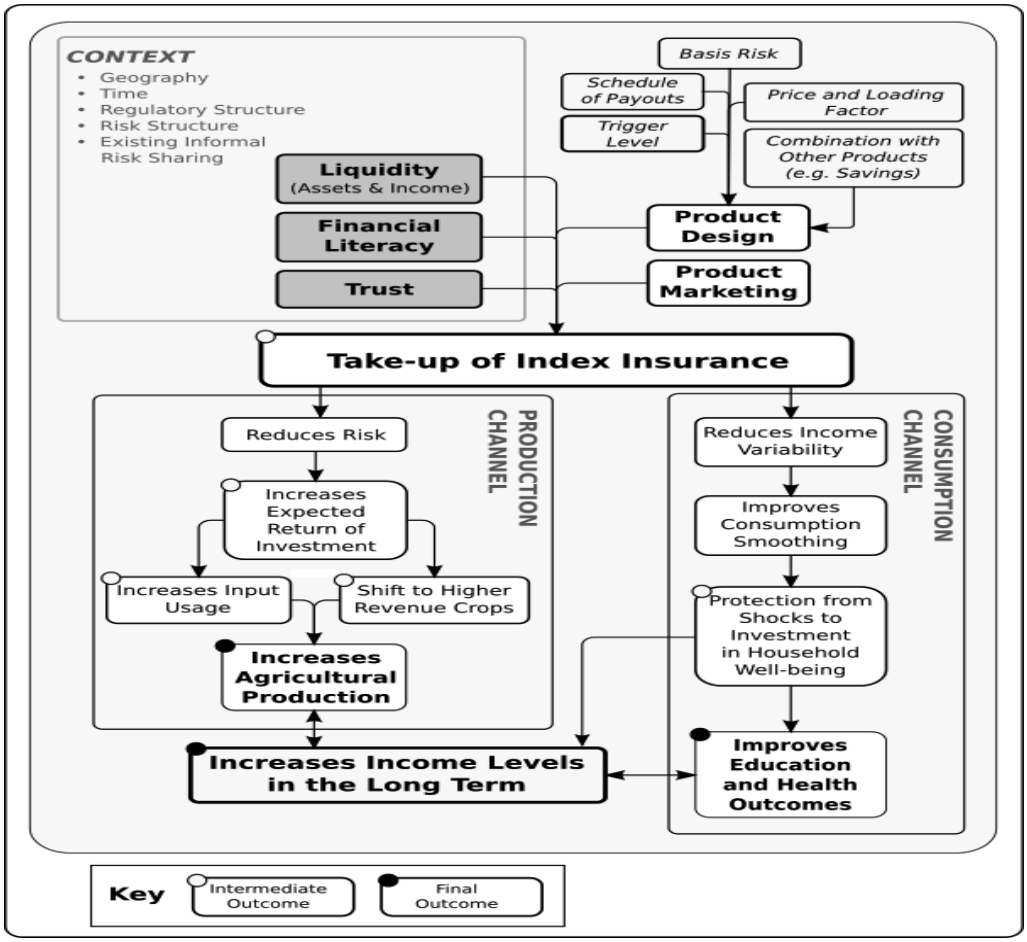


Figure 2. 16: *Showing Causal Mechanisms for Index Insurance.*

Source: Adopted the Effectiveness of Index-Based Micro-Insurance in Helping Smallholders Manage Weather-Related Risks (Cole *et al.*,2012).

2.31 Monitoring and Evaluation

Although both institution capacity and staff capacity in terms monitoring and evaluation, the ministry of agriculture has set up a specific unit for the insurance intervention that is jointly monitored at the province, district, and camp officers. This though, may require institutional capacity building for both skills and tools to for the field staff to be able to monitor effectively. In some schemes like the pula consortium scheme, the private insurance companies are monitoring the farmers both electronically as well as physical (Brown et.al.,2018). However, much input is needed into this area. The government ZIAMIS systems is used to aggregate all necessary electronic data for the farmers that can be used for monitoring and extension provision to the farmers (Mwemberi,2020). Beyond the camp officers the lead farmer model since the farmers in most cases are aggregated as model, the lead farmer or intermediaries can be recommended to support the monitoring systems of the programs. Further, as the insurance programs grows further and resources allowing it would be good to introduce the drones as monitoring tools. This could be a good area to using the donor funds not on the premiums. Data at weather stations remain a challenge for both management and transmission of data to the required partners. In some cases, the weather stations are present but efficient delivery of data might be a challenge other completely the weather capturing instruments are missing. Though initiative around satellite data is used today.

2.32 Political Economy Considerations

2.32.1 Policy, Regulation and Legal Environment

Finally, the key role of government support in developing policies, regulating the markets, and creating an enabling environment for insurance providers, cannot be overstated. There are two dimensions of how governments might act. First, governments as the main market player through the provision of other agricultural services such as extension and farm inputs can include agricultural insurance in its core services provided such as in Zambia (World Bank, 2019). Other relatively larger programmes such as ACRE Africa in East Africa also provide insurance alongside farm inputs. This combination of services with inputs is often referred to as bundling. Although evidence on bundling insurance with other services is clear we do not have strong views regarding making programmes compulsory as is the case in Zambia. However, national governments can take decisive and cost-effective actions especially by leveraging an already existing infrastructure of delivering other services, and mandatory insurance might be one of the options.

Governments can also provide regulation and market coordination functions. The principal role of the government should be to address market and regulatory imperfections so that private insurance and reinsurance providers can participate (Mahul & Stutley, 2010). Market regulation is therefore necessary to both farmers and pastoralists on the one hand and insurance providers on the other. It protects farmers from underhanded and predatory behaviours from providers and creates a competitive environment for providers. From a demand perspective, without government regulation, there is a high likelihood of a low product quality equilibrium (Clarke & Wren-Lewis, 2013; Carter & Chiu, 2018), which in turn hurts farmers through poor, unhelpful products. From a supply-side perspective, regulation keeps prices in check to avoid high premiums and low demand and finally exiting by providers due to poor markets. Effective regulation ought to be embedded in the law and regulatory organisations must be legally empowered to act to balance markets.

One major challenge is that agricultural insurance is relatively new in many SSA countries and laws and regulations on it are non-existent or still in the early stages of development (Jegede *et al*., 2020; Onyiriuba *et al*., 2020). Countries, therefore, need to re-evaluate their policies and laws, given recent innovations. There is some progress, but it could be made faster with better in-country and across countries' coordination. Two examples of progress on this front are the West African Inter-African Conference of the Insurance Markets (CIMA) countries and in Kenya. Pre-2012, the CIMA countries operating a regional regulatory body on insurance and reinsurance had only one article regarding agricultural insurance (Mahul & Stutley, 2010). In 2012, 14 CIMA countries adopted a new law that allowed regulation and oversight of agricultural insurance (World Bank, 2015a). In Kenya, the government has updated the Insurance Bill and expanded the jurisdiction of the Insurance Regulatory Authority to agricultural insurance (World Bank, 2015b). These two examples provide opportunities on how countries and inter-country bodies can update their laws, regulations, and policies to provide more space for insurance providers while setting standards with emerging technologies.

2.32.2 Drought Risk Management Strategies

Household Level

Households which specialize in farming are more vulnerable to the effects of weather variability compared to those which diversify (Hazell *et al.,* 1986). Smallholders being price

takers and lacking basic market information implies that they should rely on diversification for adapting the effects of drought in the foreseeable future. This reinforces the need for improved varieties that are drought tolerant. Hence, the key challenge for crop/livestock breeders is to develop varieties capable of adapting to drought risk, while maintaining better yield and other desirable characteristics perceived by farmers. For instance, crop varieties with abiotic stress tolerance saved more than 50 % of the current yield loss in drought-prone areas (Wang *et al.,* 2003). Hence, developing drought-tolerant varieties and investing in small-scale irrigation should also be key risk management strategies for low-income countries in their medium- and long-term plans.

2.32.3 Meso - Community-Based Arrangements

Climate variability is expected to reduce the effectiveness of traditional risk management strategies and may require a market-based risk management strategy, such as weather index insurance in agriculture (Skees *et al.,* 1999; World Bank 2005; Linnerooth-Bayer *et al*., 2005; Meze-Hausken *et al.,* 2009). However, the cost of insurance is expected to rise with an increase in the unpredictability of weather conditions that may call for a partial insurance subsidy using climate change adaptation funds for highly-vulnerable countries/regions (Linnerooth-Bayer *et al.,* 2005; Hazell & Hess, 2010). Thus, a balance between community-based risk management arrangements and market-based risk management strategies may benefit many households in low-income countries.

2.32.4 Macro level External assistance

The African Risk Capacity (ARC), a specialized agency of the African Union, aims to develop a pan-African risk pooling and transfer instrument using weather index insurance to pre-finance disaster risks (e.g. drought, flooding) for affected member states (ARC 2014a). This is an important institutional response from the African Union Commission to manage agricultural risks in Africa and ARC has recently provided weather index based playouts in Senegal, Mauritania and Niger (ARC 2014b). When it is widely implemented, this will be an important macro-level drought risk management system that allows African countries reduce the high social and humanitarian costs from delayed responses to drought and related risks by providing predictable and timely responses to food insecure populations affected by extreme weather events based on a measurable index to trigger playouts to member states.

A key constraint of weather index insurance for small-scale farmers in low income countries is basis risk – often aggravated by poor data quality in calibrating indices (e.g. for drought, soil moisture or vegetation cover) in a given area (Barnett et al. 2008; Osgood *et al.,* 2007; Clarke 2011; Hill *et al.,* 2010; Cole *et al.,* 2013). Poor correlation between yield at farm level and rainfall records at the nearby weather station results in spatial basis risk. A farmer with more experience and/or investments in soil and water conservation practices is less likely to be affected by flood compared to others with little or no experience/investments.

Subsidies have been variously used to make agricultural insurance including weather index insurance more attractive to farmers (Mahul & Stutley, 2010; Mahul *et al.,* 2012). The challenge would be to find a balance which will make the insurance product attractive to risk-prone smallholder farmers by lowering basis risk without unsustainable subsidies and a micro-level delivery mechanism that will be profitable to the insurance providers.

Social scientists can contribute to developing better methods and tools that increase the demand for weather-index insurance through demand analysis and the understanding of farmer decision-making behaviour and the effect of imperfect and asymmetric information. Hence, collaboration among social scientists, economists, remote sensing experts, agro-climatologists, crop modellers, climate scientists and development practitioners, including end-users, is essential to streamline the weather-index insurance approach for agricultural risk management. despite the promising conceptual justifications, the suggested solutions for interlinking insurance with credit markets still require ground level applications and empirical evidence on the benefits in terms of lowering insurance costs or reducing the cost of borrowing and making credit more accessible to smallholder farmers in low-income countries. Agricultural input credit schemes may be interlinked with insurance to enhance access to credit services and improve adoption of improved agricultural technologies (Carter, 2009).

Ali *et al.,* (2020) study on the Willingness to pay for weather index-based insurance in semi-subsistence agriculture: evidence from northern Togo. The effects of climate change on agricultural production are pushing countries to reconsider risk management policies in their development plans. Opportunities exist to increase agricultural production and improve the policy environment. However, policymakers lack local empirical evidence to provide local solutions to agricultural development in many developing countries, including Togo. This paper assesses farmers' willingness to pay for weather index-based insurance (WII) as a market

option for sharing climatic risks. A choice modelling approach is used based on data collected from 704 randomly selected households in northern Togo, West Africa. Statistical analysis of the data shows that dry spells are the major concern of farmers and maize is perceived as the most affected food crop. Results also indicate that respondents are willing to participate in a WII market and would prefer insuring crops, such as maize over sorghum and rice against drought by paying on average about $14.5 per hectare. The results show that WII should not be offered standalone but interlinked with other factors such as providing drought tolerant and high yielding varieties; loans to organized farmers' groups; and weather information through TV, radio and mobile phones in local languages, while encouraging education to enable the diffusion of more advisory services. These factors are likely to influence positively farmers' preferences in participating in a WII market.

The impact of climate change on agricultural productivity is widely recognized (Doelle & Seck, 2019; Mendel- Sohn *et al.,* 1994; Nordhaus & Yang, 1996). Besides positive impacts predicted in some regions (Deschênes & Greenstone, 2007; Hossain *et al.,* 2019), negative effects of climate change on agricultural production are also projected, and these are more pronounced in developing countries (Davenport *et al.,* 2018; Di Falco, 2014; IPCC, 2014; Rosenzweig & Parry, 1994). In Sub-Saharan Africa, variability in temperature and precipitation, the shortening of growing seasons, flooding, drought, and erosion are frequently observed and are becoming real challenges for agricultural production leading to an increase in food imports (Deressa *et al.,* 2009; Di Falco *et al.,* 2011; Egbendewe *et al.,* 2017; Wossen *et al.,* 2017).
Climatic risks can escalate poverty levels, especially given the proportion of the population involved in the agricultural sector and its contribution to welfare of households in low income and developing countries. Moreover, people in low-income countries who heavily depend on agriculture tend to be more vulnerable, because of their low adaptive capacities (Fisher et al., 2015; Hönle *et al.,* 2018; IPCC, 2014; Rosenzweig & Parry, 1994).

There is, therefore, the need for intervention, not only of the public and private sectors in climate risk management, but also at the individual level through adoption of adaptation technologies at the farm or household levels. Being aware of economic losses due to weather risks, policymakers are concerned with finding solutions to support vulnerable households in case of poor harvests (Budhathoki *et al.,* 2019; Dale *et al.,* 2019). Indeed, within the context of developing countries, pro-poor growth policies require risk mitigation and adaptation tools that

can help farmers offset the negative effects of climate change and enhance productivity. In that sense, the uptake of an insurance product can play an important role in risk pooling and enhance climate change resilience (Broberg, 2019; Budhathoki *et al.,* 2019; Glauber, 2004; Nordlander *et al.,* 2019).

Traditional agricultural insurance programmes such as hedging plus weather index-based insurance (WII), are existing market instruments used in addressing the effects of climate change on farm household production (Fuchs & Wolff, 2011; McIntosh *et al.,* 2013; Turvey *et al*., 2006). Traditional agricultural insurance programmes have often failed in developing countries due to moral hazard and adverse selection issues (Du *et al*., 2014; Glauber, 2004; Miranda & Glauber, 1997; Smith & Goodwin, 1996). Indeed, a farmer might have a poor harvest because of lack of incentives to an optimal use of input knowing that s/he will be paid for such an outcome. This behaviour cannot be controlled by insurance companies. An alternative is to use WII as a market instrument for sharing climatic risks (Clarke, 2016; Hill *et al.,* 2019). WII is a common approach used to respond to crop yield variability induced by rainfall deficiencies (Clarke, 2016; Du *et al*., 2014; Fuchs & Wolff, 2011; Hill *et al*., 2019; Shirsath *et al.,* 2019). In fact, among the coping instruments, WII is seen as one of the most efficient that could be used in climate risk management in developing countries (Chantarat *et al*., 2007; Horton & Keith, 2019; Miranda, 1991; Richards *et al*., 2004; Shirsath *et al.,* 2019). The research was relevant and various key lessons were learned and applied some in the current research, among them were.

The WII policy intervention would be attractive if the insurance contract could jointly consider the provision of DTS, credit as well as weather information. The market share of such a hypothetical insurance product could reach at least 61%. Also, the education level of farmers is likely to positively influence the adoption of WII and DTS. Meanwhile, the highest premium level tends to decrease farmers' willingness to participate in the WII programme.

The study indicates that, as a complement to WII, attention should be given to additional attributes such as providing DTS to farmers, offering loans and ensuring that farmers not only have access to weather information, but more importantly, that such information is also integrated these into their decision-making processes through farmer-based organizations. Linking WII to other risk management instruments such as DTS, credit and weather

information could be a great step in moving toward a semi-subsistence farming system, where a farmer produces not only for subsistence, but also for market.

There is also the need to educate and advertise WII and help farmers better understand the advantages of the WII programme. Having easy access to locally relevant weather forecasts is also important. Therefore, increasing the number of weather stations and the quality of needed instruments is recommended for better implementation of a WII. Future research could analyse the supply side of WII, to determine the equilibrium price of offering such packages. Such research could consider the potential for existing financial institutions and/or insurance companies, in Togo.

2.33 Empirical Review and Gap Analysis from Selected Studies

There are recent studies that examined the impact of weather index insurance on new agricultural technology adoption. This section reviews selected journals and to draw key lessons and evidence.

Ephias Maudze (2012) studied robust decision-making for sustainable and scalable drought index-based microinsurance in Ethiopia: reducing weather-related disaster risk with rural agro-insurance. The research revealed that there was an improve index quality for more robust risk assessments; considered initially offering standalone micro insurance products with established demand and supply-side impact criteria; addressed demand and supply-side capacity constraints and gauged domestic interest relative to other index insurance model designs.

Weaknesses were because of uncertainties; the methodology was scenario-based; farmers were selected by stratified purposeful sampling; FGD was 5–10; and there was no mention of guiding theories (theoretical gap).

Rose Goslinga (2012) researched practical experiences in improving the affordability and delivery channels of weather index insurance for Kenyan smallholder farmers. This was at the Rose Goslinga Syngenta Foundation for Sustainable Agriculture, Basel, Switzerland.

The findings revealed that premiums needed to be made more affordable and to develop partnerships with agribusinesses willing to sponsor part of the premium; new cost-effective

delivery channels needed to be developed that are practical and relevant for farmers; and input retailers offered a viable alternative to traditional insurance agents.

Weaknesses were based not emphasize more on the model that would encourage uptake of WII; no mention of methodology, sampling frameworks, data analysis; no mention of guiding theory. The research revealed both a methodological and theoretical gap.

Akter et al. (2016) carried out research on the influence of gender and product design on farmers' preferences for weather-indexed crop insurance. The findings were: attribute-based choice experiments (CE) were widely used for product designing and value elicitation in the absence of a real market and revealed preference data; men and women had different preferences, bundling of insurance with other financial products and services. Both weaknesses and strengths were revealed. complicated methodology, but adequate data was collected using both quantitative and qualitative data. There were no specific questions, but there were clear objectives; no mention of theory was made.

Samples limited to farmers would suggest including other stakeholders, such as insurance firms and extension staff, who would add insight and information. Theoretical gaps and population gaps were found.

Makoni et al. (u.d.) carried out research on the analysis of the uptake of agricultural insurance services by the agricultural sector in Zimbabwe. The findings were: well-articulated factors affecting uptake of WII but not linked to theoretical underpinnings (theories); farmer knowledge and awareness were key in WII uptake; rainfall data was key; and communication and interaction between farmers and insurers.

Both weaknesses and strengths were revealed: no mention of the methodological approach, sampling techniques, target areas, no mention of theories, though the conceptual model is presented, and poor mention of the research design.

Kenneth et al. (u.d.) studied small farmers' preferences for weather index insurance: insights from Kenya. The findings were: choice experiment and social economic survey; the theoretical basis for DCEs was Lancaster's consumer choice theory, which postulates that an individual derives utility from the different attributes of a good; contract signing with groups not

individual farmers; good guiding theory and process of data mentioned and well-articulated methodology process.

Weaknesses were based on the fact that the choice-experimental methods had not yet been widely used to analyze farmer preferences for WII, so there was a need for a methodology that has proven evidence on WII uptake by farmers; there was no mention of a clear methodology approach; suggested a mixed approach to the study, though it appeared they only looked at quantitative methods. There was an evidence gap and a methodology gap.

Shweta and Tripathi (2016) researched the challenges of successful implementation and adoption of crop insurance in Thailand. The findings were: in Thailand suggested low awareness among farmers about the potential benefits of weather index insurance products; relatively low compensation was also an obstacle; proper marketing and awareness raising campaigns should also have accompanied the introduction of index-based insurance products; vulnerability analysis was well-done; other coping mechanisms by farmers such as drought tolerant crops insurance models to take these into account for new products.

Weaknesses and strengths were that the data collection tools and stakeholders were all good, but there was no mention of the methodological approach, no mention of the guiding theories, and no mention of the models; not why question was used in the FGD discussions; this limited the study in getting underlying causes for why farmers were making different choices and why there was a methodology and theoretical gap.

Shirsath et al. (2019) studied designing weather index insurance for crops for the increased satisfaction of farmers, industry, and the government. The findings were: The study presents 'Farmer Satisfaction Index' as a powerful evaluation tool in determining the effectiveness of insurance products through measurement of basis risk by combining agro-meteorological statistical analysis, crop growth modelling and optimization techniques, a heuristic model was developed which generates superior contract design which yields better and frequent playouts at no extra cost of subsidies (in terms of premium rates).

Weaknesses and strengths were from the start, no mention of the methodological approach and design outline, no mention of the sampling techniques used, sample sizes, vulnerability assessment for picking the areas, questions the study is trying to answer, though the aims and

objectives are well articulated, philosophical underpinnings are not mentioned, and it was appreciated that the study was using historical data. The presence of a methodological gap.

Sarah et al. (2015) carried out research on flexible weather index-based insurance design. The findings were: farmer panel data; well-explained index insurance frameworks; well-explained methodology; we explained the index insurance framework applied in our analysis and derive an expected utility approach based on mean and semi-variance; we adapted this approach to our objective function in the second subsection. In the third subsection, we describe the GDD concept and the index design approach. In the fourth subsection, we present our case study and explain the empirical procedures.

Weaknesses and strengths were all quantitative methods, which are okay but may not have detailed explanations or detailed reasoning from the farmers and industry players. Qualitative methods help to bring out this reality. heavily reliant on data availability, without which outcomes become questionable. Evidence gaps and methodology gaps were found.

Willemijn et al. (u.d.) studied index insurances for grasslands—a review for Europe and North America. The findings were: Different insurances are developing isolated, which prevents knowledge spillovers. Tailor-made solutions and combining different data sources can improve insurance basis risk, which is often reduced using more complex indices. This would also go along with reduced transparency of the underlying to farmers.

Weaknesses and strengths were a good, detailed article on index insurance, but no mention of a clear methodology, which is equally important to define when undertaking this type of investigation into what is available on the ground of index insurance. found a methodological gap.

Carriquiry and Osgood (2012) studied index insurance, probabilistic climate forecasts, and production working papers. Findings were: It was found that levels of input usage increase when farmers are insured. The failure of the development of commercially viable traditional crop insurance products and innovations in financial markets has fed a renewed interest in the search for alternatives to help farmers in developing countries manage their risk exposure.

Weaknesses and strengths were no description of the methodology used, sampling techniques, objectives, questions, or philosophical underpinnings. population gap and methodological methods found.

Chengyi and Yueyun (2018) studied weather indexes, index insurance, and weather index futures. Findings were a mixed-methods approach, insurance companies, and mutual/hedge funds were major participants in this futures market.

Weaknesses and strengths were well-organized journal article—but no mention of the sampling designs for data collected; research design not discussed; philosophical underpinnings not discussed; objectives and questions not outlined clearly. A methodological gap was found.

Sarthak et al. (2011) studied marketing complex financial products in emerging markets: evidence from rainfall insurance in India. Findings were: Financial education has a positive and significant effect on rainfall insurance adoption, increasing take-up from 8 to 16 percent.

Weaknesses and strengths were no mention of theories driving the research; no mention of the methodological approach; no clear mention of the population; and sampling done well. A theoretical gap was found.

In China, Chengyi *et al.,* (2018), did a study on weather indexes, index insurance and weather index futures. Methods used in this paper are mixed. It mainly uses a comparison method to compare different types of risk management of agricultural products, including traditional weather insurance, weather index insurance and weather index futures and explain why developing countries like China should develop and implement the weather index futures to better manage farmers' risk.

This study focused on the achievements and challenges of China's weather index insurance programs and found that farmers had weak demand for such insurance. Chengyi *et al.,* was built on Lin *et al.,* (2015) who founded some factors affecting farmers' willingness to purchase weather index insurance in China and concluded that besides the recognition of risk itself, factors such as their type of agricultural products and farmers' trust to the insurer affected the farmers' willingness.

Reviewing research by Chengyi *et al.*, was relevant to the current research on understanding the diffusion of weather index insurance among smallholder farmers in Zambia, a case of Petauke, Mumbwa, Chongwe and Choma districts. This current study sought as well to focus on the achievements and challenges of weather index insurance programs and reasons why smallholder farmers have weak demand for such insurance innovation. Though China and Zambia are not on the same level of development, the research was an eye opener to the researcher. The researcher had many lessons from the study, among them.

Weather index-related financial derivatives are based on the event of bad weather, not the outcomes or damages from bad weather. Its contracts will also pay for less extreme events so there will be better protection for the buyers/investors. Since the index is standardized and easy to measure, it will reduce participants' transaction and administration costs (Stoppa & Hess, 2003; Barnett & Mahul, 2007). Since insureds behaviours will not be related with the insurance payment, index related derivatives can eliminate adverse selection and moral hazard problems (Gronberg & Neilson, 2007).

Weather index insurance has been attractive to developing countries with small size of farms. Large farmers prefer buying traditional weather insurance because it can cover its actual loss. Also, large farmers pay lower insurance premiums per unit coverage than small farmers, since the insurer's underwriting cost will be lower due to the economies of scale and because of less adverse se- lection and moral hazard problems (Boyd *et al.,* 2011). In addition, large farmers receive huge government subsidies for its weather insurance and its premiums (Mahul & Stutley, 2010).

Traditional weather insurance is costly because of higher administration costs, like sales costs, loss measurement costs, moral hazard, and ad- verse selection. It typically covers high-risk, low-probability events, as defined in a highly tailored, or customized, policy. It fits large size farmers well (Chengyi *et al*., 2018).

Weather index insurance is based on the covered area's average weather condition and its payment is not directly related to the farms' actual losses. Its advantages are to lower the administrative costs and avoid potential moral hazard and ad- verse selection problems. It fits small size farmers better.

This study emphasized the issue of selection of the areas correctly for successful programs for example they suggested - To form a futures market, there must be large enough participants. Current index insurance is usually based on a specific region/area and that will be too narrow to attract enough participants. A county-level weather index will be better. First, it is large enough to cover necessary farmers and attract other participants/investors; secondly it is narrow enough to have the similarities and avoid differentiations of weather conditions in different areas. Also, weather data are easy to collect at the county-level since each has its weather station(s). We suggest first to select 20 county-level cities in which its agriculture industry is significant to the local economy (at least 12% of its GDP from this sector). This approach is necessary to start-up this proposed program since its primary purpose is to help farmers and stabilize the agri- culture industry. In the future, more cities can be added based on the needs.

Further suggested that government has a role to encourage farmers to participate in such programs. To encourage farmers to buy this kind of weather index futures, governments need to subsidize these farmers, as they have been in weather-based insurance and weather index insurance. The suggested subsidy is 30% of the required premium/price of the futures contracts. To other types of investors, both buyers and sellers, any subsidies will not be necessary as long as the pricing of the futures contracts is fair. Also, governments should pay for start-up costs of developing the weather indexes.

Another empirical enquiry by Cole *et al.*, 2012 studied the effectiveness of index based micro-insurance in helping smallholders manage weather-related risks. He used systemic research method in London by searching for relevant related studies and collected 17 electronic databases from 16 journals and 23 development and policy institutions through their websites. This study was done at EPPI-Centre, Social Science Research Unit, Institute of Education, University of London. Results revealed two of the most important influencing adoption. First, several non-price factors including financial literacy, trust and liquidity appeared to affect demand for index-based micro-insurance products, and secondly, there was some evidence that access to index-based insurance increased the use of agricultural inputs, such as fertilizer.

In terms of take-up, higher liquidity, and income levels available to the household were found to be positively associated with take-up. A lower level of income diversification appeared positively associated with insurance demand.

Financial literacy was found to be positively correlated with interest in weather insurance. Familiarity and trust in the external agent or organization selling the insurance product as well as trust in the insurance product elicited by information from, or decisions by, personal networks are also associated with higher levels of take-up. Surprisingly, higher levels of risk aversion are associated with lower demand for index-based micro-insurance.

There were mixed evidence of the impact of insurance cover on input usage. Farmers offered a bundled loan and insurance products were found to be less likely to accept the loan to finance hybrid seeds. In another study, insurance coverage is associated with greater purchases of fertilizer, where heterogeneous effects revealed that this effect was larger for smallholders who had used fertilizer in the past and portrayed better understanding of the insurance product. In addition, it was found that having to pay for the insurance product, rather than it being offered for free, increased the impact on fertilizer purchases.

The review showed several non-price factors, including financial literacy, trust, and liquidity, appeared to have affected demand for index-based micro-insurance products and that there was some, although mixed, evidence that access to index-based insurance increased the use of agricultural inputs, such as fertilizer.

In terms of research implications, the review revealed substantial evidence gaps in the literature on take-up and impact of index-based micro-insurance. Little is known about issues such as the level and impact of basis risk, financial literacy, consumer education and the possibility of group-based index insurance.

A study by Tadesse *et al*, (2015) on weather index insurance for managing drought risk in smallholder agriculture: lessons and policy implications for sub-Saharan Africa was carried out. The study focused on understanding weather insurance index as an innovation that could help to manage the increasing risks for the farmers in the sub- Sahara region that is facing ravaging climate change challenges in recent times. Despite its promise to integrate local agricultural risk smoothing with insurance principles, there remain many challenges to its mainstreaming in low-income countries. Scaling up of weather index insurance pilot projects is particularly constrained by high-basis risk, related to the divergence between the calculated weather index and actual productivity loss on the farm. Various options may be considered to enhance uptake of weather index insurance. Linking reliable weather data with location-

specific crops and agronomic conditions using flexible geospatial crop modelling tools is one option to reduce the basis risk. The other option is interlinking weather index insurance with credit or safety nets. In the end, insurance should be offered as part of a wider set of business services that provide real value to smallholders. Finally, the review acknowledges that the suggested conceptual solutions, especially interlinking index-based weather insurance with credit will require more empirical evidence on the extent to which insurance would reduce the cost of borrowing and make credit more accessible to the smallholder farmers.

Despite continued pilot testing of weather index insurance products in low income countries, its actual uptake has been far below expectations (Giné & Yang, 2009; Binswanger-Mkhize 2012; Cole *et al.,* 2013). The high price (premium) and lack of trust in the index and its ability to properly predict the risk of loss as well as the credibility of the insurance providers are key factors negatively influencing the demand for weather index insurance (Brans et al. 2010; Cole *et al.,* 2013). Clarke (2011) shows that the low demand for weather index insurance by poor farmers is a rational response to basis risk. For higher uptake, weather index insurance should be cheaper than the current risk management practices of smallholders, such as reliance on social networks and self-insurance mechanisms by owning assets (Binswanger-Mkhize 2012). Others argue that promoting access to productive assets (e.g. land), credit, improved seeds, better agronomic practices, and rural infrastructure are the key factors for the poor to build their own capital to self-insure in case of disaster. It is however difficult for the poor to build capital for climate risk management and risk transfers (insurance) in the short run as current consumption competes with future savings. Insurance and credit instruments for smallholders may need to be seen as essential complements rather than substitutes for risk-reducing and profitable technological innovations. This is particularly relevant as technological solutions per se will be inadequate in managing production risks caused by severe climate shocks and extreme events expected under progressive climate change.

Ali *et al.,* (2021) looked into the risk, ambiguity, and willingness to participate in Crop insurance programs using evidence from a field experiment. This paper analysed smallholder farmers' willingness to participate in crop insurance programs, using recent data from cocoa farmers in Ghana. Given the significance of output uncertainty and imperfect capital and insurance markets, we develop a theoretical framework to analyse how risk and ambiguity aversion, and liquidity constraints influence farmers' crop insurance participation decisions.

From this study key lessons are drawn that influence participation of the farmers for crop insurance, among them revealed.

The model revealed that farmers will be willing to participate in crop insurance if the expected utility of net benefits is positive; and that farmers' crop insurance uptake decisions will be affected by farm and household characteristics, as well as ambiguity and risk aversion.

Liquidity constraints and input use variables may be potentially endogenous. As argued by Carter *et al.*, (2016), insurance can crowd-in credit, as farmers with insurance incomes pose less risk to creditors. Thus, purchasing insurance could in fact be driving farmers' access to credit and liquidity constraints status.

Most non- participants in crop insurance lack understanding of the insurance products (Gine´ *et al.,* 2008) and, as Garrido & Zilberman (2008) rightly point out, the non-awareness of the benefits from crop insurance may limit farmers' participation in these programs. The general level of trust, may be associated with farmers' trust in receiving payments from insurance agents in the event of crop failure, is expected to have a positive effect on farmers' willingness to participate in the insurance program.

When farmers are liquidity constrained, premium payments would be more expensive for them, because of lack of adequate financial resources prior to income receipts after crop harvests. Thus, liquidity constraints do not only limit the purchase of inputs for production purposes, but also play a relevant role in decreasing the tendency for farmers to participate in insurance programs. These findings are in line with the results from Casaburi & Willis (2018), who found that liquidity constraints mattered in farmers' demand for insurance in Kenya.

Empirical results further show that farmers spending more on fertilizer have a higher tendency to participate in crop insurance programs. This is not surprising, given that the economic benefits of fertilizer application are often contingent on the random state of nature, particularly on timely rainfall.

Other statistically significant variables include farmers' ability to read and write, as well as the variable representing farmers' general level of trust in people. The positive sign of influence for farmers' ability to read and write is consistent with most crop insurance studies, suggesting that literate farmers are more likely to participate in crop insurance programs (Hill *et al*., 2013).

Trust, which is a social capital variable, plays a relevant role in farmers' participation decisions in insurance programs. Farmers who generally trust people are more willing to participate in crop insurance programs, because they tend to trust that they would receive the compensation in the event of crop failures (Casaburi & Willis, 2018).

Awareness of insurance programs shows a positive effect, confirming the proposition that farmers with knowledge on insurance are more likely to participate in crop insurance programs (Gine´ *et al.,* 2008). The positive and significant coefficient of the variable representing total land owned increases the probability of participation in crop insurance programs. These findings are in line with the notion that crop insurance is a normal good, with demand increasing with wealth (Clarke, 2016).

The results from the empirical analysis revealed that insurance premium has a negative influence on farmers' willingness to participate in the programs, indicating that insurance is a normal good, with demand declining with increasing prices. We also found that those farmers who were risk-averse are more likely to participate in crop insurance programs compared to the risk-loving farmers, confirming the significance of risk preferences in farmers' willingness to participate in crop insurance. However, even though ambiguity-averse farmers were less willing to participate, we did not find significant changes in our empirical estimates upon interacting it with their risk preferences. These findings suggest that policymakers need to take into consideration farmers' risk preferences when introducing crop insurance programs to help them accurately predict farmers' participation decisions.

From a policy perspective, the government and other actors can leverage on the available mobile technologies to make yield data easily accessible to farmers. This will be relevant for ambiguity-averse farmers in forming priors about states of the yield distribution. Their averseness to extreme events may be reduced to improve participation. Government can also enact regulations to deal with extreme negative outcomes, which has often been the underlying cause of ambiguity aversion. Regulations on these 'left tail' events could be particularly helpful in minimizing the ambiguity and improving uptake of index-based insurance product.

The empirical results also revealed positive and significant impacts of farmers' ability to read and write on willingness to take up crop insurance. From a policy perspective, this indicates that providing farmers with a clearer understanding on how crop insurance works through

training and workshops would increase their awareness and subsequent uptake of crop insurance programs. To the extent that crop insurance is a way of hedging against yield and income losses from adverse weather conditions occurring from climate change, supporting farmers to participate in insurance programs could help farmers stabilize their incomes. Moreover, it is significant to mention that smallholder farmers need an insurance package that is suited to their specific needs and characteristics and that future research could aim at designing such insurance packages.

Research on agricultural index insurance for development was done by Jensen and Barret in 2016. Provided are summaries on the state of index insurance, paying special attention to the key challenges facing index insurance as a more effective tool for development. Recommendations were offered to tackle those challenges by strategically investing in a set of public goods and services geared towards addressing key informational gaps and improving the quality of index insurance products around the world. The following statements were key points from the study.

Index insurance was found not a panacea, and there were some situations in which even a high-quality index insurance product would not effectively assist agricultural households. In fact, the short lifespan and disappointing outcomes of some index insurance projects should have served as a caution against uncritical, wholesale promotion of index insurance products. However, the emerging empirical evidence showed that given appropriate circumstances and good data, index insurance could be a cost-effective method for offering social protection and improving the lives of rural agricultural households in developing countries.

On broker services, many insurers in developing countries lack access to affordable brokerage services to coordinate and negotiate reinsurance. Access is often limited to one or two reinsurers already familiar to the insurer. In some cases, brokers could not only facilitate access to a wider range of prospective reinsurers, thereby helping to stimulate more competitive pricing, they could also help assemble consortia to take on different risk layers or to bundle different products to better suit the needs of reinsurers or public facilities and achieve the scale sometimes necessary to access a broader array of prospective reinsurers.

With regard to product accelerator, there were opportunities in facilitating a more favourable reinsurance market for local index insurance insurers by offering services directly to the domestic-level insurers that were presently only available through global reinsurers. One

approach is to provide small pilot projects with access to industry experts, perhaps as a sort of "index product accelerator" program. Many local insurers need expert guidance on the technical (actuarial) details of product development, and on how to better market their products to reinsurers. A pool of pro bono or subsidized expert providers could help accelerate the development of high-quality products and potentially help reduce information asymmetries between local insurers and global reinsurers.

Empirical research on the demand for crop insurance in developing countries: new evidence from India was carried out by Ghosh *et al.,* (2020). A discrete choice experiment was conducted with agricultural households across four states in India, which enabled to estimate preferences for specific insurance policy attributes such as coverage period, method of loss assessment, timing of indemnity payments and the cost of insurance.

The results suggested that farmers do value crop insurance under certain conditions, and some were willing to pay a premium for such coverage more than the subsidized rates they were currently required to pay under the programme. Farmers value the assurances that they would receive timely playouts when they incur losses and may not have a strong preference for the method with which losses are assessed. On the other hand, farmers were quite sensitive to coverage periods. The baseline assessment showed that when optimized to farmer requirements, there could be a sizeable demand for crop insurance by developing country farmers. Arising from this research, many lessons were learned, and these are summarised below.

While there were attempts to examine farmer level risk characteristics that influenced product selection, evidence was scarce on assessing valuations for individual attributes of a crop insurance. The top-down approach – failed to engage local stakeholders, particularly farmers, in the design process leading to low levels of programme acceptance among target groups and reduced chances of success for such development programmes (Feder *et al.,* 1985, Ambrus *et al*., 2014)

In the Indian context, it raises important questions about the demand for insurance and the overall viability of the existing policy. Why is voluntary participation still very low when premiums are quite affordable for almost all farmers? Is it the quality of insurance product that is a deterrent, and not the farmers' ability to pay? What features of an insurance policy are most

attractive to farmers, given their specific needs? None of these can be satisfactorily answered unless there is a fundamental assessment of farmers' willingness-to-pay (WTP) for comprehensive crop insurance policies. Self-insurance (e.g., grain storage, livestock sales or leveraging social networks) was another factor that reduced demand for formal insurance in developing countries (Kazianga & Udry, 2006; Ambrus *et al*., 2014).

Despite the low price and attractive terms, few farmers willingly purchase insurance under the new policy framework of PMFBY. Only 25% of insured farmers purchased insurance of their own volition; the remaining 75% were insured as part of compulsory loan default coverage: specifically, according to the programme's design, any farmer who has applied for seasonal agricultural credit was mandated to purchase insurance coverage.

Determinants of uptake and strategies to improve agricultural insurance in Africa, a review study was undertaken by Rukundo, Kamau, and Baumuller in 2021. The study focused on how weather shocks affected smallholder farmers and pastoralists in Sub-Saharan Africa unequally. The review synthesises broad recent literature on why insurance take-up had remained low and highlighted six key themes, including: (1) product quality, (2) product design, (3) affordability, (4) information and education, (5) behavioural and sociocultural factors, and (6) the role of government in enabling markets.

The study used in-depth review of literature from Scopus and Web of Science covering the period up to September 2020 and depicted critical lessons that included: Agricultural insurance to have remained unpopular, unattractive and poorly demanded by a majority of farmers in low- and middle-income countries (Binswanger-Mkhize, 2012). This was despite the evidence of its potential in improving farmers' and pastoralists' livelihoods, unlocking investments in production and eventual poverty reduction.

In the region, droughts between 1980 and 2013 are said to have affected more than 360 million people and caused more than US$31 billion in losses (FAO, 2015). The 2008–2011 drought in Kenya alone led to US$11 billion in losses (FAO, 2015) and the 2016 drought in Malawi dented the country's economy by US$400 million (Reeves, 2017). The trend of losses is not likely to decrease (Haile *et al*., 2020a; Spinoni *et al*., 2020). Despite these losses, insurance take-up remains the lowest in the world. Accordingly, of the 51 million smallholder farmers in Africa (Lowder *et al*., 2016) only about 1.3 per cent have agricultural insurance (Hess and

Hazell, 2016). Our more updated estimate suggests current take-up around 3.5 per cent but this remains far below rates in Asia and Latin America. The low insurance coverage situation in SSA therefore raises questions possibly specific to the region and requires closer assessment. Various key results were revealed, that included.

On product quality, a key concern is that insurance products are often of poor quality and their acquisition can lead to worse outcomes than without them (Clarke, 2016). One aspect of poor product quality is the level of basis risk, which refers to the probability that insurance does not cover an insurance-holding farmer when they experience the insured shock because the level of the insurance threshold (often an index) is imperfectly correlated with losses incurred. Both simulations (Elabed *et al*., 2013) and empirical studies (Hill *et al*., 2013; Jensen *et al*., 2018, 2019) have shown that when basis risk is higher, farmers are less likely to purchase insurance. There are three categories of basis risk. The first is the geographical/spatial basis risk (Jensen *et al*., 2018), which measures the distance from a farmer's plot to the measurement point. The second is design basis risk which emanates from the models and variables used to construct an index (Elabed *et al*., 2013; Jensen *et al*., 2019). The third is temporal basis risk which is related to the timeframe in which the index is measured (Díaz Nieto *et al*., 2010). Simulation studies in Cameroon and Niger have indicated that basis risk might be as high as 50 per cent in most indices (Leblois et al., 2014a, 2014b), implying that there is a 50 per cent chance that an insured farmer's risk might not be covered by their insurance due to such poor correlation. To this farmer, purchasing insurance with substantial basis risk might not only introduce a loss of income (in paid premiums) but also leave her in a worse off situation since it also limits her alternative options (Barré *et al*., 2016; Clarke, 2016; Jensen *et al*., 2016).

With regard to product and contract design, a second major reason hampering agricultural insurance take-up in Africa is product design. By product design, we imply four main issues: (1) the spatial or geographic scale of coverage, (2) product item coverage, (3) timing of index triggers, and (4) insurance provided alongside other services (bundling).

Regarding spatial coverage of insurance policies, design risk could be reduced by implementing multiple-trigger contracts where the index was not assessed on one scale but rather on more than one scale (Elabed *et al*., 2013). In an experiment with Malian cotton farmers, Elabed *et al*. (2013) found that demand for a two-trigger or two-scale insurance

contract was about 40 per cent higher than the conventional single trigger contract. They found that the multi-scale insurance contract reduced both false negatives, where an individual whose yield was below the average and he/she did not receive insurance pay-out (basis risk), and false positives, where an individual whose yield was above the average still received an insurance pay-out. One example of a multi-scale insurance product is an area-yield insurance product in Tanzania that introduces a conditional audit (Flatnes *et al*., 2018). The authors compared a satellite-based index insurance contract and another contract that incorporated an audit requested by farmers if basis risk reached a certain threshold. Flatnes *et al*. (2018) found that willingness to pay an audit-incorporated contract was 64 per cent higher than the non-audit contract.

Concerning, product item coverage profile; Siebert (2016) showed the necessity of using two different indices to cover millet and rice across similar climatic regions because of the negative correlation in the shocks affecting both crops. Therefore, in such cases where the incentives for the provision of single index-based insurance products are not conducive, providers might devise multi-crop and multi-peril insurance products with one or two 'leading' crops and additional 'secondary crops. Recent evidence shows farmers value multi-crop, multi-peril insurance products highly (Bulte *et al*., 2019) though there is need for more research to assess the willingness to pay for such products versus the common single crop, single peril insurance products.

About trigger period; Norton *et al*. (2014) showed that farmers preferred high-frequency insurance when such products were on offer. By pointing at the benefits such as insuring high probability-small loss events (which are usually self-insured), farmers might find such products attractive (Norton *et al*., 2014). In addition to the frequency of pay-outs, their timing also matters. Optimizing remote sensing data for instance and providing earlier pay-outs could allow vulnerable farmers to utilise mitigation strategies such as alternative forage sources for livestock (Vrieling *et al*., 2016) or access to food to prevent farmers from falling below the minimum food requirements (Hochrainer-Stigler *et al*., 2014). Vrieling *et al*. (2016) showed that payouts made between one to three months before the onset of the drought would give farmers more time to optimize protective alternatives.

Vis a vis bundling insurance with other services; agricultural insurance could be combined with other products or services. Carter *et al*. (2016) made a theoretical case for combining insurance with other services such as credit (often referred to as bundling), suggesting it as one of the ways to make insurance popular. Insurance can be combined with credit services (Giné & Yang, 2009; Meyer *et al*., 2018; Ahmed *et al*., 2020) or inputs such as drought-tolerant seeds, high yielding seeds or fertilisers (Leblois *et al*., 2014b; Lybbert & Carter, 2015; Awondo *et al*., 2020; Visser *et al*., 2020). The Zambia Farmer Input Support Programme offers an example of bundling insurance with inputs. Under this programme, farmers pay premiums when receiving input from a government programme. In case of triggers, the insurance companies (through the Ministry of Agriculture) pay farmers through e-vouchers to secure inputs for a new cropping season. The programme covered more than 900,000 farmers in the 2017/18 Zambian financial year (World Bank, 2019). Similarly, the second largest insurance programme in the region, ACRE Africa, currently providing coverage to over 313,000 farmers, works with input service providers under One Acre Fund, a farm inputs and credit providing organisation (Hess & Hazell, 2016).

With reference to income and affordability, a major challenge with bolstering demand for agricultural insurance was farmers' budget constraints. The prospective market for insurance was therefore divided into those with higher incomes demanding more insurance and those with lower incomes who cannot afford it (Hill *et al*., 2013; Karlan *et al*., 2014; Bogale, 2015; Takahashi *et al*., 2016; Tadesse *et al*., 2017; Bishu *et al*., 2018; Fonta *et al*., 2018; Janzen and Carter, 2019). Moreover, weather shocks in previous periods reduce farmers' future income and demand. Conventionally, as farmers' incomes improve, so does their demand for insurance. Agriculture income is, in particular, predictive of insurance demand (Takahashi *et al*., 2016; Abugri *et al*., 2017; Bageant and Barrett, 2017). However, as households' incomes improve, so does the likelihood to move out of agriculture and therefore income diversification tends to dampen demand (Bogale, 2015). To increase demand, we highlight two avenues below that might increase demand through income-based interventions. However, there are certain caveats to bundling insurance with other services. The first is that farmers generally prefer to have freedom in deciding which products and services to purchase and not to be forced to take products that they do not want, and products that might be inadequate for them later. In one of the major studies on agricultural insurance in SSA, Giné & Yang (2009) found that farmers who were offered loans with insurance for high yielding

groundnuts had a 13 percentage point lower insurance demand compared to those with simple credit without insurance.

As to demand subsidies; demand can be induced through discounts and demand subsidies (Mcintosh *et al*., 2013; Giné *et al*., 2014; Karlan *et al*., 2014; Tadesse *et al*., 2017; Bulte *et al*., 2019; Janzen & Carter, 2019; Matsuda *et al*., 2019; Ahmed *et al*., 2020; Stoeffler *et al*., 2020). A third party such as the government would then pay the remainder of the premium. However, two crucial issues remain of concern regarding demand for subsidies. The first concerns the sustainability of subsidies and the eventual demand when subsidies end. Relating to flexible payment mechanisms, in conventional insurance of all kinds, premiums are paid before coverage begins. For rural farming households, agricultural insurance premiums would have to be paid before the cropping season. However, at such times, smallholder farmers' budgets are limited due to other necessary expenditures such as farm inputs and extension services. Insurance ends up being at the bottom of their priorities list (Binswanger-Mkhize, 2012). One avenue of easing farmer budgets is by making flexible the time of payment. Casaburi & Willis (2018) tested a pay-at-harvest insurance product with smallholder sugarcane contract growers in Kenya. In their experiment, they found first that farmers demanded less insurance at the beginning of the season, not due to liquidity challenges but because paying upfront was not marginal appropriate for their expected return. Secondly, when farmers had the option of paying premiums after harvest, demand increased from 5 per cent in the pay-up-front option to 72 per cent in the pay-at-harvest option. In a related study in Ethiopia, Belissa *et al*. (2019) found that when farmers had a pay-at-harvest option, demand increased from 8 per cent to 24 per cent. However, the main challenge with pay-at-harvest insurance products might be contract enforcement as default rates might be high.

Finally, there is the role of Information and Communications Technologies (ICTs) in enabling farmers to utilise payment platforms. Insurance companies are often thin on the ground and not able to reach most locations where farmers are located. Moreover, agricultural factor markets in SSA are grossly lacking in that most services are urban biased (Dillon & Barrett, 2017; Allen IV, 2018). Lack of well-functioning agricultural factor markets makes distribution expensive and prohibitive. However, ICTs help to bridge the gap of financial intermediation between suppliers and consumers by providing the last mile payment service.

In relation to education, knowledge, and information; most rural farmers were not only illiterate but also unaware of new technologies such as insurance. An assessment in Ethiopia found that 49 per cent had never heard of insurance, 41 per cent did not know how it worked, and 25 per cent did not know where to find it (World Bank, 2018). More educated farmers and pastoralists portray higher demand and the less educated portray lower demand (Giné & Yang, 2009; Patt *et al*., 2009; Hill *et al*., 2013; Bogale, 2015; Okoffo *et al*., 2016; Takahashi *et al*., 2016; Abugri *et al*., 2017; Bishu *et al*., 2018; Fonta *et al*., 2018; Amare *et al*., 2019; Janzen and Carter, 2019; Vasilaky *et al*., 2019). Literacy is not only important in order to know about insurance but also to correctly understand insurance contracts. When farmers are not able to understand concepts like basis risk, demand remains low (Stoeffler & Opuz, 2020). Education and information tend to run concurrently. While insurance providers might not change the literacy skills of the farmers, they can provide more information. The evidence shows that where information has been provided, farmers and pastoralists increase their understanding of insurance as well as demand (Patt *et al*., 2009; Lybbert *et al*., 2010; McPeak *et al*., 2010; Takahashi *et al*., 2016; Belissa *et al*., 2019; Vasilaky *et al*., 2019; Ali *et al*., 2020a). Information might be provided through games (McPeak *et al*., 2010; Vasilaky *et al*., 2019), information brochures (Takahashi *et al*., 2016), or training sessions (Dercon *et al*., 2014). However, it is not merely information or literacy, but a better understanding of insurance concepts and underlying mechanisms that is crucial. While farmers might know more about insurance, demand does not seem to improve with knowledge automatically (Takahashi *et al*., 2016). Exposure needs to be consistent to nudge demand. Previous experience also matters in that farmers who have previously insured are more informed and hence more likely to purchase insurance again (Karlan *et al*., 2014; Castellani and Viganò, 2017; Belissa *et al*., 2019). Insurance providers could therefore invest in increasing insurance awareness through more marketing campaigns and training.

Concerning low trust; distrust in insurance products and insurance providers reduces agricultural insurance demand among farmers and pastoralists (Patt *et al*., 2009; Suarez and Linnerooth-Bayer, 2010; Karlan *et al*., 2014; Tadesse *et al*., 2017). Low trust is partly related to education and inadequate knowledge and information about formal insurance. Farmers are therefore not able to understand how new technologies such as insurance work (McPeak *et al*., 2010; Bryan, 2019). Farmers reveal distrust in: (1) the insurance product, (2) the insurance providers, (3) the technology on which insurance is based, and (4) interpersonal

trust among individuals (Platteau *et al*., 2017). Lack of trust in the product can be improved if farmers receive better information about insurance. Distrust in insurers might be related to three issues. First, insurers generally have a low presence in rural areas in SSA. Agricultural insurance is generally new and has not proliferated in rural areas. Rural farmers are less likely to trust institutions that they do not have a previous relationship with and do not know well. With this bottleneck, insurance providers could use channels of higher trust such as community-based groups. We expand on this issue in sub-sections. Other channels might include well-known financial institutions, such as banks and microfinance organisations, and input retailers (World Bank, 2018) or farmer organisations (Patt *et al*.,2009). In some instances, farmers trust governments over commercial insurance companies (Tadesse *et al*., 2017). In general, it can be very useful to leverage existing trusted institutions rather than starting new operations. It might also be useful if prospective providers conduct sufficient market research before, they launch operations. Strategies to reduce basis risk can increase trust in indices.

On farmer participation; to increase insurance acceptability, farmer-driven product design should be fostered and prioritised, especially at early design stages (Patt *et al*., 2009; Greatrex *et al*., 2015). Patt *et al*. (2009) provided two examples of participation that increased trust. In Ethiopia, farmers and experts worked together using local materials to assemble historical rainfall distribution data of the area. Farmer provided information was found to highly correlate with historical meteorological data, and insurance experts, therefore, used it to calculate the monthly weights for rainfall in these areas. The second example was in Malawi where through farmer workshops, farmers participated in calculating the pay-out levels under different rainfall regimes, increasing both their understanding, and building trust in the products.

On cultural perceptions; the general position of women in society and second, the influence of religion. While women comprise a very large demographic within farming households, their roles regarding decision making in agriculture investments are largely limited by restrictive cultural norms (Fisher and Carr, 2015; Perez *et al*., 2015). Such barriers also permeate insurance adoption (Delavallade *et al*., 2015; Abugri *et al*., 2017; Born *et al*., 2019) among others. Since women farmers are likely to be poorer than men farmers, their involvement in insurance is limited (Delavallade *et al*., 2015; Abugri *et al*., 2017; Fonta *et al*., 2018). Though in some cases there are no significant differences between women and men farmers regarding

insurance adoption (Bageant and Barrett, 2017), gendered data on the adoption of insurance is not broadly available (Born *et al*., 2019), and this limits analysis of how women farmers are affected in agricultural insurance provision. Such data would be essential in tailoring insurance products to cater to any gender-disaggregated needs (Fletschner & Kenney, 2014; Born *et al*., 2019).

Regarding the influence of religion, individual beliefs might conflict with market-oriented technologies such as insurance. This issue has been observed in northern Kenya (Johnson *et al*., 2019) and Niger (Fava *et al*., 2018), both predominantly Muslim regions. In Kenya, Johnson *et al*. (2019) qualitatively detail the case of index-based livestock insurance in northern Kenya regarding expectations, aspirations and the challenges experienced. In their narrative, they show that some of the difficulties related to low sales emanated from the way predominantly Muslim communities viewed profit-making insurance products as not culturally and religiously permissible under the Sharia Law.

Concerning offering insurance to groups; providers of agricultural insurance might find them appropriate platforms for introducing and distributing insurance (Trærup, 2012; Dercon *et al*., 2014; Belissa *et al*., 2019). Because individuals trust groups in which they already have informal membership, they prefer group-based contracts to individual contracts (Hill *et al*., 2013; Dercon *et al*., 2014; Sibiko *et al*., 2018; Belissa *et al*., 2019). Belissa *et al*. (2019) observed that in contrast to individual index insurance take-up of only 8 per cent, when farmers had the offer of insurance through their informal groups, take-up rates increased to 43 per cent. Some of the benefits of group-based insurance include cost-effectiveness in information transmission and the pre-existing experience of risk-sharing (Dercon *et al*., 2014). Finally, groups enhance community social capital that enables the flow of information. In Ghana, Karlan *et al*. (2014) found that farmers who knew a farmer who had been insured and received a pay-out were more likely to purchase insurance in forthcoming years. Therefore, farmers improve their trust in insurance by observing the experiences of other farmers in their networks.

With regard to the role of governments, a key connection to complete the circle is the role of governments in both demand and supply dimensions. Meso- to macro-level factors might pose a challenge for a single insurance provider. Many providers require market regulation and policy oversight, and governments can induce demand through various support strategies to

farmers. In this section, we consider the role of governments in: (1) reducing the costs of delivering insurance through better market coordination, (2) providing both consumer and provider subsidies, and (3) developing and updating policies to suit an increasingly dynamic market.

Emerging points of evidence suggest that financial innovations can improve aspects of a smallholder farmer's quality of life and that of other rural agricultural actors by expanding access to financial services, improving resilience, and raising income. Products that facilitate access to markets and price information help farmers sell their goods at times and places in which higher prices may be available. Digital savings and insurance can give farmers the capital to weather a failed crop or medical emergency. Digitally enabled credit may allow farmers to purchase inputs that increase yields and therefore income. Recent studies also show that, in specific communities, rural households with access to savings have enjoyed more food security, increased farm investment and augmented education spending (World bank, 2012)

Karlan *et al* (2013) in a randomized control trial also find that weather index insurance leads to riskier production choices in agriculture among smallholder farmers in northern Ghana. In a related study on how risk management influences production decisions, Cole *et. al* (2014) demonstrate through randomized control trial that insured farmers are more likely to devote larger number of inputs to high risk but profitable castor and groundnut crops in India. Carriquiry & Osgood (2012) investigate the relationship between input choice and index insurance under uncertainty and find that levels of input usage increase when farmers are insured. Hill & Visceisza (2010) find a positive effect of insurance provision on technology adoption (fertilizer purchase) among Ethiopian farmers in a framed field experiment. Mubarak & Rosenzweig (2012) find that insured farmers in India take less ex-ante risk mitigating measures against weather shocks. They reported insured farmers going in for high yielding rice varieties.

Cai (2012) in an impact study of insurance provision on households' production and financial decisions among tobacco farmers in China, find that introducing insurance increases the production area of the insured crop by almost 20% and decreases production diversification. She also finds that insured farmers' credit demand increases by 25%. In a similar study, Liu *et al.,* (2013) studied livestock insurance in China and find evidence that insured livestock farmers increased their stock by purchasing more piglets for fattening. Shapiro (2009) also finds that

weather insurance provision encourages farmers to use more expensive capital inputs and adopt different technologies.

In a study that focused on experiences in Thailand, Sinha & Tripathi (2016) suggested low awareness among farmers about the potential benefits of weather index insurance products. Relatively low compensation is also an obstacle. Proper marketing and awareness-raising campaigns should also accompany the introduction of index-based insurance products. The purpose of this paper is to assess the gaps in the adoption of crop insurance in Thailand and suggest possible solutions relating to policy support and framework, implementation mechanisms, technology adoption, and awareness amongst farmers. In study by Barun *et al.*, (2009) which focused on new methodology contract design for WII indicated that WII is a powerful tool for stabilizing income by providing timely playouts linked with weather patterns. However, its performance can be marred by faulty design, leading to high basis risk and insufficient pay-out.

2.34 Field Experiences from Other Countries

Looking at what has been done -The impact value of index insurance where implemented. There are several developing countries where index insurance has been implemented. The experience of agriculture WII projects to protect smallholders in developing countries shows a high rate of pilot failures, low uptake, and little evidence of commercial sustainability. The findings show very low uptake by farmers in developing countries, and less than a handful of the many pilots tested are still operational (Carlos, 2016). This has been both at the individual farmer level (Table2: 1) and at the regional, national, or institutional level (Table 2:2). We review the impact evaluations of some of these experiences.

Table 2. 1: country year policy-holder project name instrument scale note

Brazil	2001	Participants in government seed program	AgroBrasil	Area-based yield index	15,000	Government pays 90% of premium
Ethiopia	2007	Teff and bean farmers	HARITA	Rainfall index	300	Ongoing

India	2003	Smallholders growing various crops	BASIX, ICICI Lombard, others	Rainfall, temperature index	150,000	Ongoing. See Cole et al 2009.
India	2007	Potato farmers under Pepsico contract	Pepsico	Temperature and humidity index	4000	Ongoing
India	2004	Smallholders	AIC	Rainfall, Temperature Index	1,000,000	Government Premium Subsidy; Ongoing

Table 2. 2: Country Policy Holder Project Name, Instrument and Scale Note

Kenya	2009	Smallholders	Rockefeller	Rainfall index	500	Pilot stage
Kenya	2009	Maize and wheat smallholders	Kilimo Salama	Rainfall index	200	Pilot stage
Malawi	2004	Maize and groundnut	World Bank, Opportunity Intl, others	Rainfall index	1700	See Giné and Yang (2009)
Malawi	2008	Maize, tobacco farmers	MicroEnsure, others	Rainfall index	2500	Initially maize, moved to tobacco; ongoing
Millennium Villages (Kenya Ethiopia, Mali)	2007	Smallholders	Millennium Villages	Rainfall and satellite-based	1000	Premiums paid by MVP; not continued

				greenness index		

Table 2. 3: Country Policy Holder Project Nam Instrument Scale Note

Mongolia	2006	Herders	IBLIP	District-average livestock losses	5000	Ongoing
Nicaragua	2008	Smallholders	World Bank	Rainfall index	200	Pilot stage
Rwanda	2009	Smallholders	MicroEnsure	Rainfall index	500	Ongoing
Tanzania	2009	Smallholders	MicroEnsure	Rainfall index	400	Ongoing
Thailand	2007	Smallholders	BAAC	Rainfall index	400	Ongoing

2.34.1 Field experiences from Countries in the Sub Region and the Globe

2.34.1.1 Malawi

Malawi like any other countries in Africa countries face continue to face severe challenges imposed by extreme weather events particularly droughts. Malawi's economy is highly vulnerable to vulnerable to extreme weather especially drought. (Paul et al) estimated that on average Malawi losses 1.7% of GDP (equivalent to 41 million USD) every year due to an extreme drought event. Because agriculture is the dominant sources of livelihood to millions of smallholder farmers, WII has the potential to provide effective risk protection mechanisms against the often-high disruptive drought events. Because the economy is agro based, agriculture is the most feasible strategy to promote economic growth in Malawi with knock effects on food security and poverty improvement. with this background, WII could provide realistic opportunities to commercialize and transform rural agriculture in ways that accelerate rural development in Malawi.

Empirical studies suggest that WII can facilitate access to agricultural financial markets and improved farm inputs for smallholder farmers such as fertilizer, high yields, and seed technologies. In Malawi WII pilot projects was initiated in 2005 with the support of world bank and other development partners. The project kicked off on a high note with the initial involvement of 900 smallholder groundnuts producers who received financial support from two locally based micro finance institutions. The project was expanded to include maize and tobacco crops, for instance by 2008/2009 about 2600 small scale tobacco produces were insured for a sum of $2.4 million, while 1700 growers (groundnuts and maize) were insured for a total sum insured of $310,000.

But, by 2014 most of the lending institutions had discontinued any form of direct crop insurance coverage to small scale farmers – WHAT WENT WRONG??? With the promising initiative that generated too much hype" and immense insurance practitioners, reinsurers, academies, and development specialists.

Outcomes of the pilot

Farmers seem to prefer group based compared to individual based premium payments. This suggests that farmers prefer to participate in WII as a group as opposed to individual households. National small farmers' association (NASFAM) makes a similar observation when it noted high loan recovery rate (95 to 100%) payment by farmer groups as opposed to individual owned. The group premium approach indicated some advantages. Administratively less cumbersome, provides peer pressure amongst group members resulting in low default rates as well as bargaining power.

For WII to be successful therefore, not only must there be need for massive insurance literacy campaign but also benefits must be tangible, attractive, and comparable to village bank schemes. Some societies in Malawi, it is just un cultural and against norms to discuss about future catastrophes such as funerals, accidents, burglary and disasters. Limited number of automated weather stations and insured farmers faces the basis risk as a measurement at meteorological stations do not always perfectly match or corelate with events on the farmers' plot.

2.34.1.2 India

With 22 million farms covered by a yield-based index, 3 million by a weather index insurance and 340,000 farms covered by an insurance combining the two indices, India is probably today the most innovative and experienced country in agricultural index insurance in the world. Given that the agricultural sector contributes 18 percent of GDP and employs 60 percent of the population, the Government of India closely monitors meteorological risks and plays a key role in the financing of agriculture in general and agricultural insurance. Climate risks, including rainfall, have a significant impact on the yields of farmers whose farms have an average size of 1.2 hectares, are rarely irrigated, and poorly supplied with water and thus dependent on the monsoon rains. While the first yield indices were developed in 1979, the first meteorological agricultural insurance indices were sold in 2003, linked to agricultural credit.

Outcome of the pilots

In addition to having significant involvement from the government, India, has also experimented with various types of indices and has extensive experience with private and community programs as well.

As expressed by Martine Dahoun, Head of Regulation at the Insurance Department of the Ministry of Finance in Benin, "As regulators, we can't just wait for the products to appear. The insurance industry is constantly changing, and we must adapt to this reality. We must be part of this movement and encourage the creation of new products."

Another important lesson is that the value of products can be enhanced by adding services to the insurance. For example, insurers can offer weather-related forecast information to farmers via SMS as part of the insurance package. With the increasing mobile access in Africa, this was proposed as an interesting solution to adopt for some participating countries.

The problem of reaching scale was partially solved in India by making insurance mandatory for agricultural loans. Although this is only applied to 22 percent of loans, it has helped to significantly increase the volume of insurance policies. In addition, the federal government and the states subsidize between 50 and 70 of premiums and require private insurance companies to achieve a defined percentage of their turnover in rural areas. Whether all countries can afford to, or should, put in place such subsidies and mandate services from the private sector is a subject ripe for lively debate.

The design of an insurance product based on weather data is a complex exercise requiring close collaboration with the government and its agencies. The coupling with other interventions such as the provision of credit or farm inputs facilitates distribution at the village level.

Oscar Chamale, of the insurance company Aseguradora Rural from Guatemala was impressed by the close working relationship between the Farmers' organizations and their insurer, «I was surprised by the involvement of the farmer organization in the management of the product, and they were even responsible for the claims process. It's very much integrated with their other activities and hence becomes a part of the value chain. In Guatemala, I have not yet seen any farmer organization take on this role." In Tamil Nadu, Farmers' organization helps its members to fill in the subscription forms and works with the insurance company to accelerate the payout process and to refine index.

"The farmers are the key actors at every stage of delivering agricultural insurance and need to be involved at each step. We need to listen to the farmers as they are always smarter than us. They know what they want and what is good for them, just like the Senegalese farmers." Lessons from India on Weather Insurance for Small Farmers **(**Sandmark**,** 2012)

2.34.1.3 Kenya

Kenya is one of the countries where both index-based crop insurance (IBCI) and Index-based Livestock Insurance (IBLI) pilots have been tested. A recent review of the Financial Sector Deepening (FSD) supported by several donors in Kenya provided important lessons and recommendations based on the performance of weather index insurance pilots in the country (FSD, 2014). The FSD review recommends that FSD scale down the retail pilots and take a longer-term view by concentrating on meso- and macro- level cover, such as an agricultural lending portfolio or area drought cover for government agencies and others responsible for drought response (FSD 2014) which is quite interesting and pragmatic given the challenges of micro-level commercialization of the product using the existing delivery mechanisms and weather data for computing locally relevant indices to trigger pay-out.

In 2010/11, an innovative index-based livestock insurance (IBLI) was introduced in Northern Kenya through the joint effort of the International Livestock Research Centre (ILRI), Cornell University in USA, a private insurance company in Ethiopia and Swiss Re. Initial results from

this initiative indicate that high premium, basis risk and risk preferences have strong effects on the uptake of insurance, similar to earlier findings (Mude & Barrett 2012). Using the NDVI index for vegetative cover on rangeland, Chantarat *et al.*, (2012) found that risk preference, perceived basis risk and the subjective expectation of loss were important factors affecting Northern Kenyan pastoralists' willingness to pay for index-based livestock insurance. Besides index-based livestock insurance pilots, index-based crop insurance schemes (*Kilimo Salama,* meaning safe farming) are being tested. To reduce delivery costs, mobile phones are in use to pay premiums, receive playouts and weather information. The delivery mechanism is based on linking insurance with input marketing. When farmers buy seeds, fertilizer, or other agricultural inputs, they can also buy insurance for their inputs by paying 5 % of the input cost. Covered farmers need to register in one of the weather stations close to their farm.

By the end of 2011, these innovations covered 23,000 households in five regions of Kenya and expansion to the remaining regions and other countries in Africa is expected (Syngenta, 2012; ASN, 2012). By the end of 2013, the program reached over 185,000 farmers in Kenya and Rwanda (Syngenta, 2014). However, part of the success/expansion may be related with the 50 % premium subsidy offered by this scheme although the program plans to achieve operational sustainability by the end of 2016 (Syngenta, 2014). Timely delivery of agricultural inputs (fertilizer and improved seeds) interlinked with insurance services through mobile banking could bring a breakthrough in transforming the rural economy in Kenya. If the index is properly developed, this approach has the potential to further reduce administrative costs in reaching the clients with specific information and affecting playouts in the event of shocks. Use of automated weather stations also overcomes the problem of manipulation of weather records. Syngenta claims that insured farmers earned 16 % more income compared to their uninsured neighbours (Syngenta, 2014). Kenya insuring against drought related livestock mortality, piloting index-based livestock insurance in Northern Kenya

Outcomes, among them

A flawed sales process – failure in the delivery systems dumped sales and left many clients frustrated.

Publicity should be improved – it was noted that in certain places individuals were not aware of the product and that the best way to improve awareness and knowledge of the programming

was by ensuring that the area chief was informed, radio programming on vernacular stations was also encouraged.

The payout trigger level too high – that was also the feeling that 15% payout to trigger level was too and that it should be 10% whose payments would be made more frequently and cover more of the loss. There was no conclusion when it was clear that reduced trigger level would mean more prices. However, it is an important issue to consider as relatively minute indemnity payouts made infrequently may begin to erode confidence in the product.

Lack of payout may affect demand – indications, due to the heavy rains, meant that the contract would not payout in September left several worried that without a payout soon, demand for the product would severely affect. It's clear that ensuring that clients have a solid understanding of how the product works is critical. The extension messages need to be tweaked to emphasis the downside and risk protection role.

2.34.1.4 Ethiopia

Ethiopia is one of the largest food aid recipients in sub-Saharan Africa, largely due to drought-induced production shocks. Donor agencies and international organizations including national and regional governments are, therefore, looking for new ways of mitigating the effects of weather variability, including application of weather index insurance principles for disaster prevention (see Skees *et al.*, 1999; World Bank 2005, 2011). In 2005/2006, the World Bank and World Food Program (WFP) tested the relevance of weather index insurance schemes for disaster relief in Ethiopia. During this period, WFP purchased drought insurance from Axa Re-insurance of about US$1 million (with a maximum pay-out of US$7.1 million) to finance weather insurance derivatives for Ethiopian farmers. Similarly, the World Bank provided a loan of US$180 million which included a pilot project for disaster relief (US$2.3 million).

However, none of the pilot projects were viable (e.g., drought was not a problem in that period and those who paid a premium wanted to claim it back) and it was later discontinued. This does not mean the risk has disappeared. Farmers need insurance to transfer this risk although playouts may not have occurred. Because weather index insurance for famine prevention (drought mitigation) was in its infancy, farmers, local governments, and policy makers were not in favour of supporting this pilot project in Ethiopia when they faced the real trade off in this particular year with good rainfall. This indicates that farmers and policymakers were not sufficiently educated on how weather index insurance principles operate and become hesitant

after a good harvest to pay for the insurance coverage in the following season. The good year seems to create a short-lived euphoria that undermines the demand for insurance. It is important to design such pilot projects with full information on the principles and in close consultation with the end users and local officials. In some places, the lack of safety nets to integrate with weather index insurance is considered a challenge rather than conceptualizing its benefit.

In 2009, the Horn of Africa Risk Transfer and Adaptation project (HARITA) of Oxfam America (OA) along with local and international organizations such as the International Climate Research Institute (IRI) at Columbia University, Swiss Re and Nyala Insurance (a private company in Ethiopia) were able to develop a more participatory weather index insurance product in Northern Ethiopia. The HARITA project tried to integrate the Productive Safety Nets Program (PSNP) activities of the Ethiopian government with the so-called insurance-for-work (IFW) model (Brans *et al.*, 2010). Farmers overwhelmingly supported the idea of insurance-for-work and suggested several creative ways of participation (Brans *et al.*, 2010). This pilot insurance scheme initially covers 200 *teff*-producing farmers in the Kola Tenben districts of Northern Ethiopia (Brans *et al.*, 2010; OA 2010). Later this pilot was scaled up from 200 farmers in one village to 13,000 in 43 villages (OA, 2010). Supported by WFP, the International Fund for Agricultural Development (IFAD) and Oxfam America, the program was rolled out to additional regions in Ethiopia and Senegal (OA, 2013; Greatrex *et al.*, 2015). For instance, in 2012 about 19, 000 farmers were insured over 76 villages in northern parts of Ethiopia (OA, 2013). However, the pilot project still faces the challenge of developing a viable and flexible index that could predict losses. More innovation (to minimize the problem of basis risk and behavioural problems affecting adoption of weather index insurance) and analysis will be needed to see the sustainability of this model.

Several other studies have been conducted in various parts of Ethiopia. For instance, Dercon *et al.* (2014) find that the uptake of weather index insurance is higher when insurance is channelled through group-based informal insurance schemes *iddir* (a funeral society) with appropriate training for group leaders. Hill & Viceisza (2011) found some evidence on the positive role of weather index insurance on fertilizer adoption. Other economic studies in Ethiopia on household willingness to pay for weather index insurance also found several factors, such as basis risk, education and trust as an important determinant for insurance uptake (Hill *et al*., 2010; Clarke, 2011; Sarris, 2013b).

Many rural households in Ethiopia have a limited understanding of crop insurance. For instance, in Tadesse et al. (2013) 64 % of households reported that they perceived insurance as something designed for rich people who can afford to pay insurance premium as is the case of motor insurance (many people in the survey areas are aware of motor insurance).

A few others (5 %) thought drought was too infrequent. Other reasons include the lack of trust in insurance providers. Thus, focusing only on bigger, but infrequent, shocks may allow households to buy time and save a little money year after year.

2.34.1.5 Experience on 2006 Drought Insurance Pilot

i. If insurance is to become an attractive risk-management tool for Ethiopia, it must be coordinated with other financial instruments to provide more comprehensive coverage of Ethiopia drought risks.
ii. The timeliness payout to famers is crucial in any scheme as it is likely to have a major impact on the trust and perception that farmers will have in containing with the scheme or influence on other farmers joining the scheme in future.
iii. Understanding of the rules and regulations that govern the operation of the insurance scheme in particular the criteria employed to determine premium, and payout is important to the farmers hence the insurance company will have to invest heavily in the education and awareness campaigns. The cost of educating the farmers by the insurance company had not been reflected in the premiums.
iv. Insurance could build confidence and hope in the farmers to produce more than usual and is perceived to create incentives by farmers to adopt and apply improved /modern farm technologies.
v. Farmers stated they are more likely to have insurance if it relates to loans/credit.
vi. The existence of reinsurance is a prerequisite for the scheme to continue as in the case where reinsurance does not exist the insurance company may lose money leading to a collapse of the scheme.
vii. Farmers and farmer cooperatives can be involved in covering their own premium based on simple index-based insurance.

2.35. Lessons Learnt

i. Products are not Easily Replicable.

In contrast to other pro-poor financial innovations, such as micro finance WII is not easily replicable though the initial stages of implementation in early often appears promising. Though some aspects of product design maybe transferable, such as common elements of insurance, contract language, marketing and possibly delivery mechanisms.

Rather, WII must grow out of the local context. When designing a WII product, practitioners' must; recognize geographical differences in household and business promotion activities, weather risk vulnerability, and the availability of weather and loss data; and must be innovative, but also recognize the bounds imposed by local market institution and legal and regulatory constraints.

ii. Data Limitation

Limited data availability, common in lower income countries, pose significant challengers to developers of WII products. Data limitation create difficulties with the pricing of the WII product and measuring the basis risks. Historical data on frequency and severity of the underlying weather risk are necessary to determine the pure premium rate for a WII product. These data are used to estimate the parameters of the probability distribution for the underlying weather risk.

i. Basis, Transaction Costs and Product Design

Determining which type of product has the greatest likelihood of being sustainable in the long run is largely a balance act between transaction cost and data needs for keeping basis risk in check. Products that require geographically precise measurements, and therefore dense data systems infrastructure, will also experience significant basis risks if this infrastructure is not in place.

Basis risk tends to be higher for household's products that require point specific assessment than for risks aggregator products that require assessment at a community or regional level. Fewer lower income countries will have data systems sufficient to support the development of scalable household products.

iii. Lack of Index Insurance Experience

Individual living in rural areas of lower income countries often have little experience with any type of insurance product (and ever less with WII) and little knowledge of insurance products. WII thus must be a risk aggregating business that generally have more familiarity with insurers

and providers. Local insurers also typically lack experience with index insurance products and require careful capacity building efforts to ensure product's scalability and sustainability.

iv. Determining Appropriate Delivery Channel

The delivery of distribution channel is the component of product design that determines how the insurance company reaches its clients, which include sales and most important customer service. The delivery channel handles purchase agreement, transfer of premium, transfer of insurance playouts, and on-going customer care. This may be carried by different stakeholders; however, education and delivery are complimentary activities and should be carefully coordinated.

A central theme of delivery is the strong positive relationship between client contract and transaction costs. Client contacts creates additional opportunities for customer training and may increase the probability that the insurance is used effectively. Working through an intermediary maybe particularly helpful to increase access to the product.

v. Limited Demand

Household demand for insurance against catastrophic natural risks is low. People tend to underestimate the likelihood of a catastrophic event thus are likely to undervalue the insurance. In lower countries, demand is further reduced by limited household resources and the common perception that there should be a return on premium paid. For example, low uptake of an index -based flood insurance product in Indonesia was attributed to low consumer demand for a product that insures only the loss for frequent catastrophic levels of flooding (Chong, 2009; Mkhize, 2012). Similar, experience with WII products being offered in India seem to confirm the notion that households have little demand for catastrophic insurance cover (Gine *et al.*, 2008).

vi. Premium Subsidies

The use of subsidies is rationalized by acquiring that they support development objectives and will last for a few years until consumers have become accustomed to purchasing the products.

Since premium subsidies lower the cost of the insurance, policy holders do not receive the accurate price signal regarding the magnitude of their actual risk exposure, and has thus, make economically insufficient decisions. When premium subsidies are eventually removed, demand

for that insurance product tend to drop. Premium subsidies also distort markets by crowding out alternative risk transfer or mitigation.

For these reasons, anyone who is seriously concerned about scalability, sustainability and economic efficiency must question the use of premium subsides for WII products. However, there is widespread agreement that and efficient use of donor funding should be invested into; risk assessment, feasibility studies, product development, capacity building, and other start -up costs is necessary and beneficial (Mkhize, 2012).

2.35.1 Going Forward Some Suggested Remedies

The difficulties in scaling up index-based insurance has led to a wide variety of suggestions on how to resolve the problem of lack of demand, summarized in Hazell *et al.,* (2010). The analysis has distilled light principles to help, index insurance reach scale and sustainability.

i. Create a position of local value to the insured and other offer insurance as part of a wider package of services.
ii. Build capacity and ownership of implementation stakeholders.
iii. Increase client awareness of index insurance.
iv. Graft onto existing, efficient delivery channels, engaging the private sector from the private sector from the beginning.
v. Access international risk transfer markets
vi. Promote enabling legal and regulatory framework.
vii. Monitor and evaluate products to promote continuous improvements.

Indeed, for sustainability and scaling up of index insurance, government and donor will need to intervene more actively by playing important facilitating role and supporting the development of the sector. Key support areas for improvement government and donors include.

i. Provide ongoing technical assistance, training, and product development.
ii. Educating clients about insurance.
iii. Promoting innovation.
iv. Facilitating access to insurance.
v. Developing national weather services, data systems and research.

vi. Creating an enabling legal and regulatory environment and designing second national rural risk management strategies.

vii. Supporting impact studies (Mkhize, 2012).

2.36 Summary Lessons, Opportunities, and Challenges

Based on literature review from wider scholars, some lessons can be shared

i. Focus on Bundling WII Products with the Aggregator**.**

Experience has so far shown that bundling WII products with risk aggregators is perhaps the most feasible strategy to ensure success of WII. Risk aggregators refer to firms, such as financial institutions (micro financial banks and other lenders) and value chain enterprises (input suppliers, outputs processors, transporters). Because of spatial correlation risk aggregators become severely important either directly or indirectly once their customer or client becomes affected by a catastrophic event. According to Barnette *et al* (2010), risk aggregators can help with markets breakthrough of WII products. The suggestion is two step approach which initially focuses on developing WII that sells direct risk aggregation and once market takes off is achieved, then can focus on WII products that target households. Because of the extensive connections with millions of smallholder farmers, the risk aggregator approach is perhaps the most feasible mechanism for extending WII into the rural areas of many countries in Africa.

ii. Focus on Subsidizing Startup Cost and not Premium.

More emphasis from Donor and government should focus on, start-up costs, such as feasibility studies, capacity building, insurance education, and awareness campaign for farmers since all these activities are necessary to push the development of WII markets.

iii. Establishing Legal and Regulatory Framework from Start

Establishing a sound legal and regulatory framework is one of the most significant yet commonly ignored aspects of WII. As with any market, a well-defined legal and regulatory framework is a prerequisite for creating enforceable contracts that both buyers and sellers can trust (Skees & Collier, 2008).

iv. Establishing Efficient and Trusted Delivery Channels from Start

Insurance providers or their intermediaries need to be efficient, trusted, and responsive to farmers' needs otherwise they will fail to resonate with the farming community. One approach has been to work with farm cooperatives/unions to reach as many farmers as possible. As

observed in Ethiopia farmers' unions have proven to be effective delivery channels for WII products (Mukuasa,2016, Vhurumuku, 2010, Meherette, 2009,).

v. Establishing a Leading Institution to Overcome Initial Set Up Problems

In nearly all cases a leading institution is needed to initiate, catalyze actions, and overcome initial set-up constraints and barriers (Hazell & Hess,2010). Leading institutions can include agencies like WFP, World Bank, Oxfam etc but it is more desirable if a local institution assume their leadership and promote development.

vi. Assess Insurance Literacy from the Start.

Training farmers on how to use index insurance as risk -reducing investments can give them more realistic expectation about payments, provide credibility and greater familiarity with the nature of the products. Establishing trust in the insurance product is essential.

vii. Considerations from Related Studies

Several related studies have been done across the globe, Africa and the region. A few select studies are summarized below to appreciate their conclusions on the uptake of WII and their associated key considerations that drive the farmers position on the innovation adoption/diffusion process.

Table 2. 4: Considerations from other related studies

Journal and Author	**Considerations**
Analysis of the uptake of agricultural insurance services by the agricultural sector in Zimbabwe. Catherine Mazwi R. Tsikirayi; Ephraim Makoni, Joseph Matiza University of Zimbabwe.	Farmer knowledge and awareness is key in WII uptake, rainfall data is key, communication and interaction between farmers and insurers is key. The abstract never mentioned the methodology which is important to define how the study was carried. It is important to indicate the paradigm used either quantitative or qualitative
Practical Experiences in Improving Affordability and Delivery Channels of Weather Index Insurance for Kenyan Smallholder Farmers. Rose Goslinga	It is key to develop partnerships with agribusinesses willing to sponsor part of the premium, new cost-effective delivery channels need to be developed that are

Syngenta Foundation for Sustainable Agriculture, Basel, Switzerland.	practical and relevant for farmers. Input retailers offer a viable alternative to traditional insurance agents, commodity markets are key.
Marketing Complex Financial Products in Emerging Markets: Evidence from Rainfall Insurance in India. Sarthak Gaurav, Shawn Cole, and Jeremy Tobacman*	Financial education has a positive and significant effect on rainfall insurance adoption, increasing take-up from 8 to 16 percent.
Weather indexes, index insurance and weather index futures". Chengyi Pu https://orcid.org/0000-0003-1612-8335 Yueyun (Bill) Chen https://orcid.org/0000-0002-6927-7521 Xiaojun Pan 2018	Mixed method approach Indicates and emphasised that Insurance companies and mutual/hedge funds will be major participants of this futures market

2.37 THEORETICAL AND CONCEPTUAL FRAMEWORK

2.37.1 Overview

Literature review provided both the different concepts and understanding of other studies done in the global, region and in Zambia. It provided empirical insights, definitions of the study key concepts and the existing gaps. This chapter looked at the theoretical and conceptual frameworks of the study. This included understanding different theories that support the study, establishing and analysing the study variables and their elements to clearly understand the concept and logic of the study. Further, it established the hypothesis of the study based on the theory and the logical conceptual frameworks coming with various assumptions that the study finally tested to assume the results of the study.

2.37.2 Theoretical Framework

A theory is a systematic explanation of the relationship among phenomena and provides a generalized explanation to an occurrence (Dawson, 2009). In the literature of financial innovation, there is a wide range of theories that have been developed by various scholars. The function of theory is to inform the rest of the design—to help the researcher to assess and refine the goals, develop realistic and relevant research questions, select appropriate methods, and identify potential validity threats to the conclusions. It also helps one to justify the research (Grant & Osanloo, 2014).

We begin by looking at the summary of different theories that explain the adoption process of uptake on technologies and innovations. Theories and models are important in directing the research process and scholars have reviewed the different theories of adoption and acceptance over the years (Kwinuka, 2015).

Indeed, relying on a single theory to explain and effectively manage financial innovation is not sufficient given the complexity and high diversity of financial innovation. For this study financial innovation diffusion theory, stages of innovation adoption and technology adoption theories were used to explain the assumptions. This multiplicity of theories shows that there is not one best way to approach change and the development process.

Multiple theories give varying perspectives on the same issue. Thus, each researcher must decide which lens to use, or which blueprint to follow to build an argument, establish the context of the problem, and explain the findings. The researcher must keep the theoretical

framework front and centre in justifying the research questions, the problem, the significance of the study, and as a way to help determine the research design and the analysis plan (Grant & Onsoloo, 2014).

Therefore, each basic change theory provides an essentially different viewpoint on the sequence of events and assumptions about the influences (or change drivers) for explaining the process of change and adoption of innovations (Fitsgerald, 2005; Grant & Onsoloo, 2014; Kwinuka, 2015). The theory posits that five perceived attributes influence adoption: relative advantage, compatibility, complexity, observability and trialability. These attributes' characteristics are provided for the sake of a common understanding.

i. **Compatibility**: The degree to which using an innovation is considered consistent with existing organizational values, experience, and needs. Thus, it is how easily an individual can incorporate the new technology into their life (Wamuyu, 2017).

ii. **Relative Advantage:** The degree to which using the innovation is perceived as being more advantageous than using its precursor. It is manifested in form of increased efficiency, increased effectiveness, economic gains and enhanced status. Thus, it is how well this new technology serves a purpose over past or existing technologies (Wamuyu, 2017).

iii. **Complexity:** It is the degree to which using and understanding an innovation is perceived as a difficult task. Researchers have suggested that a complex innovation requires more technical and greater implementation effort to adopt, thus reducing likelihood of adoption. Thus, it is how easily an individual can understand and learn to use the new technology (Wamuyu, 2017).

iv. **Observability:** The degree to which using an innovation generates results that can be observable and communicated to others. Thus, it is how often an individual sees others using the technology, and the positive or negative outcomes of the observed use (Wamuyu, 2017). For farmers mostly, "seen is believing" – is the principle that works with most of the smallholder farmers in adopting new technologies regardless of how good the technologies are. It is therefore important to ensure the visibility of the technology is definite in the mind and eyes of the farmers. The farmers are experience and indeed threatened by climate change which may imply are looking for solutions to this challenge. Therefore, visibility of solutions to this farmer challenge should easily be adopted by farmers because it is reducing or providing absolute solution to the

farmers loses. If the farmers cannot see this, then adoption or uptake of the solution may be difficult or next to impossible. One way to model product adoption is to understand that people's behaviours are influenced by their peers and how widespread they think a particular action is. For many format-dependent technologies, people have a non-zero payoff for adopting the same technology as their closest friends or colleagues. If two users both adopt product A, they might get a payoff $a > 0$; if they adopt product B, they get $b > 0$. But if one adopts A and the other adopts B, they both get a payoff of 0 (Luis, 2008).

v. **Trialability:** Of a new technology is how easily an individual can use it as they begin to adopt it into their life (Wamuyu, 2017). Technology adoption may need the farmers to have first-hand experience before they fully appreciate, learning based on experiences is key for the smallholder farmers to appreciate and become comfortable and ready and willing to invest in a particular technology. Farmer field schools were in the past emphasized to allow farmers learn practically on agronomy technologies equally the same can be done on any other technology for farmers to adopt and utilize them. Demonstration on how the technology is used end to end helps the farmers make decisions to adopt. The perceived newness of the idea for the individual determines his or her reaction to it. If the idea seems new to the individual, it is an innovation. From the above, it can be said that an innovation needs not to be something new or recent in origin, rather it can be an erstwhile idea or object that a user perceives to have an unexampled use (Wani & Ali, 2015).

2.37.3 Diffusion of Innovation Theory

Diffusion of innovation theories were first discussed historically in 1903 by the French sociologist Gabriel Tarde who plotted the original S-shaped diffusion curve. Ryan and Gross in 1943 introduced the adopter categories that were later popularised by Everett Rogers in 1995 (Rogers, 1995; Kaminski, 2011). Later, Moore adapted Roger's Technology Adoption Categories and the Technology Adoption Curve in 1991 (Moore, 1991, Dube & Gumbo 2017). These theories were chosen for this study because they relate to the study in that diffusion of innovation explains and determines the rate of adoption of technology in a society. An innovation or an innovative product or service is useless and fruitless until it is properly diffused to the final user. Diffusion alone is not important, the new product or services shall be adopted and acknowledged by the user for further diffusion (Wani & Ali, 2015). The

innovation diffusion theory (IDT) is a very well-established theory both in academics as well as in practice (Wani, 2015).

Diffusion of Innovation theory has been used to study user adoption of innovation in many sectors including agriculture, sociology, information systems, and manufacturing, among others. According to Rodger 1995, Wani & Ali 2015, diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system; while an innovation is an idea, practice, or object that is perceived as new by an individual or another unit of adoption (Rodger, 1995; Salim *et al..,* 2014). Diffusion of Innovation theory considers five constructs that influence technology adoption. The constructs include complexity, observability, compatibility, trialability and relative advantage (Rodger, 1995; Wani & Ali, 2015; Wamuyu, 2017). The theory shows the process of innovation diffusion which includes five stages: knowledge, persuasion, decision, implementation, and confirmation. The theory categorises the adopters of a technology into innovators, early adopters, early majority, late majority, and laggards forming a bell-shaped curve (Rodgers, 2003). The theory further puts forward those prior conditions that may affect innovation adoption include innovativeness, norms of social systems, previous practice and felt needs.

Similarly, Rogers (2003), indicates that the decision to adopt or reject an innovation is subject to a wide variety of factors some of which relate to the characteristics of the technology itself. He identified five attributes of innovations that are viewed to determine the rate of technology adoption. He concluded that these perceived attributes are particularly influential in any innovation usage and adoption decisions. The five characteristics of innovations that significantly influence consumer attitudes are relative advantage; compatibility; complexity; observability; and trialability. According to Loevinsohn *et al.* (2013), farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting it (Hall & Khan, 2002). Figure 2:17 below illustrates this.

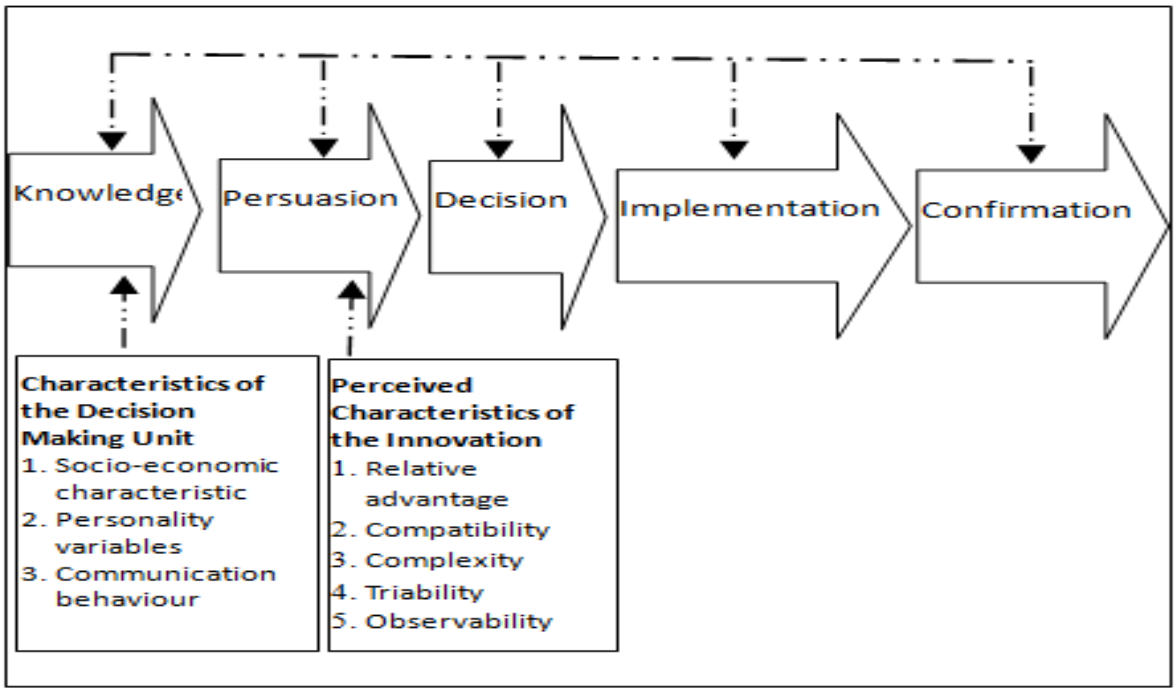


Figure 2. 17: Innovation Decision Process (Adapted from [Rodgers,1995, Dube,2017).

A study carried out in Zimbabwe by Dube and Gumbo 2017 entitles, "Diffusion of Innovation and the Technology Adoption Curve: Where Are We?" The Zimbabwean experience described diffusion as the process by which an (i) innovation is (ii) communicated through certain channels over (iii) time taken by members of a (iv) society as shown in Figure 17 (Rogers, 1995; Wamuyu, 2017). The innovation is the technology that is perceived as new by an individual or organisation. Communication channels refer to the ways in which the information about the innovation flows from the source to the receiver for example, social media, mass media and interpersonal communication, whereas time refers to the rate of adoption or the time taken by different individuals to adopt the innovation. The social system is a set of interrelated units engaged in joint problem solving to accomplish a common goal (Dube & Gumbo, 2017).

It is, therefore, important to appreciate the process of decision making by the farmers towards diffusion of innovations. It is not an automatic process that allows the farmers adopt innovation but rather a process that helps change the mind set of farmers towards innovation adoption. Hence, it is essential to understand such aspects of the process such as the following: Why does one individual choose to adopt a technology while another resists? What is the influence of social context on the decision to adopt? These questions are addressed in the context of adoption and diffusion theories (Wani & Ali, 2015). A farmer typically adopted the innovation

because of interpersonal communication with other farmers who already had adopted it. Consequently, innovation diffusion is a social process in which "subjective evaluations of an innovation spread from earlier to later adopters rather than one of rational, economic decision making" alone (Valente, 2016). In fact, it is a social system that is influenced by societal norms, tolerance of deviance and its integration (Straubs, 2009; Scheler *et al* 2020). From literature, the innovation decision process was composed of 5 stages, namely the knowledge, persuasion, decision, implementation, and the confirmation stages as shown in figure 17. At the knowledge stage the individual learns about the existence of innovation. This stage includes becoming aware of the innovation through communication via the media and interpersonal interactions. The individual also learns how to use the innovation correctly and the functioning principles describing how and why the innovation works (Dube, 2017). This is a crucial stage that helps farmers mind set change process to happen. The farmers today, regardless of the hardships from climate change are not adopting for example weather insurance index at the rate crop disasters are happening. This to a large extent is because of poor knowledge transfer to farmers.

Knowledge alone might not be enough to attract farmers to innovation diffusion therefore, the persuasion stage, the individual/organization develops an opinion (either positive or negative attitude) about the innovation through subjective evaluations of others like colleagues and peers (social reinforcement). Persuasion is also determined by the attributes/characteristics of the innovation, namely, relative advantage, compatibility, complexity, trialability and observability. Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes, and compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters. On the other hand, complexity refers the degree to which an innovation is perceived as relatively difficult to understand and use whereas triability refers to the degree to which an innovation may be experimented with on a limited/ test basis. Observability is the degree to which the results of an innovation are visible to others (Rogers, 1995; Wamuyu, 2017). These are the five characteristics that the study tested if they applied in the theory of innovation diffusion.

At the decision stage, the individual/organisation chooses to either adopt or reject the innovation. In this case, adoption refers to full use of an innovation as the best course of action available and rejection means not to adopt the innovation (Rogers, 2003). According to Rogers

there are two types of adoption, that is, continued adoption or active acceptance where there is continued and sustained use and discontinuance or passive acceptance where the innovation is initially accepted and then discontinued. Rogers also identified two types of rejection, that is, later adoption or active rejection which is rejecting an innovation but eventually adopting it later and continued rejection or passive rejection which is straight non-adoption where the individual does not think about adopting the innovation at all (Rogers, 1995; Nabih, Bloem & Poiesz, 1997; Chang, 2010).

At the implementation stage, mental information processing and decision making come to an end, but the behavioural change begins, and the innovation is put into practice (Rogers, 2003). At the confirmation stage the individual/organisation looks for support for their decision. The adopter keeps evaluating the results of their decision and if the level of satisfaction is significant enough and the level of support is high, the use of the innovation will continue. However, if the level of satisfaction is low and there is inadequate support, it is possible that rejection occurs after adoption as shown in Figure 2:18 (Rogers, 1995; Mirthinti, 2020).

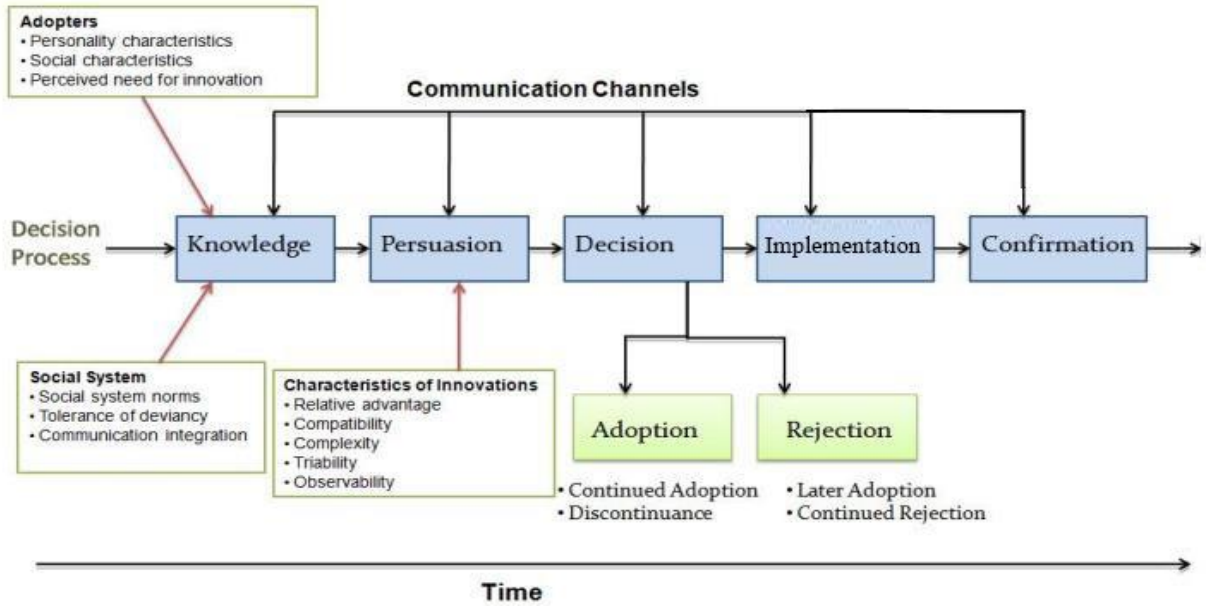


Figure 2. 18: Adoption Communication Channels *Adopted Rodgers (2003);* Chang (2010)

2.34.4 Stages of Innovation Adoption Theory: Early Adopters, Late Adopters, and Laggards

It is a common phenomenon that farmers, like any other kind of entrepreneurs, do not adopt innovations simultaneously as they appear on the market. Therefore, it is essential to understand such aspects of the process such as the following: Why does one individual choose

to adopt a technology while another resists? What is the influence of social context on the decision to adopt? These questions are addressed in the context of adoption and diffusion theories (Straub, 2009).

Diffusion typically takes several years, seldom reaches a level of 100% of the potential adopters' population, and mostly follows some sort of S-shaped curve in time. Apparently, some farmers choose to be innovators (first users) while others prefer to be early adopters, late adopters, or non-adopters (Bijak *et. al,* 2003). In fact, some of these innovations are relatively new: they are in an early stage of their diffusion process. Other innovations are further down their diffusion curve. By adopting an innovation that has a specific degree of novelty, a farmer chooses to be an innovator, an early or a late adopter. The perceived newness of the idea for the individual determines his or her reaction to it. If the idea seems new to the individual, it is an innovation. The innovation needs not to be something new or recent in origin, rather it can be an erstwhile idea or object that a user perceives to have an unexampled use (Wani & Ali, 2015).

The appearance of an innovation on the market creates opportunities for improvements in efficiency, but these are not realized immediately because markets for new technologies are characterized by a lack of transparency and by imperfect information. This is not so much a lack of information on the existence of the innovation, but rather uncertainty about the operating conditions, risks and performance characteristics of the new technology. The number of adopters of the innovation increases as information is generated in the process of innovation implementation and spreads gradually among the potential adopters (Bijak *et.al,* 2003). From this perspective, gradual innovation diffusion is not due to market imperfection, but to variation of the adoption benefits over the potential adopters. The diffusion innovation theory provided the concept of S-shaped curve of adoption which was also called as the epidemic model of adoption.

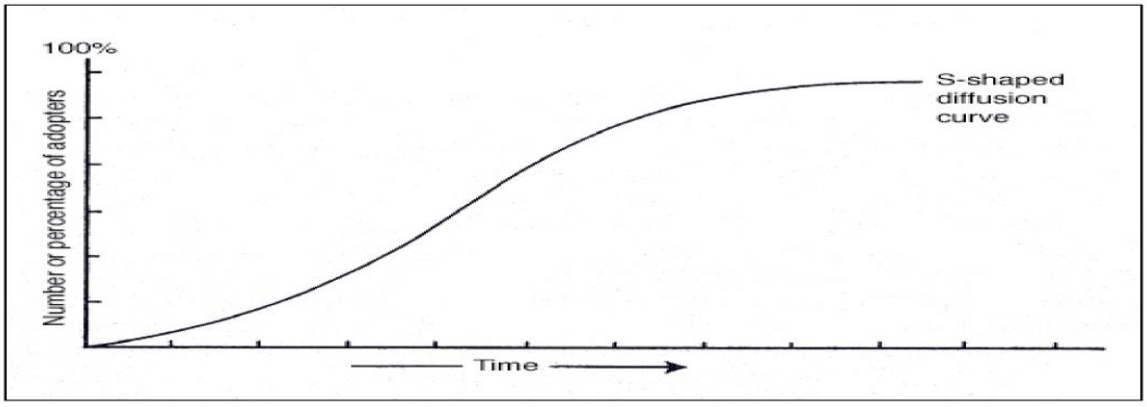


Figure 2. 19: Showing S-shape Adoption Curve (Rogers, 1960; Mirthinti, 2020)

The reasoning for such an S-shape curve is that initially the innovation has to come from outside the boundaries of the social system prevalent at that time. This implies that the number of people that are exposed to the innovation are few in the beginning. As these people in the social system start accepting the innovation, they bring it in contact with more and more people. Therefore, the rate of spread keeps on increasing. Eventually, the innovation is accepted by most of the members of the social system and the rate of spread declines. As there are no more members left for ace (Sharma & Mishra, 2014).

The number of adopters of the innovation increases as information is generated in the process of innovation implementation and spreads gradually among the potential adopters.

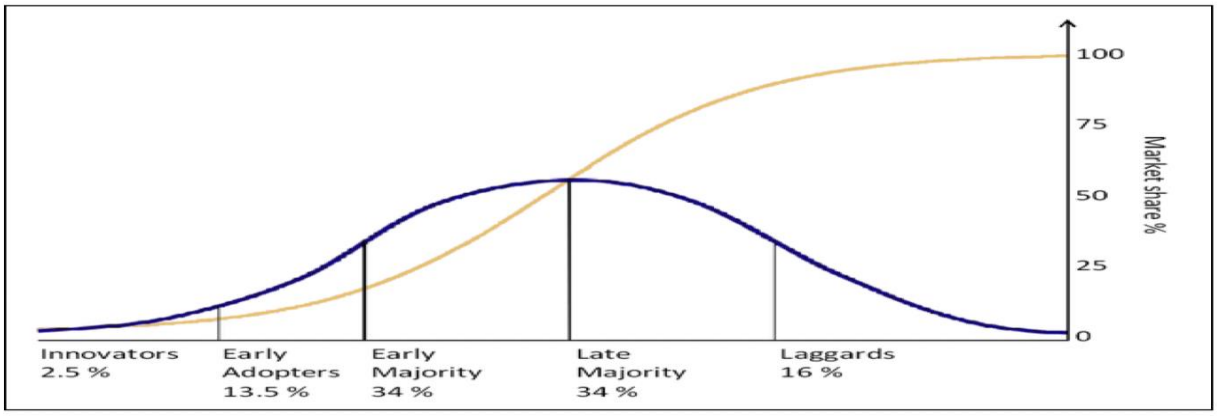


Figure 2. 20: Rodgres Stages of Innovation Adoption *Adopted* (Rodgers, 2003, Mirthinti, 2020)

We begin by understanding the definitions of the different categories of farmer adopters and their motivations that may lead to the uptake of the innovations.

i. Innovators (2.5%)

Innovators are those who are willing to take risks. Innovators are those in the technology adoption life cycle who love trying new things and may even be the people encouraging others to try out a new app or tool. Adopters from this part of the technology adoption curve like going against the grain and trying new things. They're the first to upgrade their phones or experiment with a tool during better testing. Because innovators are rarely concerned about failure, they're very willing to give new technology a shot (Mirtinti, 2020).

> *This category is motivated by the exciting opportunities the new technology presents. Although innovators don't need much convincing, the best way to motivate them is to get them excited about what a new tool can do.*

ii. Early Adopters (13.5%)

Early adopters are those farmers who indicate to belong to the first quarter of adopters of a certain innovation, relative to the full range of potential adopters. While early adopters are trendsetters and tend to be comfortable taking risks, they want to form a solid opinion of technology before they vocally support it. Early adopters love being the first to know about new technology. These people are quick to sign up for new social media sites or experiment with a new project management tool just for fun. What separates early adopters from innovators is early adopters' concerns about their reputation (Mirtinti, 2020).

> *This category is motivated by providing guides on how to get started. Early adopters want to hit the ground running. By giving them the guides and training they need to start using a tool, they can become internal champions of change (Mirtinti, 2020). In the case of farmers, these are part of the lead farmers or agents of change that help other farmers believe in change.*

iii. Early Majority (34%)

The early majority are interested in technology but want proof of its effectiveness. These are the people who scour product reviews before making a purchase, and they quietly test out tools before committing. Case studies and real-life user stories trump generic promises of what a tool or program can do. For adopters in this category of the technology adoption curve, you'll need a pragmatic approach. Go to the early majority with evidence of what technology can accomplish (Mirtinti, 2020).

This category is motivated by motivating the early majority, show how the new technology solves a problem. To win over the early majority, you need to demonstrate what problem technology solves and how it does so. Remember, this adopter category responds to data-driven arguments, so show these users how your solution has solved a similar problem in the past).

iv. Late Majority (34%)

Late adopters are those farmers who adopted an innovation but did not belong to the first quarter of potential users. Much like the early majority, the late majority want a data-driven reason to adopt technology. Convincing people in this adopter category requires research and solid proof that the technology is worth their time. People in the late majority do not like to take risks, and they tend to question the need for changes. They are not easily persuaded by trends, preferring instead to watch how changes play out before they get involved. These are the people who hit snooze on software updates for as long as they can, waiting to hear how their peers react to the updates (Mirtinti, 2020).

The late majority needs to see it to believe it. At this stage of the technology adoption curve, you'll need extensive research and proof that the new technology is effective. Late majority adopters appreciate seeing how technology relates to their farming operations (Mirtinti,2020).

v. Laggards (16%)

Non-adopters are farmers who do not introduce any kind of new technology. Laggards are wary of new technology. Before they consider getting on board, they need answers to their "what's in it for me?" (WIIFM) questions. Laggards prefer the status quo because they know what to expect. They are your most stubborn users — easily frustrated by new technology and quick to give up on a tool that does not immediately make their life easier (Mirtinti, 2020).

To motivate laggards, demonstrate how the new technology has helped other users succeed. Combat skepticism by showing laggards how technology has helped other users within their same organization or team. Go to the laggards with proof of effectiveness and put a heavy focus on user benefits. Just like the late majority, laggards want documented success stories from their co-workers. However, laggards aren't as easily convinced (Mirtinti, 2020).

2.37.5 Technology Adoption Theories (Acceptance Theory)

Understanding the farmer adoption of technology and innovations is not as can be concluded by mere observations. Technology adoption is a complex, inherently social, developmental process; individuals construct unique yet malleable perceptions of technology that influence their adoption decisions. Thus, successfully facilitating technology adoption must address cognitive, emotional, and contextual concerns (Straub *et al*, 2009). Several studies have revealed that technology adoption is not related to the aspects of technology alone but has evolved as a much more complex process involving dimensions of user attitude and personality (Venkatesh *et al.* 2012), social influence (Ajzen & Fishbein, 1975), trust (Gefen *et al.* 2003). According to Mwangi & Kariuki (2015), technology adoption in agriculture is the mental process the smallholder farmer goes through from hearing about a technology to the point of actual utilization (Fadeyi, 2022). Loevinsohn *et al* (2012) define technology as the integration of new technologies into existing farming systems through a period of trying and some degree of adaptation.

2.37.6 Technical Adoption Model (Fred D Davis, 1989)

Technology Adoption Model (TAM) has been widely used in technology adoption studies. The strength of the model lies in its simplicity as it has only two constructs, namely, "perceived usefulness" and "perceived ease of use" for predicting extent of adoption of new technologies at individual (Sharma & Mishra, 2014) as shown below.

Figure 2. 21: Technology Adoption Model (Davis, 1989, Sharma & Mishra 2014).

3.37.7 Extended TAM2 Model (Venkatesh & Davis, 2000)

Venkatesh & Davis modified TAM to include additional key determinants of TAM's perceived usefulness and usage intention constructs in their extended TAM model. The additional constructs included social influence processes (subjective norm, voluntariness and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability and perceived ease of use).

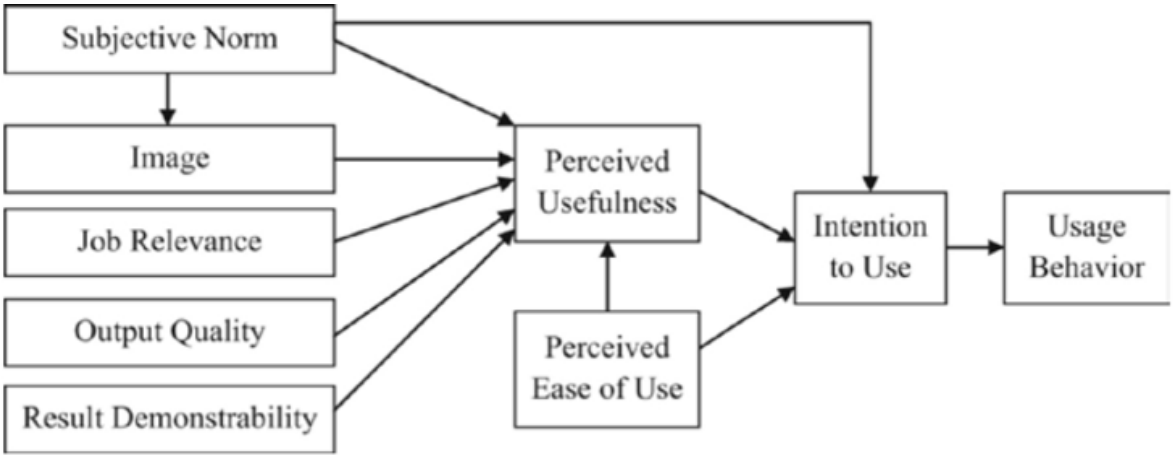


Figure 2. 22: Extended Technology Adoption Model (Venkatesh & Davis, 2000; Sharma & Mishra, 2014).

2.37.8 Unified Theory of Acceptance and Use of Technology (Venkatesh, 2003)

This theory popularly referred to as UTAUT was postulated in 2003 by Venkatesh *et.al.* by a systematic review and consolidation of the constructs of earlier eight models (TRA, TAM, MM, TPB, TAM2, DOI, SCT and model of personal computer use). It is meant to serve as a comprehensive model that can be applied across a range of applications. It has four key constructs namely "performance expectancy, effort expectancy, social influence and facilitating conditions (Sharma & Mishra, 2014).

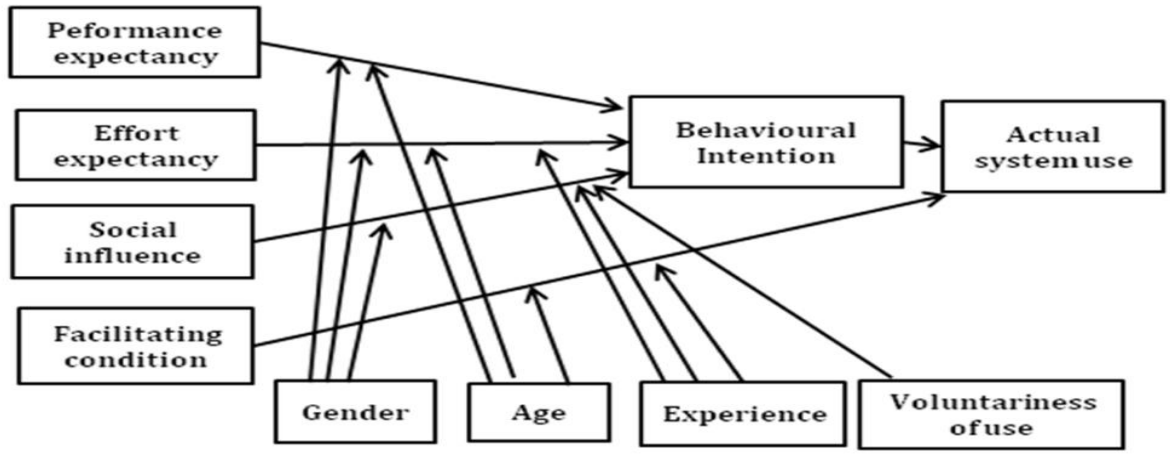


Figure 2. 23: Showing UTAUT Model (Venkatesh *et. al.* 2003).

It is therefore clear from the above theories that no single theory can be used to clearly understand the diffusion or uptake of innovations and technologies by the farmers. Further, theories such as the technology life cycle theory indicate that technology adoption is just as a life cycle cannot be adopted promptly but will grow steadily as the customers appreciates it.

The adoption ladder theory also indicates that technologies are adopted takes a steadily step by step process that allows the players to appreciate and experience before adoption. Therefore, utilization of innovations on the markets won't follow a linear fashion but will need the customers and intermediaries to learn and appreciate the accompanied incentives.

2.37.9 Other Related Theories

Appreciating the farmer position on the adoption of innovations require the wide appreciation of the various theories positions on the process as well as the aligned factors that influence change including the time factors, social and economic issues, behavioural change aspects, farmer experiences (experimental learning) and the rationalization aspects. Below are the highlights of the related theories of innovation diffusion on tables 4.A to 4E as used by other authors.

Table 2. 5: Theory of Planned Behaviour (Technology Diffusion Theories).

Theory	**Findings**	**Reference**
Theory of Planned Behaviour (TPB) and diffusion of innovations theory (DIT) & Attitudinal (relative advantage, compatibility with respondent's understanding the internet banking adoption: A unified theory of acceptance and use of technology and perceived risk application	Attitudinal (relative advantage, compatibility with respondent's (has positive influence on the adoption of innovations, act as key drivers for diffusion). Attitudinal (relative advantage, compatibility with respondent's values, experience, needs, trialability, and risk) and perceived behavioural control factors as the major determinants of intention to adopt Internet banking	Tan and Teo 2000

Source: Owner's Compilation (2023).

Table 2. 6: Theory of Technology Acceptance Model (Technology Diffusion Theories)

Theory	**Findings**	**Reference**
Technology acceptance model (TAM), personal innovativeness in information	Perceived usefulness is the strongest predictor of Internet banking.	Yiu *et al.*

technology (PIIT) and perceived risk	Perceived usefulness is the strongest predictor of Internet banking. adoption intention, followed by perceived ease of use and perceived risk.	(2007)

Source: Owner's Compilation (2023).

Table 2. 7: **Theory of Transaction Cost Innovation** (Technology Diffusion Theories).

Theory	**Findings**	**Reference**
Transaction cost innovation Financial Innovations and Financial Performance of Commercial Banks	The importance of Transaction Costs Innovation theory in the set-up of Internet-related Information Technology (IT) considerably lessens a company's exchange costs since it delivers effective coordination, administration, and utilization of data.	Kurgat David Kiplangat Accountant Officer, Kenyatta University, Kenya Dr. Charles Tibbs Lecturer- Finance, Department of Business Administration, Kenyatta University, Kenya 2018

Source: Owner's Compilation (2023).

Table 2. 8: **Theory of Technology Adoption** (Technology Diffusion Theories).

Theory	**Findings**	**Reference**
Technology adaption theory Theoretical Approaches to Study SMEs eBusiness Progression	Teleological theory- rational: assumes that organizations are purposeful and adaptive. In other words, there is a stated goal and organizations purposefully take action to reach it. Change is rational and occurs because organizations and individuals see the necessity of change.	Fernando Alonso Mendo and Guy Fitzgerald -2005

Source: Owner's Compilation (2023).

Table 2. 9: **Life Cycle Theory (**Technology Diffusion Theories).

Theory	**Findings**	**Reference**
Life cycle theory Theoretical Approaches to Study SMEs eBusiness Progression	Life-cycle theory revolutionist or developmental- The process of change is in a linear and determined fashion. The process is cumulative, successive stages building from the previous one. The process is irreversible.	Fernando Alonso Mendo and Guy Fitzgerald - 2005

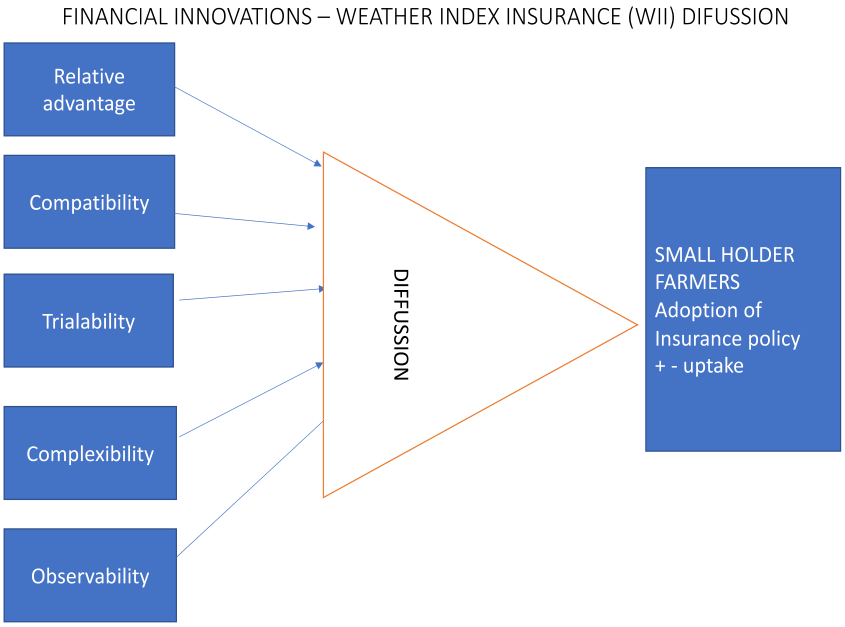
Source: Owner's Compilation (2023).

2.38 Conceptual Model

The conceptual framework shows how the technology characteristics can lead to the uptake of the weather index insurance. The uptake of WII is dependent on the clear understanding, demonstrated relative advantage, easiness of the technology, compatibility, trialability. Understanding the puzzle of WII uptake thus relays on investigating how the technology characteristics apply with the farmers' viewpoints as well as experiences.

For this study, specific objective number one's purpose was to establish the extent of weather insurance index uptake among the smallholder and emergent farmers. Relative advantage, easiness of the technology, compatibility, trialability are the independent variables affecting WII uptake among the smallholder and emergent farmers. While WII will also depend on the technology characteristics and the suppliers of WII insurance vis a vie putting marketing systems that encourage the farmers to uptake the financial instrument. This specific objective will confirm in quantitative terms the extent to which the factors identified affect WII uptake among smallholders and emergent famers.

To measure WII uptake means a smallholder and emergent famer has purchased the insurance or not. This means that the WII uptake has two responses; that is yes or no. Therefore, the assumption of a linear regression is violated. Therefore, the researcher proposed to use a logit model. Logit model will be used to measure the factors identified. Many empirical researchers have been successful in the use of logit regression model to examine similar issues. In this current study, WII uptake is the dependent variable defined as taking up the financial innovation or not taking up the insurance and independent variables are: Relative advantage, easiness of the technology, compatibility, trialability. The Framework is illustrated in figure 3.



Source: Author (2023).

Figure 2. 24: Conceptual Framework Showing Relationships between Independent and Dependent Variables.

The diagram above, in a non-linear regression equation of a logit model can be summarised in many forms depending on what the researcher's knowledge of econometric models showing the relationship between independent and dependent variables. The logit models is shown below as follows:

$$\text{logit}[\pi(Y \le j \mid x_1, x_2, ..., x_p)] = \ln\left(\frac{\pi(Y \le j \mid x_1, x_2, ...x_p)}{\pi(Y > j \mid x_1, x_2, ...x_p)}\right)$$

$$= \alpha_j + (-\beta_1 X_1 - \beta_2 X_2 - ... - \beta_p X_p)[2]$$

Or putting it in a simplified way for the sake of understanding.

Ln (pi/(1-pi) = $\beta_o + \beta X_i \ldots \varepsilon_i$ where;

Ln=Probability of consuming WII by smallholder farmers, where Ln on y_i * the dependent variable is unobservable but determined by a dummy variable y which is defined by:

y = 1 if y_i * > 0

y = 0 otherwise

P_i= Probability of a by smallholder farmers consuming WII

1-pi = Probability of a smallholder farmers not consuming fire insurance

β_o = Intercept

β = Vector of coefficients of the predictors.

X = Vector of independent variables: Relative advantage, easiness of the technology, compatibility, trialability.

εi = Error Term

2.39 Variable Operationalization

The specific way in which a variable is measured in a particular study is called the operational definition. It is critical to operationally define a variable to lend credibility to the methodology and to ensure the reproducibility of the results (Creswell, 2013). The dependent variables are either one takes it or no by buying the financial innovation from the insurance company.

The independent variables are operationalised below.

i. **Relative Advantage:** This looked at the benefits WII has over other insurance products, increased efficiency, timely pay outs, economic gains, social gains and speedy of technology response to the needs of the users. What is the farmer understanding on the perceived advantages of WII. To what extent is this influencing the farmers' decisions to uptake WII.
ii. **Compatibility:** This looked at how the technology is compatible with their own lives, experiences, values and the needs. Is the technology in line with the farmer needs and addressing the contemporary challenges?
iii. **Complexity:** This looked at how simple the technology is for the farmers to understand, appreciate and finally decide to uptake or not.
iv. **Triability:** This looked at how easy the farmers can adopt WII and apply it in their lives, including experiential learning, demonstration experiences, trainings been offered to the farmers. chance or the farmers to experience the technology and becomes party of their own.
v. **Observability:** This looked at how easily the tangible benefits of the technology are observed by the farmers including how widely it is adopted and seen by the communities, can the other farmers see the benefits accrued by the farmers involved with WII, what changes can they observe at the household as a result of using WII.

2.40 Hypotheses

Observability

H_0: Observability is not related with the smallholder's farmer uptake of WII.

H_1: Observability is related with the smallholder's farmer uptake of WII.

Complexity

H_0: Complexity is not related with the smallholder's farmers' uptake of WII.

H_1: Complexity is related with the smallholder's farmer's uptake of WII.

Relative advantage

H_0: Relative advantage is not related with the smallholder's farmer uptake of WII.

H_1: Relative advantage is related with the smallholder's farmer uptake of WII.

Compatibility

H_0: Compatibility is not related with the smallholder's farmer uptake of WII.

H_1: Compatibility is related with the smallholder's farmer uptake of WII.

Trialability

H_0: Trialability is not related with the smallholder's farmer uptake of WII.

H_1: Trialability is related with the smallholder's farmer uptake of WII.

2.41 Summary of the Chapter

Conducting an in-depth literature review enriched the theoretical viewpoints of the study. The literature review highlighted some of the previous studies by other researchers in the region and Zambia pointing out key factors and gaps in WII. Key concepts were defined and also some of the empirical findings by other researchers all-pointing out to the significance of the study and contributes to the basis of the study. Lessons learnt were reviewed that showed that uptake of WII is a resultant of several factors among which include information and awareness, clear pay-out systems and responsive distribution channels that allows access of WII to the farmers. Specific gaps in information and awareness provision on WII is key, the distribution channels of the systems are important that includes the pay-out systems, bundling of WII with other products such as credit, the regulatory or enabling environment, the collaborative approach and financial literacy. Evidently, the uptake of WII across many countries is very low regardless of the appeal. Chapter three therefore will present the conceptual and theoretical framework underpinning the study.

Further, the chapter looked at the theoretical and conceptual frameworks of the study. Both detailed theoretical understanding of different theories that support the study and conceptualization was done establishing and analyzing the study variables and their elements. This helped to clearly understand the concept and logic of the study. Further the chapter established the hypothesis of the study based of the theory and the logical conceptual frameworks coming with various assumptions that the study finally tested to assume the results of the study.

CHAPTER 3

METHODOLOGY OR MATERIALS AND METHODS

3.1 Introduction

Chapter three provided clear understanding of the conceptual and theoretical frameworks, variables, and hypothesis of the study. This chapter describes the methodology of carrying out the study. It gave information on the research design, sampling design, target population, research techniques and instruments, sources and types of data, data analysis tools. The methodology included literature review, interaction with officials, insurance experts, and discussion with farmers. As such, research methodology is a philosophical stance of worldview that underlies and informs the style of research (Sapsford & Jupp, 2006). In another view, Collis and Hussey (2003) & Creswell (2009) considered research methodology as the overall approach to the design process of conducting research including all phases from the theoretical underpinning to the collection and analysis of data. Therefore, it could be deduced from the above that the philosophical worldview of things is vital to the meaning of research methodology. Hence, research philosophy is concerned with the way in which things are viewed in the world (Saunders *et al.,* 2009; Yin, 2009).

3.2 Research Design and Rationale

A research design is a plan that guides the investigator in the process of collecting, analysing and interpreting observations. It is a logical model of proof that allows the researcher to draw inferences concerning causal relations among the variables under investigation (Nachimias & Nachimias, 1992). The study used pragmatic approach and adopted the mixed methods approach. For the mixed method approach, it is a research inquiry that employs both qualitative and quantitative approaches in a research work for the purposes of breadth and depth of understanding and partnership (Johnson, Onwuegbuezie & Turner, 2007).

Creswell and Plano Clark (2011) added that the indispensable premise of mixed method design was that the use of qualitative and quantitative, in rapport, would provide a better understanding of the research problem than the use of either one method alone in a study. This is argued to be one, if not, most of the central premise of the pragmatic philosophical reasoning in research today (Tashakkori & Teddlie, 2003). The pragmatic approach emphasizes that multiple realities exist in any given proviso, and that, the researcher's choice of paradigm is dependent on the research question the study is trying to solve (Saunders *et al.,* 2009). The pragmatic approach

provides for the use of both qualitative and quantitative research methodologies to collect information and make inquiry into complex phenomenon of social and natural contexts (Creswell, 2009; Morgan, 2007).

Therefore, the pragmatic research philosophy provides for the adoption of mixed methods as the data collection method which opens the opportunity to be objective and subjective in analysing the points of view of the participants (Paulinus *et al.*, 2013). As such, both quantitative and qualitative paradigms were used in the study to help understand and interpret the different phenomena taking both the positivism and interpretivism stand points.

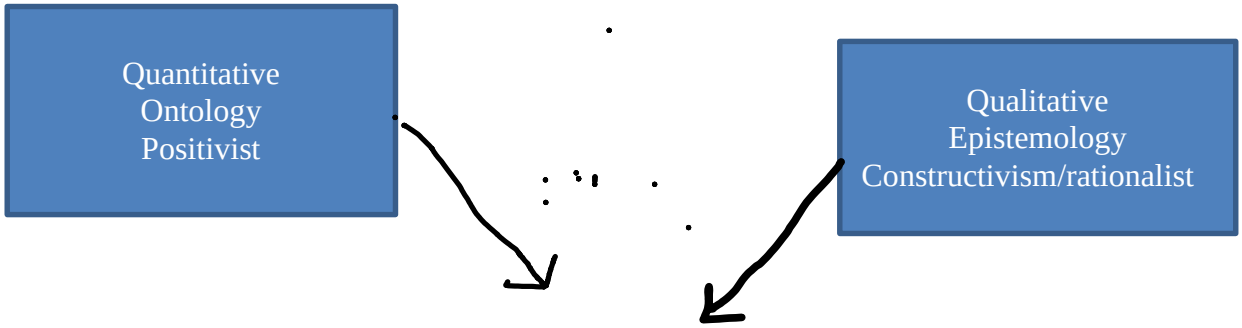


Figure 3. 1: Mixed approach. Source: Author (2024).

The mixed-method approach is a research inquiry that employs qualitative and quantitative approaches in research work for breadth and depth of understanding and partnership (Johnson, Onwuegbuezie, & Turner, 2007). The quantitative approach brought out the status core of the adoption rates, perceptions, or understandings of the technology characteristics to quantitatively establish the viewpoints and the established reality on the ground. The qualitative approach brought in and attached meaning to some of the numbers and further pushed in for detailed explanations of why the farmers expressed themselves as such. This required structured discussions with the farmers. Further thematic analysis was employed to understand the trends around certain themes, such as information asymmetry, for example.

Bivariate and multivariate analyses were used in the statistical package. SPSS was used to help with descriptive statistics. A mixed approach was used because qualitative and quantitative methods can also support each other, both through a triangulation of findings and by building on each other (e.g., findings from a qualitative study can be used to guide the questions in a survey). For qualitative analysis, thematic network analysis, which took more of the exploratory approach that the study is looking at, and framework analysis were used. For quantitative data, we used statistics to summarize the data, describing patterns, relationships, and connections. Statistics can be descriptive or inferential. The study, therefore, followed an analytical cross-sectional survey design as it envisioned seeing the frequency, characteristics, and snapshot picture of the utilization of WII in the four clusters namely Choma, Mumbwa, Chongwe and Petauke no weights were used. As mentioned briefly, for descriptive statistics, real numbers and percentages were reported for the study, which did not have continuous variables. Further, bar charts and pies were used to present the percentiles or proportions. For bivariate analysis to check for associations between categorical variables against the outcome uptake of WII, the Chi-squared test was used for variables that satisfied the assumptions of the Chi-squared test which had a sample of five or more, however for those variables that did not satisfy the assumption the Fishers exact test was used at 95% confidence interval. Any p-value that was below 0.05 was deemed significant. To check for further associations at multivariable analysis and further adjust or control for confounding between utilization and factors associated with utilization, the simple and adjusted multivariable logistic regression was used.

3.3 Research Philosophy

Our research followed an interactive approach with the communities. Therefore, setting the right inquiry for the challenge of smallholder poor uptake of WII sets the basis for unlocking the puzzle. It required establishing the reality on the ground with the different stakeholders, which include farmers, insurance companies, input suppliers, and government agencies. This required both the ontology (positivism), realistic, rationalist, and interpretivism standpoints or approaches. As such, both quantitative and qualitative paradigms were used in the study to help understand and interpret the different phenomena, taking both positivism and interpretivism into account. All the questions were subjected to the philosophical standpoint to form the basis for developing the inquiries defined from either the positivism, interpretivism, or humanist standpoint, which was important to establish.

Triangulation was used to gain meaning from the multiple respondents that were targeted by various tools including interviews, questionnaires (closed and open), focused group discussions, survey. The financial diffusion and technology adoption theories will be used to understand the different issues of the enquiry theoretically.

In summary, a research design matrix is shown below on the table. Mwanza, (2017) observed that a matrix is just a set of rows and columns where different components of a research fit. Components such as research questions, objectives; sampling, data collection tools and data analysis are displayed among others. The research design matrix for the research is shown below.

Table 3. 1: Research Design Matrix

Research Question	**Research Objectives**	**Population and sampling**	**Data Collection technique**	**Methodological choice and strategies**	**Data analysis**
1. What is the extent of diffusion of weather insurance index among the smallholder farmers **(Realistic Ontology, Induction, Positivists**)	**1.**To understand the extent of weather index insurance diffusion among the smallholder famers	Farmers ZIAMIS/ MoA data Donor agencies (FAO/CFU) Private input suppliers /insurance Random sampling	Survey Questionnaire	Quantitative	Univariate and Bivariate analysis
2.Why is weather insurance index	**2.**To test the	Farmers	Structured interviews	Mixed method	Framework analysis

diffusion exhibited as such among small holder farmers (**Rationalist/Humanists epistemology, Abduction)**	theory of innovation diffusion if it applies in explaining the diffusion of WII	Input suppliers/insurance. ZIAMIS /MoA Donor agencies Purposive sampling	FGD	Exploratory research design	
3.How can the diffusion and uptake of weather index insurance among smallholder farmers be enhanced **(Pragmatism, Pragmatic Methodology)**	**5.** To recommend a framework that will enhance the diffusion of WII by smallholder farmers	Farmers Input suppliers. MoA Donor agencies Purposive sampling	Structured interviews GFD Workshop	Mixed methods Pragmatic methodology	Univariate and bivariate (multivariate analysis

Source: Author (2020).

The table above shows research questions, objectives; sampling, data collection tools and data analysis.

3.4 Study Area or Site

The study areas were purposively selected based on the national vulnerability assessment and restricted to Central, Southern, Lusaka and Eastern Province vis a vie Mumbwa, Choma, Chongwe and Petauke districts. The selected provinces and districts were suitable because the areas are prone to adverse weather effects and had farmers that both participated on the

government supported WII and the private sector driven WII and hence gave broad perspectives of adoption and diffusion. Climatic shocks such as prolonged dry spells and late onset of rains impacted negatively on agriculture production during the 2017/18 agriculture season, while flash flooding in some southern districts in Zambia led to widespread leaching and loss of crop nutrients. The prolonged dry spell affected mostly the southern half of Zambia where rainfall performance was below normal. About 28 districts had prolonged dry spells of between 31 and 40 days mostly in the Central, Eastern, Lusaka, Southern and Western provinces. In addition to the dry spells, fall army worm and stalk borer outbreaks also impacted on crop production. The map of Zambia below shows needs assessments.

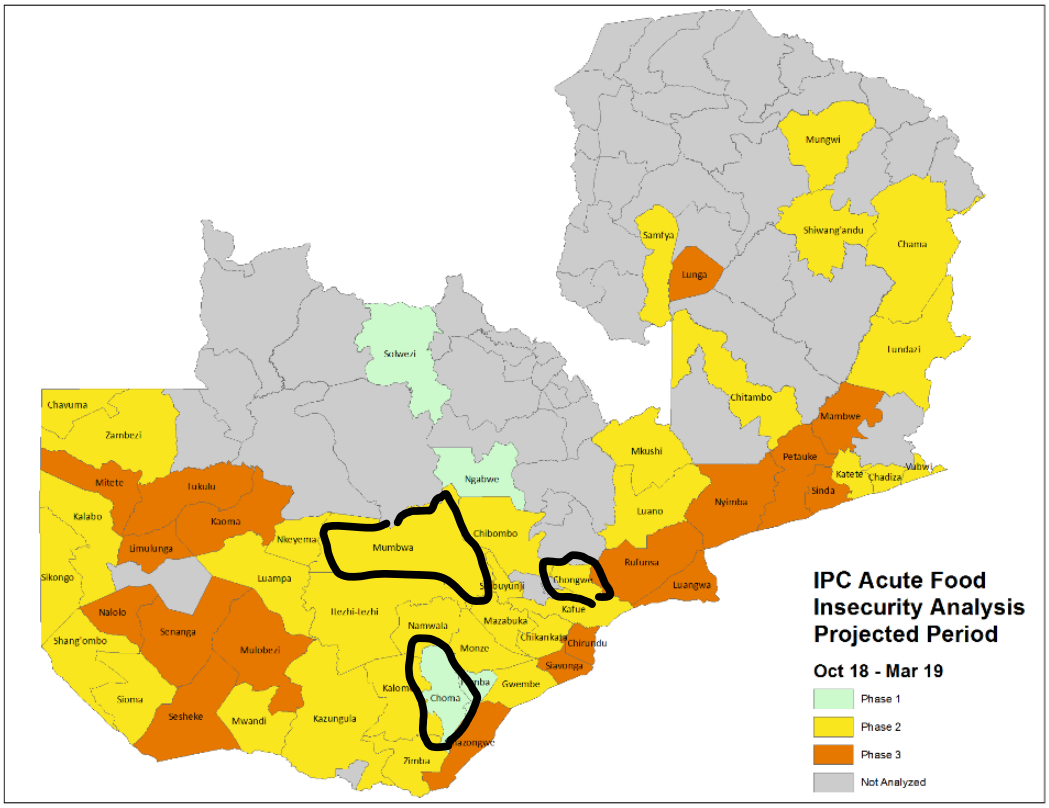


Figure 3. 2: Zambia Vulnerability and Needs Assessment report (2020)

3.4.1 Background on Select Districts for the Study

4.4.1.1 Mumbwa

The district is situated about 140Km from Lusaka in the Central Province of Zambia, and has a population of approximately 332,237 of which 167,134 are females and 165,103 are males. It has a population of 30,887 households participating in agriculture production according to the central statistics' office 2022 census. Its average annual Population Growth Rate stands at

5.6%, and the population distribution is 10.7 per square kilometre. The district has a total land size of approximately twenty-three thousand eight hundred square kilometres (23, 800km^2). Mumbwa district is subdivided into 5 agriculture blocks and 29 agriculture camps.

3.4.1.2 Choma

The district is situated in the southern province of Zambia approximately 300k from Lusaka with a population of 266,916 according to the 2022 census of which 129,035 are male and 137,881 are female with agriculture household 30,778. The district is predominantly agriculture with a total of 7,296 km^2. The annual growth rate is 3.3% (CSO, 2022) and is the highest rate in the province. It has the typical climate of southern Zambia with temperatures between 14^{o}C and 28^{o}C and sunshine ranging between 9 and 12hrs per day. Choma is predominantly a Tonga speaking area. Choma district is subdivided into five agricultural blocks, further divided into 37 agricultural farming camps(areas). An agricultural block takes care of several agriculture camps in the district for supervision purposes and aggregation. Agricultural camps are geographical and ecological dimensional areas where extension workers are tasked to man.

3.4.1.3 Chongwe

Chongwe is dominantly a soli speaking area surrounded by Rufunsa, Chisamba, Kafue, Chilanga and Lusaka districts. District is situated in Lusaka Province of Zambia, 45km from Lusaka and has a population of 313,389 of which 160,466 are female and 152,923 are male according to the 2022 census, with 22,665 agriculture households. The district has an annual growth rate of 6.9%. It has 3 agriculture blocks and 18 camps. The district is predominantly agriculture with the total of 2505km$^{2.}$

4.4.1.4 Petauke

District is situated in the eastern province of Zambia approximately 406 km east of Lusaka and 170km west of Chipata with a total population of 259,385 (127,270 males and 132,115 females) according to the 2022 census with 53,960 agriculture-based households. It has 4 block and 29 agriculture camp. The district growth rate stands at 3.3 and dominantly Chewa speaking people. The district is covered with 8,573Km^2. of agricultural land.

3.5 Study Population

The study outlook targeted a number of stakeholders. According to Creswell (2012), a target population or study population is a group of individuals with some common defining characteristics that the researcher can identify and study. In this regard, the study population is the total number of small holder farmers in Mumbwa 30, 887, Petauke 53, 960, Chongwe 22, 665 and Choma 30, 778 districts bringing the total to 138,290 farmers. This is according to the Zambia 2010 Census of Population and Housing Agriculture analytical report by the Central Statistical Office. The study furthermore targeted the MOA district employees for Mumbwa, Choma, Petauke and Chongwe districts in the agribusiness department, 144 agriculture camp officers, input suppliers based in Mumbwa, Choma, Petauke and Chongwe districts staff from the national insurance companies offering WII.

3.6 Study Sample Size

Creswell (2012) describes a sample as a subgroup of the target population that the researcher plans to study for generalizing about the target population. The researcher selected a sample from the target group of the four districts selected vis a vie Choma 253, Petauke 251, Mumbwa 247 and Chongwe 273 in Zambia and with Key Informants. Sample size would mean a part taken from the population for the study and that size sampled must be justified to carry out this research. Since the design was mixed, the selection met the criteria of both. Both groups must be taken on board by those who have either taken or not.

Using the standard sample size table by Sekeran (2003) the study targeted a sample of 1024 at 0.05 accuracy level at 95% confidence level of farmers in Mumbwa, Choma, Chongwe and Petauke districts using stratified sampling. The study used purposive sampling targeting 2 agribusiness department officers, 2 agriculture camp officers in the field (communities), 2 staff in charge of the WII product in the insurance companies and 2 staff from the input suppliers. Purposive sampling was used for FGD targeting at least 12 farmers and 10 participants for a workshop. The participants were chosen based on relevance, experience, and readiness to provide information.

For quantitative data and analysis, the researcher used or sampled a total of 8 key informants. In qualitative, at least one participant is sufficing or until one reached saturation from the key informants. Eight were sufficient for the research.

Purposive sampling was used for FGD targeting at least 12 farmers and 10 participants for a workshop. This is reasonable as many researchers have used the same number. Three (3) FGD were done in each district making the total of 12 FGDs.

For quantitative data, a sample of 1, 024 was selected. The number for quantitative must start from 30 or more. Gujarati (2006) affirms this minimum of 30 in quantitative analysis to be justified. According to Gujarati, he stated that a random sample from any population distribution, the sample mean tended to be normally distributed with mean and variance as the sample size increases indefinitely (technically infinitely). He further noted that, no matter what the underlying probability distribution is, the sample mean of a sample size of at least 30 observations will be approximately normal.

3.7 Sampling Techniques

The study used systematic random sampling for quantitative questions based on realistic ontology assumptions philosophically and detected facts happening and being used among smallholder farmers to understand the patterns of occurrences without bias. The study further used purposive sampling philosophically using the nominalist approach and abduction/deduction logic which required to purposively select people that were interviewed to get their detailed point of view of issues and their suggested solutions were possible**.** Snowball sampling in some case was be used to help identify the people with in-depth understanding of the weather insurance index product. A mixed approach provides a balanced point between the deductive and inductive perspectives of thinking which offers practical answers for merging different paradigms. The sampling techniques used was stratified sampling.

3.8 Data Collection

The process of data collection involved careful design of data collection instruments; individual interviews, Focus Group Discussions to have in-depth and breadth understanding for reasons of low diffusion with the farmers. This also involved training of enumerators that helped with the process, testing of the questionnaires to ascertain fitness and accuracy**,** data collection was conducted in the selected districts. The study used survey questionnaires, interviews, documents and FGD to gather data from the respondents. Most important is the accuracy of the process of data collection process and tools. After collection, the data was coded and entered

into the software for analysis. The data was manned by the researchers to avoid any duplication or exposure to the public.

3.8.1 Data Collection Instruments

This study used two instruments to collect data. These were in-depth interviews with key informants and Focus Group Discussions (FGDs) as well as questionnaires. This was important because a mixed study requires multiple data collection techniques. Primary data was collected from the smallholder farmers in Choma, Mumbwa, Chongwe and Petauke by the enumerators and the researcher. The chosen data collection instruments are discussed in the subtitles.

3.8.1.2 Interviews

Interviews are preferred in a qualitative study. According to Briggs *et al.* (2012), interviews are a common type of data collection tool that takes the form of a few major questions with sub-questions and possible follow up questions, adding that interviews are detailed discussions using open answers to collect facts on members' meanings of their views about the world. Interviews in a qualitative study provide a number of advantages that make research gather quality information. According to Tromp & Kombo (2006) an interview has an advantage over the questionnaire because the language of the interview is adapted to the ability or educational level of the person being interviewed and such misinterpretation concerning questions can be avoided. As such the study used semi-structured interviews visa vie open-ended questions. The purpose was to allow the researcher to get more data from the participants. The informants have a lot of information and knowledge in the areas. Willig (2001) supports the use of semi-structured interviews to obtain a wide range of data from investigating issues of interests that may be revealed during the interviews.

In this regard questions in this study were phrased to allow for individual responses and further probing. In addition, the researcher paid attention to the responses given for comprehensive meaning from the participants' views on the phenomena being studied, the uptake of WII. The researcher explored and probed the participants to obtain full details of the issues discussed and identified emerging themes that were directly related to the phenomenon of the study. Both the researcher and the enumerators carried out interviews to the farmers. For the other stakeholders interviews the researcher carried out the interviews. The photos below.

3.8.1.3 Focus Group Discussion

Focus group discussions were also found to be appropriate to the current study. As noted by Bryman (2008), focus group discussions present good qualities since they encourage collective stances on the views, opinions and perceptions given by the participants especially that after the researcher's questions, participants collectively reflect on the questions and reach consensus on what their collective answer should be for each question they were asked by the researcher.

Focus Group Interviews were used in this research as one of the key research tools. According to Lederman quoted in Rabiee (2004) Focus Group interviews are used to collect in-depth group information from knowledgeable participants about a subject (p.655). Hennink (2007) observes that the goal of a Focus Group interview is to produce several perceptions of a specific discussion. Both Hennink (2007) and Krueger & Casey (2000) have stated that Focus Group interviews enable the researcher to obtain detailed and valuable information in a short period.

The scholars propose any number between six and ten (Krueger & Casey, 2000; and Rabiee, 2004). The FG interviews for the study were limited to 6 to 10 participants to allow for effective engagement. The researcher moderated all the FG interviews and transcribed the data. Each interview lasted for 60-90 minutes. The interview with learners composed of both male and female. The farmers were not separated because of the nature of WII. Of the four districts under the study, three focused discussion groups per district were done, representing 12 in total. Each group discussion comprised 10 farmers, of whom 30% were women. The researcher conducted all the focus group discussions.

Focus Group Discussions in this study provided the opportunity for the men and women participants, grouped gender basis to reach general agreements and consensus regarding opinions, perceptions and experiences on WII uptake in the selected districts. In Figure 3.3 the researcher modulates the FGD

Figure 3. 3: Data Collection and Group Discussion Author (2020)

3.8.1.3 Questionnaire

Instrument that the researcher used in collecting data was the questionnaire. The researcher designed the questions according to the variables operationalized in the study. The questions were closed because the researcher was looking for quantitative data. Quantitative data was processed using a computer to generate the findings of the study. Tromp and Kombo (2009) gave advantages of using a questionnaire in that respondents had adequate time to answer the questions and that respondents were disturbed by the researchers as well as serving time. Questionnaires for the respondents addressed appropriateness questions on specific objectives.

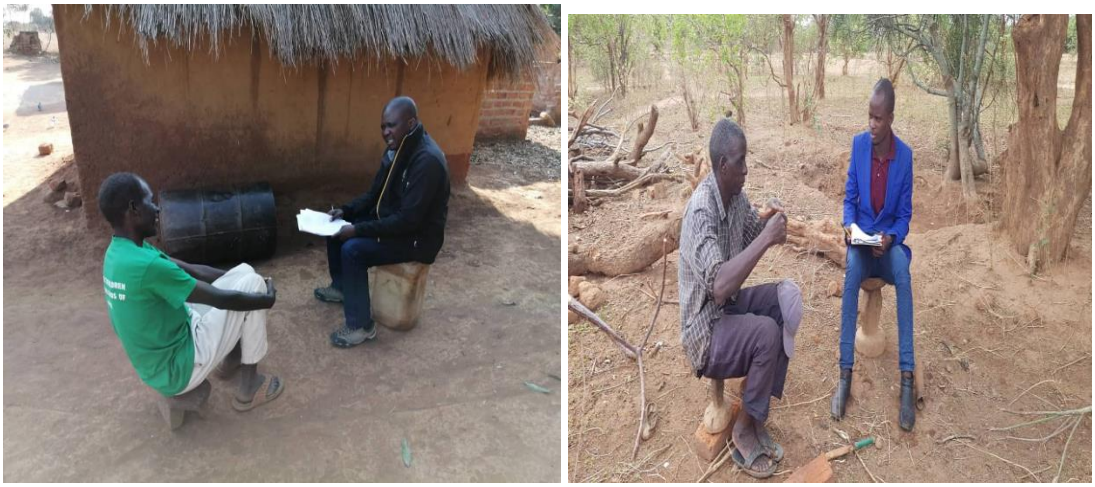


Figure 3. 4: Data Collection Through a Questionnaire. Author (2020)

The questionnaires were self-designed. This was done in line with the study objectives, the conceptual and theoretical frame works. Closed and Open questions were used which provided a list of options to choose from by the respondents. This made it easier to collect, code and analyse data.

3.9 Research instrument Pre-test

Prior to conducting of the survey, a one-day orientation session was organized by the team leader to brief the Research Assistants (in Petauke, Choma, Mumbwa and Chongwe) on the process, objectives, methods, and data collection tools for conducting the research. Further, a brief training was conducted on some ethical standards and study procedures to ensure protection of human objects. The team members were also familiarized with the questionnaires to be used. The session included a segment of a classroom session and later pilot fieldwork at one of the selected respondents. The exercise was very useful as it helped fine tune the questionnaire and provided feedback to the research team at the end of the pilot fieldwork. The study tools were presented to the university for validation by the supervisor before data collection.

3.10 Data Analysis

Data collected were both quantitative and qualitative.

For quantitative data, univariate, bivariate and multivariate analysis were used. For quantitative data, statistics to summarize the data was obtained, describing patterns, relationships, and connections. Statistics were descriptive or inferential. SPSS was used to help out with descriptive statistics. Qualitative and quantitative methods supported each other, both through a triangulation of findings and by building on each other (e.g., findings from a qualitative study can be used to guide the questions in a survey). For bivariate analysis to check for associations between categorical variables against the outcome uptake of WII the Chi squared test were used for variables that satisfied the assumptions of the Chi squared test which had the sample of five and more, however for those variables that did not satisfy the assumption the Fishers exact test was used at 95% confidence interval. Any p-value that was below 0.05 was deemed significant. To check for further associations at multivariate analysis and further adjust or control for confounding between utilization and factors associated with utilization, the simple and adjusted multivariable logistic regression were used at 95% confidence level. The AIC and BIC were used and the nested model over the full model was opted for due to the evidence provided by AIC and BIC.

For qualitative analysis, this was done using thematic network analysis which take more of the exploratory approach which the study is looking at and framework analysis.

3.11 Ethical Considerations

The study was guided by following the ethical obligations pertaining to human research, hence the need for approval from the research and ethics committee (Dufy *et al.*, 2005). The study compiled the following.

Ethical considerations in research are critical. Ethics are the norms or standards for conduct that distinguish between right and wrong. They help to determine the difference between acceptable and unacceptable behaviours. First, ethical standards prevent against the fabrication or falsifying of data and therefore, promote the pursuit of knowledge and truth which is the primary goal of research. Ethical behaviour is also critical for collaborative work because it encourages an environment of trust, accountability, and mutual respect among researchers. This is especially important when considering issues related to data sharing, co-authorship, copyright guidelines, confidentiality, and many other issues. Researchers must also adhere to ethical standards in order for the public to support and believe in the research. The public wants to be assured that researcher followed the appropriate guidelines for issues such as human rights, animal welfare, compliance with the law, conflicts of interest, safety, health standards (Cacciattolo Marcelle, 2015).

Further, privacy and confidentiality are the major ethical considerations in any research study (Preetha et.el.,2023). Caution was taken against source bias (conditions or circumstances which affect the external validity of statistical results), errors in methodology, interpretation of results and their application to real world issues (Kombo & Tromp, 2006). Ethical issues in data collection were adhered to specifically in the following areas:

(i) The study was justified via an analysis of the balance of costs. There were benefits from the study that outweighed the costs. The presentation of the research problem justified beyond any reasonable doubt the need for data collection.

(ii) Confidentiality was always maintained. Only certain people involved in the study knew the identity of the participants (Kombo & Tromp, 2006). The researcher was responsible for the conduct of the research and the consequences of that research. Thus, the researcher accepted individual responsibility for the entire process.

(iii) Informed consent was obtained from subjects who participated in the study, and it was ensured that all subjects participated voluntarily. The researcher clearly explained the study in advance and promised to de-brief subjects afterwards (Preetha et.el.,2023). The explanation was key to gaining informed consent from the participants. Informing the participants about the results of

the study-built trust and justified the study to the participants. The results of the study and the recommendations proposed impacted the participants' future actions and perceptions.

(iv) The respondents were assured that the names and other personal information would not be disclosed.

(v) The respondents were free to withdraw anytime during the course of data collection. That is, the researcher ensured as much as possible that participation in the research was voluntary.

(vi) The collected data was presented as a group instead of individual analysis.

(vii) The research respected the rights of the institution whose clients were under study by conducting the research objectively.

(viii) The fact sheet was developed that provided some information about the study to assist the respondent in making decisions to either accept or reject participating in the survey. In the case of some farmers, the fact sheet was ready to them before commencing with the questionnaire. This includes the purpose of the study, role of the respondent, duration of the questionnaire, purpose of the study (academic), benefits and confidentiality.

3.12 Summary of the Chapter

Chapter four made a systematic presentation of the research methods and procedures employed in the study. It provided necessary information on the sampling procedure employed, data collection and data analysis, ethical considerations were considered based on the fact that the study was guided by following the ethical obligations pertaining to human research and therefore contributed to achieving the research objectives.

CHAPTER 4

PRESENTATION OF RESEARCH FINDINGS

4.1 Overview

This chapter focuses on presenting the research findings based on the actual works carried on in Choma, Petauke, Mumbwa and Chongwe districts based on the 3 specific objectives of the study.

4.2 Objective 1: To Assess the Extent of the Diffusion of Weather Insurance Index among the Smallholder and Famers

4.2.1 Demographic Profile of the Respondents

Both the respondents and participants were engaged, and demographic data collected from the following variables: age, gender, marital status, and education. Table 4.1 shows the participants' age, gender, marital status, and education.

Table 4. 1 : Baseline characteristics

Variable		**Frequency: N=1024**	**Percentage=%**
Age	15-20	49	(4.79%)
	21-35	245	(23.93%)
	36-50	432	(42.19%)
	>50years	298	(29.10%)
Gender	Male	758	(74.02%)
	Female	266	(25.98%)
Marital Status	Single	227	(22.17%)
	Monogamously married	676	(66.02%)
	Polygamously married	121	(11.82%)
Education	Tertiary	93	(9.08%)
	Secondary	284	(27.73%)
	Primary	600	(58.59%)
	No education	47	(4.59%)

Table 4.1 results show 42.19% of farmers were between 36-50 years, 29.1% farmers were 50 years and above, 23.93% were 21-35 and 15-20 years were 4.79%. Further, 74.02% were male farmers, 25.98% were female farmers. 66.02% were monogamously married, 11.82% were polygamously married, 22.17% were single. 58.59% reached primary education, 27.73% reached secondary education, 9.08% did tertiary education and 4.59% had no education at all.

4.2.2 Descriptive Overview of the Problems Faced in Agribusiness

The respondents and participants were asked to give an overview of the problems faced in agribusiness. Responses were categorised into three groups namely: very significant; significant and insignificant. The table 4.2 shows the responses.

Table 4. 2 : Descriptive Overview of the Problem Faced in Agribusiness

Variable	Very significant	Significant	Insignificant
Bad and challenging weather	434 (42.38%)	420(41.02%)	170(16.60%)
Access to agricultural inputs	399(38.96%)	453(44.24%)	172(16.80%)
Market information	278(27.15%)	415(40.53%)	331(32.32%)
Commodity output markets	320(31.25%)	296(28.91%)	408(39.85%)
Extension services	398(38.87%)	260(25.39%)	366(35.74%)

Table 4.2presents results of problems faced in agriculture; 434 (42.38%) farmers indicated bad weather as a significant problem, 420 (41.02%) said it was significant whilst 170 (16.60%) indicated it as insignificant. 399 (39%) indicated access to agriculture inputs very significant, 453 (44.24%) indicated it as significant whilst 172 (16.80%) it as not significant.

For market information, 278 (27.15%) indicated it was very significant, 415 (40.53%) indicated significant whilst 331 (32.32%) indicated it was not significant. 320 (31.25%) farmers indicated commodity output markets to be very significant, 296 (28.91%) was significant, whilst 408 (39.85%) indicated was not significant.

For extensions services, 398 (38.87%) indicated it was very significant, 260 (25.39%) indicated very significant, whilst 366 (25.39%) said it was not significant.

4.2.3 Participants who Experienced or Not Experience Bad Weather

The respondents and participants were asked to give an overview of whether they experienced or not experience bad weather by responding “Yes or No”. The table shows the responses.

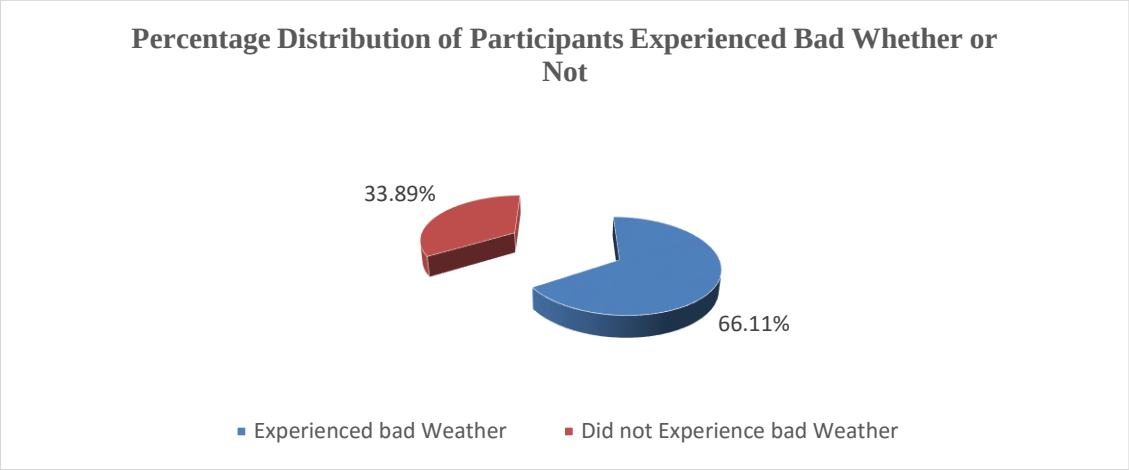


Figure 4. 1 Percentage Distribution of Participants Who Experienced Bad Weather or Not

Figure 4.1 results indicate 33.89% of farmers did not experience bad weather and 66.11% experienced bad weather.

4.2.4 The Major Challenges Faced with WII by Farmers (Pay-Out)

The respondents and participants were asked to give an overview of the major challenges faced with WII by farmers (Pay-out). The figure shows the responses.

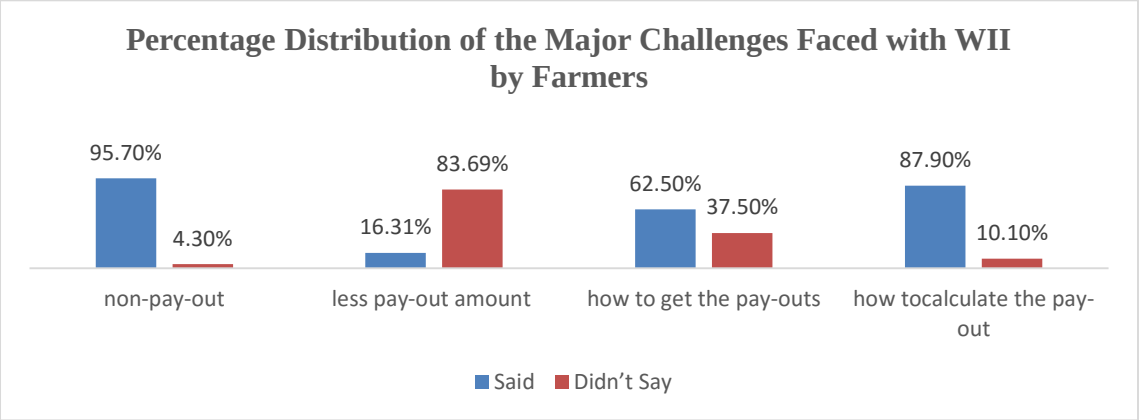


Figure 4. 2: *Percentage Distribution of the Major Challenges Faced with WII by Farmers*

From figure 4.2 above, participants were asked about their challenges which they face with WII, 95.70% said they had challenges with non-payouts of WII whilst 4.3% said it was not a challenge. 16.31% said less pay-out amounts were a challenge whilst 83.69% said it was not a challenge. 62.50% said how to get the pay-outs was a challenge whilst 37.50% said it was not a challenge. Further, the results show that 87.90% said how to calculate the pay-out was a challenge whilst 10.10% said it was not a challenge.

4.2.5 Technology Characteristics (Relative Advantage, Compatibility, Trialability, Complexibility)

The respondents and participants were asked to give an overview of the various variables affecting technology characteristics. The table shows the responses.

Table 4. 3 : Technology Characteristics (relative advantage, compatibility, trialability, competitivity, observability

Variable		**Frequency: N=1024**	**Percentage=%**
Satisfied with the pay-out time laps	Very satisfied	10	(0.98%)
	Satisfied	59	(5.76%)
	Partially satisfied	110	(10.74%)
	Not satisfied	845	(82.52%)
Satisfied with the pay-out amount you received	Very satisfied	11	(1.07%)
	Satisfied	65	(6.35%)
	Partially satisfied	112	(10.94%)
	Not satisfied	836	(81.64%)
pay-out amounts were able to cover some of you loses?	Yes	74	(7.23 %)
	No	950	(92.77 %)
How confident are you in investing more in WII?	very confident	179	(17.48%)
	Confident	317	(30.96%)
	Barely confident	138	(13.48%)
	Not confident	390	(38.09%)
What do you think you can do to better the WII service?	Bundle WII with other services	138	(13.48%)
	More education on WII	631	(61.62%)
	GRZ policy on climate mitigation to famers	58	(5.66 %)
	Increased participation by the insurance companies	129	(12.60%)
	Very effective	40	(10.00%)

Compared to the other insurance products, how would you describe WII?	Effective	147	(36.75%)
	Very poor	98	(24.50%)
	Poor	115	(28.75%)
Would you say WII is profitable in your farming activity	Very profitable	45	(4.39%)
	Profitable	201	(19.63 %)
	Average	118	(11.52%)
	Not at all	660	(64.45%)

Table 4.3 results indicated 81.64% were not satisfied with pay-out timing whilst 0.98% indicated very satisfied. 81.64% indicated they were not satisfied with pay-out amounts whilst 1.07% indicated were satisfied with the pay-out amount. 92.77% indicated the pay-outs amounts did not cover any losses whilst 7.23% indicated they covered some losses. 17.48% were very confident to invest in WII, 30.96% were confident, 13.48% were barely confident whilst 38.09% were not confident. 13.48% indicated bundling of WII with other services would better WII uptake, 61.62% felt more education would better uptake of WII whilst 5.66% felt policy environment on climate mitigation whilst 12.9% indicated participation of the insurance companies with the farmers would improve uptake.

4.2.6 Technology Characteristics (Compatibility, Easy to Use, Not Expensive, Complexibility).

The respondents and participants were asked to give an overview of whether the technology characteristics were easy to use or not expensive (compatibility, easy to use, not expensive, complexibility) by responding "Yes or No". The table shows the responses.

Table 4. 4 : Technology Characteristics (compatibility, complexibility, relative advantage, observability)

Variable		**Frequency: N=1024**	**Percentage=%**
Would you say WII is difficulty to understand?	Yes	188	(18.36 %)
	No	836	(81.64%)
What are the reasons for not purchasing insurances	It is expensive	28	(3.18%)
	it is not accessible	173	(19.68%)
	I see no benefit	36	(4.10%)
Would you say WII is easy to use	Yes	223	(21.78 %)
	No	801	(78.22%)
How would you describe weather insurance index as a climate mitigation instrument?	Complicated	164	(16.02%)
	Not consistent	213	(20.80%)
	Expensive	44	(4.30 %)
	Very risk	78	(7.62 %)
What do think should be done to improve information provision on WII to farmers?	Increased farmer sensitization	934	(91.21%)
	Increased rate of timely pay-outs	50	(4.88%)
	Clear information on the base rates	166	(16.21%)
How do you get your pay-outs from the insurance company	No clear known systems to the farmers	184	(17.97%)
	Through the farmer cooperative chairman	59	(5.76 %)
	Through the MoA system	203	(19.82%)

	Through the insurance company	18	(1.76%)

From the study results 81.64% indicated is easily understood whilst 18.36% indicated WII was very difficult to understand for the farmers. 78.22% of the farmer's indicated WII was difficult to use whilst 21.78% indicated it was easy to use. 19.68% indicated it not accessible whilst 20.80% indicated WII was not consistent, 16.02% indicated it was complicated ,7.26% indicated it was too risky and 4.30% indicated it was expensive.

On improving WII information, 91.21% indicated the increase in awareness campaigns through increase farmer sensitization and 4.88% indicated timely payouts of the payouts.
16.21% indicated that clear information on the basis risk will help the farmers understand WII and uptake. 17.97% indicated they did not understand clear the payout systems farmers. whilst 19.82% indicated they were conversant with payout system through the MoA. 5.76% indicated they were using the cooperatives to get their payouts and only 1.78% through insurance companies.

4.2.7 WII Knowledge among Participants

The respondents and participants were asked to give an overview of WII knowledge by responding “Yes or No”. The figure shows the responses.

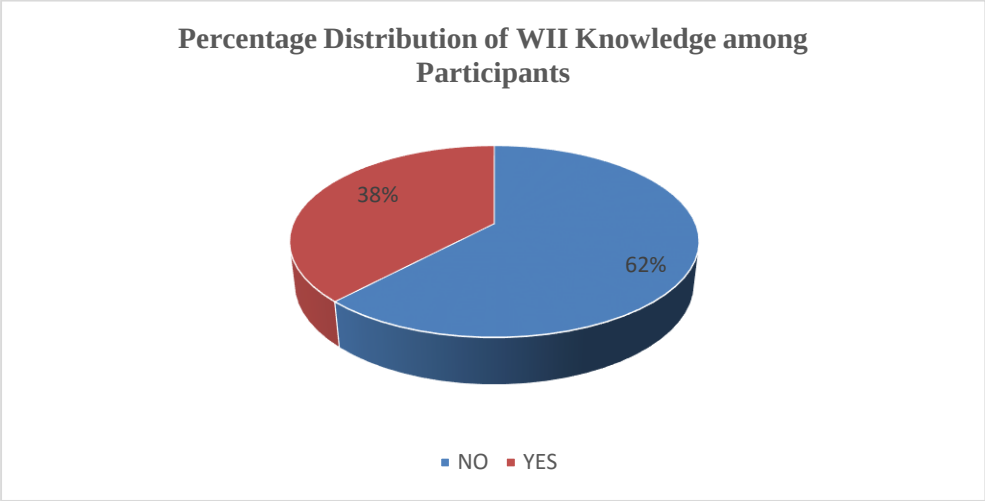


Figure 4. 3: *Percentage Distribution of WLL Knowledge among Participants*

Figure 4.3 results indicate 62% indicated did not have knowledge on WII, 38% did have knowledge on WII.

4.2.8 How the Participants Knew about Weather Index Insurance?

The respondents and participants were asked to give an overview of how they knew about WII. Different categories were given below. The table shows the responses.

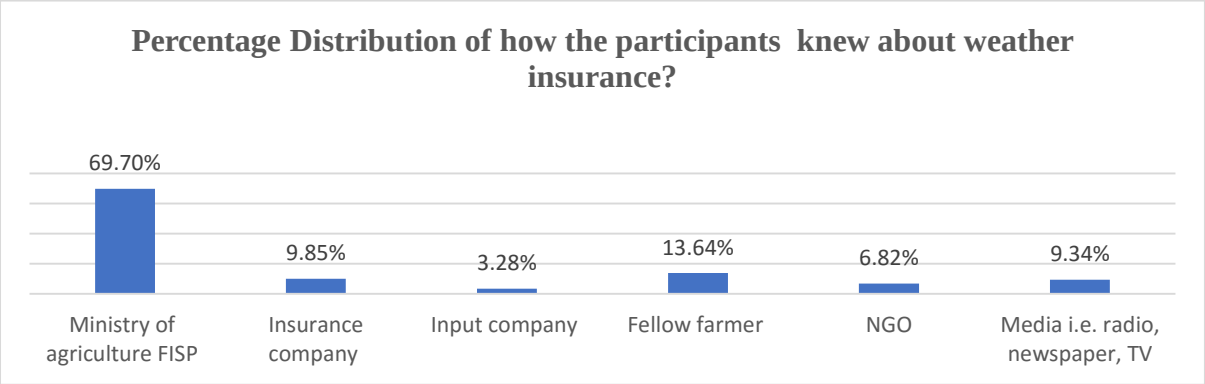


Figure 4. 4: *Percentage Distribution of how Participants Knew about WII*

Results from figure 4.4 indicate 69.70% knew WII through the GRZ Farmer input support program (FISP), 9.85% through insurance companies, 3.28% through input suppliers. Whilst 13.64% new WII through fellow farmers, 6.82% NGOs and 9.34% via media such as radio, TV and newspapers.

4.2.9 WII Awareness and Utilization

The respondents and participants were asked to give an overview of whether they were aware of WII and how it was being used. Different variables were given below. The table shows the responses.

Table 4. 5 : WII Awareness and Utilization

Variable		**Frequency: N=1024**	**Percentage=%**
have you used weather insurance index?	Yes	305	(77.02%)
	No	91	(22.98%)
40 What type of insurance did you purchase?	WII	216	(54.41%)
	Mult-peril	2	(0.50%)
	yield index insurance	6	(1.51%)
	crop insurance	88	(22.17%)
Did you receive any training or orientation on WII from the MoA or insurance Firm?	Yes	172	(16.80%)
	No	852	(83.20%)
Who trained you?	Ministry of agriculture	121	(11.82%)
	Insurance companies	37	(3.61%)
	Input company	12	(1.17%)
	Fellow farmer	23	(2.25%)
	NGO	4	(0.39%)

The study reveals from table 16 the majority of the participants significantly utilized WII 205 (67.21%) $p<0.001$ compared to other insurances, such as multi-peril 1 (0.33%), yield index insurance 6 (1.97%), crop insurance 79 (25.90%, $p<0.001$. Further the study did not show any significant association between training and utilization of WII, even though the majority of participants who utilized WII did not receive training 194(63.61%) and only 111 (36.39%) did not receive training $p=0.866$. The study shows that most of the participants who utilized WII were significantly trained by ministry of agriculture 95(31.15%), $p<0.002$, insurance

companies 16(5.25%), p<0.001, 8(2.62%), p=0.731, by input company, 17(5.57%), p=0.384 by fellow farmers, NGO 2(0.66%), p=0.669.

4.2.10 Reasons Why Participants Didn't Know about WII

The respondents and participants were asked to give reasons why participants didn't know about WII. Different categories were given for their responses. The figure shows the responses.

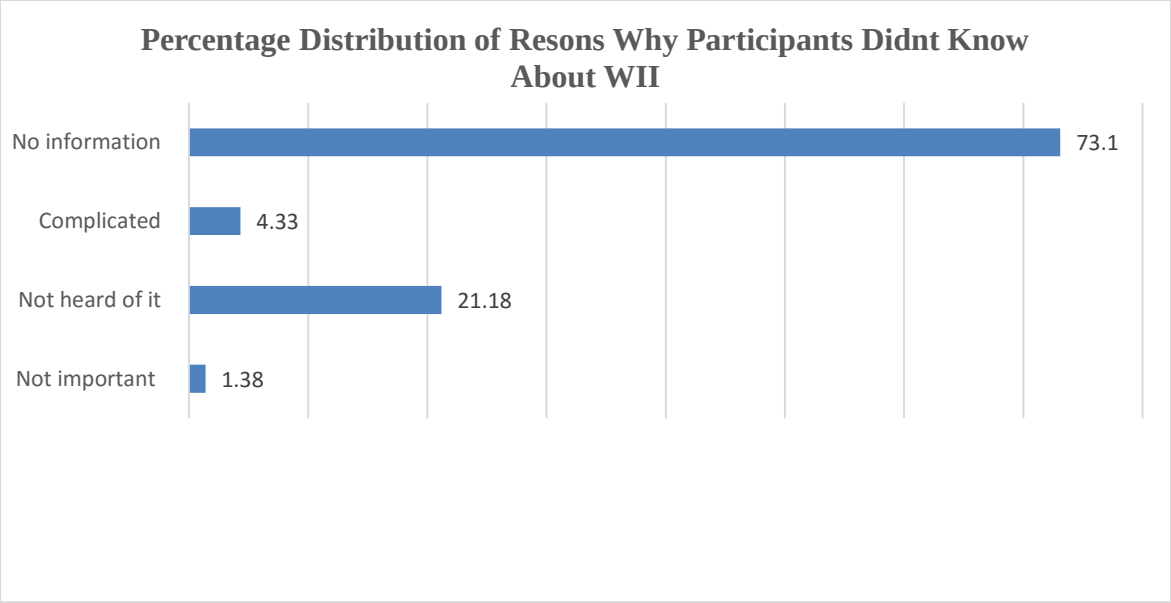


Figure 4. 5: *Percentage Distribution of Reasons Why Participants Didn't Know about WII*

Figure 4.5 results indicate 73.1% of farmers did not know WII due to lack of information, 21.18% because they never heard of it, 4.33% indicated because it was complicated and 1.38% felt it was not important.

4.2.11 Capacity Building and Training

The respondents and participants were asked to state whether they were capacitated and trained by stating Yes or No. The figure shows the responses.

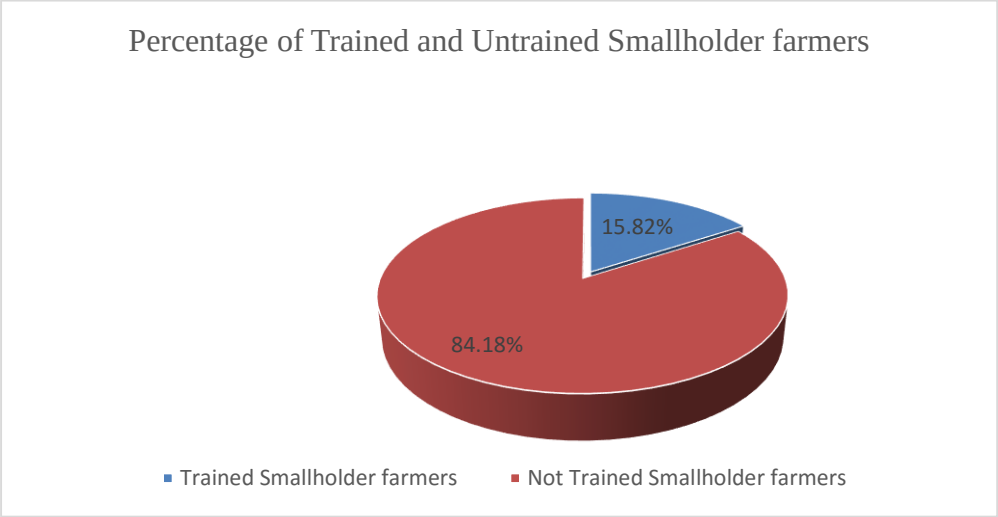


Figure 4. 6: *Percentage Distribution of Participants who were Capacitated and Trained.*

Figure 4.6 shows 84.18% farmers were not trained and 15.82% were trained.

4.2.12 Presence of Market Players/Stakeholders

The figure shows the responses.

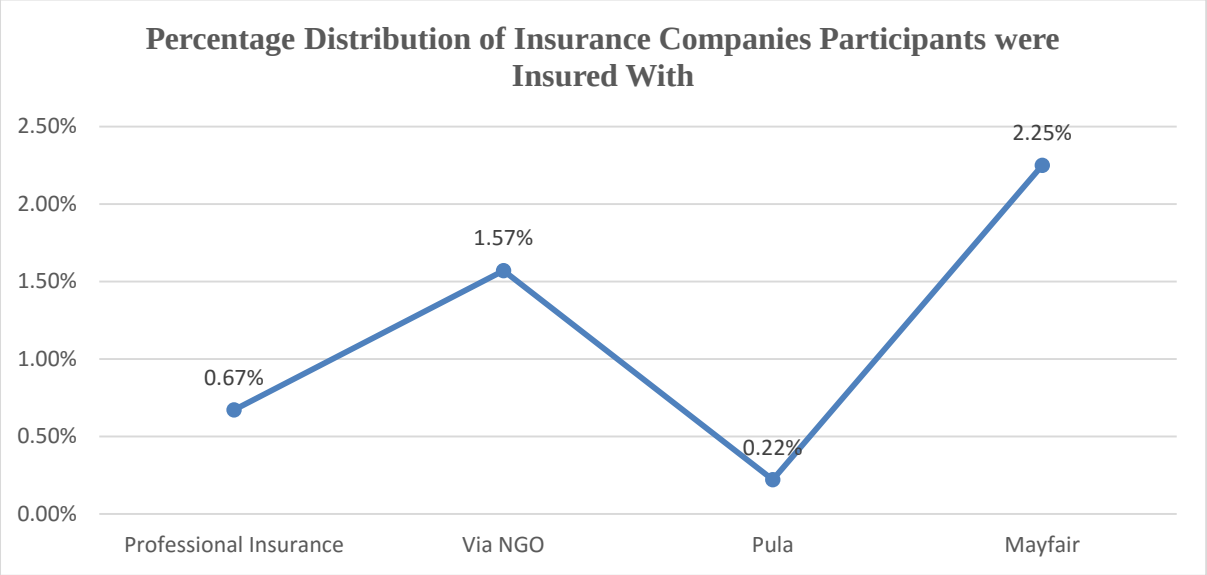


Figure 4. 7: *Percentage distribution of insurance companies' participants were insured with*

Figure 4.7 indicate the number of participants insured through Mayfair at 2.25%, Pula insurance 0.22%, professional insurance 0.07% and NGOs indicated 1.57%.

4.3 Objective 2: To Test the Theory of Innovation Diffusion if it Applies in Explaining the Uptake of WII on Demographic Factors

Table 4. 6 : The demographic factors were subjected to bivariate analysis. The results are reflected on the table.

Table 4.5 Chi-Square

Variable		Utilized WII	Didn't Utilize WII	P-value
Age	15-20	12(3.93%)	3(3.30%)	0.234f
	21-35	57(18.69%)	18(19.78%)	
	36-50	137(44.92%)	31(34.07%)	
	>50years	99(32.46%)	39(42.86%)	
Gender	Male	237(77.70%)	70(76.92%)	0.875c
	Female	68(22.30%)	21(23.08%)	
Education	Tertiary	25(8.20%)	8(8.79%)	0.975f
	Secondary	107(35.08%)	30(32.97%)	
	Primary	158(51.80%)	49(53.85%)	
	No education	15(4.92%)	4(4.40%)	
Marital status	Single	57(18.69%)	19(20.88%)	0.585C
	Monogamously married	208(68.20%)	57(62.64%)	
	Polygamously married	40(13.11%)	55(13.89%)	

The study results from the table 4.5 above show that, there was no association between utilization of the WII and age groupings, even if it shows that the majority who utilized WII were of the age grouping between 36-50 years 137(44.92%) compared to 31(34.07%) who did not utilize WII. And those who were above 50 years of age, and utilized WII were 99(32.36%) while those who did not utilize were 39 (42.86%). However, the differences in the age groupings and utilization of the WII were not significant p=0.234. For gender, there were more males 237(77.70%) that utilized WII compared to females 68 (22.30%), despite there was no significant association between gender and utilization of WII p=0.875, suggesting no evidence of significant differences. Across education level, the findings show that, the majority of the

users of the WII were those attended primary school level, 158 (51.80%) followed by those who attended secondary level of education 107(35.08%), those who did attend any education were 15 (18.89%) as the minority. However, there was no evidence of significant association p-0.975. Marital status shows that, the majority of the participants who used WII were monogamously married 208(68.20%) compared to those who were single, 57 (18.69%) and polygamous married 40(13.11%). Marital status had no significant association with utilization of WII p=0.585.

4.3.2 Technology characteristics

The technology characteristics were subjected to bivariate analysis. The results are reflected in the table.

Table 4. 7 : Analysis of Technology characteristics.

Variable		Utilized	Didn't Utilize	p-value
What are the reasons for not purchasing insurances	It is expensive	5(3.05%)	4(4.49%)	0.553
	it is not accessible	7(4.29%)	13(14.61%	0.004
	I see no benefit	3(1.84%)	4(4.49%)	0.202f
would you say WII is easy to use	Yes	209(68.52%)	11(12.09%)	<0.001
	No	96(31.48%)	80(87.91%)	
How would you describe weather insurance index as a climate mitigation instrument?	Complicated	63(20.66%)	17(18.68%)	0.681
	Not consistent	155(50.82%)	7(7.69%)	<0.001
	Expensive	25(8.20%)	6(6.59%)	0.617
	Very risk	52(17.05%)	8(8.79%)	0.054
What do think should be done to improve information provision on WII to farmers?	Increased farmer sensitization	279(91.98%)	82(90.11%)	0.687
	Increased rate of timely pay-outs	28(9.18%)	4(4.40%)	0.142f
	Clear information on the base rates	76(24.92%	14(15.38%)	0.057
How do you get your pay-outs from the insurance company	No clear known systems to the farmers	102(33.44%)	24(26.37%)	0.204
	Through the farmer cooperative chairman	54(17.70%)	4(4.40%)	0.001f
	Through the MoA system	152(49.84%)	19(20.88%)	<0.001c

	Through the insurance company	10(3.28%)	7(7.69%)	0.068

Participants were asked what the reasons were for not purchasing insurance. The majority of the participants who did not utilize WII were those who said it was not accessible 13 (14.61%) compared to other groupings, 4 (4.49%) respectively of it is expensive and I do not see any benefit. There was enough evidence that utilization was associated with reasons for not purchasing insurance $p<0.004$. However, the other reasons for not purchasing were not significant. About how easy WII is to use, majority of the participants who utilized WII 209 (68.52%) said yes it was easy to use compared to those who said no 96 (31.48%) showing significant association of being easy to use and utilization of WII services with a $p<0.001$.
Results further show that the majority of participants who utilized WII described WII to be inconsistent 155 (50.82%), compared to those who described it as complicated 63 (20.66%), very risky 52 (17.05%) and expensive 25 (8.20%) and there was a significant association between WII description and utilization of WII $p<0.001$. The study further shows that there was no significant association between what participants thought should be done to improve information provision on WII to farmers, with the majority mentioning increased farmer sensitization 279 (91.98%), others saying increased rate of timely pay-outs 28 (9.18%) and clearing information on the base rates 76 (24.92%), $p=0.057$.

It is revealed by the study findings that the majority of participants who utilized WII were paid through the MoA systems 152 (49.84%) $p<0.001$, 102 (33.44%) had no clear systems to the farmers, 54 (17.70%) $p<0.001$ through the farmer cooperative chairman and 10 (3.28%) were paid through the insurance company.

Table 4. 8 : Technology Characteristics Analysis -2

Table 4.7: Technology characteristics analysis subjected to bivariate analysis.

Variable		Utilized	Didn't Utilize	p-value
Satisfied with the pay-out time laps	Very satisfied	7(2.30%)	2(2.20%)	<0.001
	Satisfied	47(15.41%)	7(7.67%)	
	Partially satisfied	101(33.11%)	8(8.79%)	
	Not satisfied	150(49.18%)	74(81.32%)	
Satisfied with the pay-out amount you received	Very satisfied	9(2.95%)	2(2.20%)	<0.001s
	Satisfied	51(16.72%)	7(7.69%)	
	Partially satisfied	99(32.46%)	10(10.99%)	
	Not satisfied	146(47.87%)	72(79.12%)	
pay-out amounts were able to cover some of you loses?	Yes	65(21.31%)	9(9.89%)	0.014
	No	240(78.69%)	82(90.11%)	
How confident are you in investing more in WII?	very confident	40(13.11%)	14(15.38%)	0.001
	Confident	162(53.11%)	27(29.67%)	
	Barely confident	47(15.41%)	23(25.27%)	
	Not confident	56(18.36%)	27(29.67%)	
What do you think you can do to better the WII service?	Bundle WII with other services	122(40.00%)	3(3.30%)	<0.001
	More education on WII	193(63.28%)	65(71.43%)	0.152
	GRZ policy on climate mitigation to famers	42(13.77%)	1(1.10%)	0.001

	Increased participation by the insurance companies	71(23.28%)	14(15.38%)	0.107
Compared to the other insurance products, how would you describe WII?	Very effective	29(9.51%)	10(10.99%)	<0.001
	Effective	117(38.36%)	29(31.87%)	
	Very poor	93(30.49%)	5(5.49%)	
	Poor	66(21.64%)	47(51.65%)	
Would you say WII is profitable in your farming activity	Very profitable	27(8.85%)	11(12.09%)	<0.001
	Profitable	139(45.47%)	28(30.77%)	
	Average	89(29.18%)	12(13.19%)	
	Not at all	50(16.39%)	40(43.96%)	

From the result, 49.13% of farmers indicated they were not satisfied with WII, 33.11% partially satisfied and 2.3% very satisfied with p-value of 0.0001 that indicated a greater relationship with adoption of WII. 2.3% of farmers indicated they got benefits and 49.13% never got any benefits from WII. 33.49% of farmers indicated that compared to other insurance packages WII is very poor. From the study results 40.00% of the farmers indicated the need for bundled services with a p-value of <0.001 indicating strong relationship of uptake of WII. Government policy on adoption of WII indicated a p-value of 0.0001.

4.3.4 Types of Insurance Purchased and Stakeholders' Trainings and Influence subjected to Bivariate Analysis

Table 4. 9 : Types of insurance purchased and stakeholder straining and influence.

Variable		**Utilized**	**Didn't utilize**	**p-value**
What type of insurance did you purchase?	WII	205(67.21%)	11(12.09%)	<0.001
	Mult-peril	1(0.33)	1(1.10%)	0.363
	yield index insurance	6(1.97%)	0(0.00%)	0.178
	crop insurance	79(25.90%)	8(8.79%)	0.001
Did you receive any training or orientation on WII from the MoA or insurance Firm?	Yes	111(36.39%)	34(37.36%)	0.866
	No	194(63.61%)	57(62.64%)	
who trained you?	Ministry of agriculture	95(31.15%)	13(14.29%)	0.002
	Insurance companies	16(5.25%)	17(18.68%)	<0.001
	Input company	8(2.62%)	3(3.30%)	0.731
	Fellow farmer	17(5.57%)	3(3.30%)	0.384
	NGO	2(0.66%)	1(1.10%)	0.669

MoA of extension system and insurance companies had some positive influence on the farmers with P-values <0.0001 and 0.002 respectively that are below 0.005. WII had some positive influence with P-value of <0.001.

4.3.5 Analysis of the Key Constraints Influencing Diffusion

Key constraints influence to uptake were subjected to bivariate analysis. The results are reflected in the table.

Table 4. 10 : **Analysis of the key constraints influence diffusion**.

Variable		**Utilized WII**	**Didn't Utilize WII**	**P-value**
Bad and challenging weather	Very important	165(54.10%)	47(51.65%)	0.871
	Important	95(31.15%)	31(34.07%)	
	Not important	45(14.75%)	13(14.29%)	
Access to agricultural inputs	Very important	115(37.70%)	45(49.45%)	0.080
	Important	129(42.30%)	35(38.46%)	
	Not important	61(20.00%)	11(12.09%)	
Market information	Very important	80(26.23%)	19(20.88%)	0.043
	Important	116(38.03%)	48(52.75%)	
	Not important	109(35.74%)	24(26.37%)	
Commodity output markets	Very important	77(25.25%)	28(30.77%)	0.068
	Important	77(25.25%)	32(35.16%)	
	Not important	150(49.18%)	31(34.07%)	
Extension services	Very important	136(44.59%)	25(27.47%)	0.014
	Important	74(24.26%)	28(30.77%)	
	Not important	95(31.15%)	38(41.76%)	

Source: Author (2020).

Results above show the analysis of the key constraints influence to uptake:
Bad and challenging weather: Those utilised WII and stated very important were 165 (54.10%) and 47 (51.65%) and did not use WII; those who utilised WII and stated important were 95 (31.15%) and 31(34.07%) did not use WII; and those who utilised WII and stated not to be important were 45 (14.75%) and 13 (14.29%) did not use WII.
The p-value for the commodity output markets was 0.871.

Access to agricultural inputs: Those utilised WII and stated very important were 115 (37.70%) and 45 (49.45%) and did not use WII; those who utilised WII and stated important were 129 (42.30%) and 35 (38.46%) did not use WII; and those who utilised WII and stated not to be important were 61 (20.00%) and 11 (12.09%) did not use WII.
The p-value for the commodity output markets was 0.080.

Market information: Those who utilised WII and stated very important were 80 (26.23%) and 19 (20.88%) did not use WII; those who utilised WII and stated important were 116 (38.03%) and 48 (52.75%) did not use WII; and those who utilised WII and stated not to be important were 109 (35.74%) and 24 (26.37%) did not use WII.
The p-value for the market information was 0.043.

Commodity output markets: Those who utilised WII and stated very important were 77 (25.25%) and 28 (30.77%) did not use WII; those who utilised WII and stated important were 77 (25.25%) and 28 (30.77%) did not use WII, and those who utilised WII and stated not to be important were 150(49.18%) and 31 (34.07%) did not use WII. The p-value for the extension services was 0.014.
The p-value for the commodity output markets was 0.068.

On extension services: those who utilised WII and stated very important were 136 (44.59%) and 25 (27.47%) did not use WII; those who utilised WII and stated important were 74 (24.26%) and 28(30.77%) did not use WII, and those who utilised WII and stated not to be important were 95 (31.15%) and 38(41.76%) did not use WII.
The p-value for the extension services was 0.014.

4.3.5: Understand the perception of WII by the famers

Further, the study wanted to understand the perception of WII by the famers. Therefore, responses were sought from key informants and 12 focus group discussions (consisting of 120 farmers in total)

4.3.5.1 Information provision

Of the 120 farmers participants 110 farmers indicated that information on WII was important for their agriculture development and growth

4.3.5.2 Pay-out systems

Of the 120 farmer participants 115 indicated payout systems was important as it helps to mitigate against production costs during adverse weather in a farming season

4.3.5.3. Cooperative dynamics

Of the 120 farmers participants 105 farmers indicated the cooperative systems was important in aggregating the farmers for training and payment systems

4.3.5.4. Bundling of services

110 farmers out of the 120 farmers that participated in the discussion revealed that WII needs other bundled services to fully satisfy the farmers' needs.

4.3.5.5. Key informants

At the workshop in Mumbwa the key informants indicated that payouts were the major hinderance to uptake of WII. Furthermore, it was concluded that Zambia needs the weather index insurance because it is a right financial instrument that covers the smallholder farmers in the country unlike the traditional general insurance that only covers the commercial farmers well.

4.4 Objective 3: To Recommend a Model that Should Enhance the Uptake of WII in the Agriculture Sector by Smallholder Farmers**.**

4.4.1 Predictors of weather insurance index

Predictors of the weather insurance index were subjected to full logit model. The table shows the results.

Table 4. 11 : Full logit model for the predictors of WII

Variable	Odds Ratio	P-value	[95% Conf.	Interval]
	Ref	Ref	Ref	Ref
Female	1.79	0.363	0.51	6.23
Age	Ref	Ref	Ref	Ref
21-35	2.39	0.502	0.19	30.65
36-50	1.08	0.952	0.08	13.84
50	0.97	0.978	0.08	12.21
Marital		Ref	Ref	Ref
Mono-married	1.82	0.400	0.45	7.39
Poly-married	2.61	0.279	0.46	14.84
Education		Ref	Ref	Ref
Secondary	0.67	0.643	0.12	3.63
Primary	1.01	0.986	0.21	5.00
no school	0.53	0.62	0.04	6.56
reason not getting Wii				
Expensive	3.97	0.335	0.24	65.41
Descri~n_WII		Ref	Ref	Ref
Not consistent	1.03	0.973	0.18	5.89
Complicated	0.69	0.726	0.09	5.52
Very risky	1.17	0.876	0.17	8.27
		Ref	Ref	Ref
Easy to use	7.11	0.001*	2.18	23.21
Not accessible	0.82	0.824	0.15	4.52

Yes I don't know wii	37.70	0.051	0.99	1439.46
how did you get your payouts				
MOA-fisp		Ref	Ref	Ref
Yes I know WII	6.64	0.001*	2.18	20.30
Insurance company		Ref	Ref	Ref
Yes	1.13	0.883	0.21	6.05
WII-profitable?		Ref	Ref	Ref
Profitable	0.58	0.558	0.10	3.55
Average	0.92	0.938	0.12	7.32
Not at all	1.06	0.953	0.14	7.99
Have you received training?	Ref	Ref	Ref	Ref
Yes	1.74	0.459	0.40	7.49
Very Risky	2.39	0.235	0.57	10.03
Complicated	0.53	0.318	0.15	1.85
Does cost determine W uptake?				
Determinant somehow	0.29	0.146	0.05	1.54
Not a determinant	0.20	0.061	0.04	1.08
number of community members using wii	0.88	0.08	0.77	1.01
rate out of 10	0.89	0.59	0.58	1.37
payed through	1.98	0.207	0.68	5.75
payed through cooperatives	6.39	0.033*	1.16	35.14

Note: * denotes a significant variable with a p-value<=0.005

Table 4.10 shows results for a full model of the multivariable analysis of factors associated with utilization of WII among participants in Choma, Chongwe, Petauke and Mumbwa districts.

From the study findings adjusting for all variables such as age, gender, marital status, education background to mention but a few, those who were paid through cooperatives had 6.39 odds more than those who paid through MoA and other payment modes, the estimates could be as low as [1.16-35.14, 95% CI; p<0.033] suggesting enough evidence to argue that those who

paid through cooperatives had a significant high chance of utilizing WII than those who paid through other modes of payments.

Whereas the odds ratio of using WII for individuals who claimed to know controlling for other covariates was approximately (7.11; 95% CI, 2.18, 20.30; p<0.001) Participants who stated it was easy to use WII were 7.11 more likely to use WII services than participants who said no, with a range of 2.18 to 28.21 at 95% confidence intervals (CI). This finding provides.

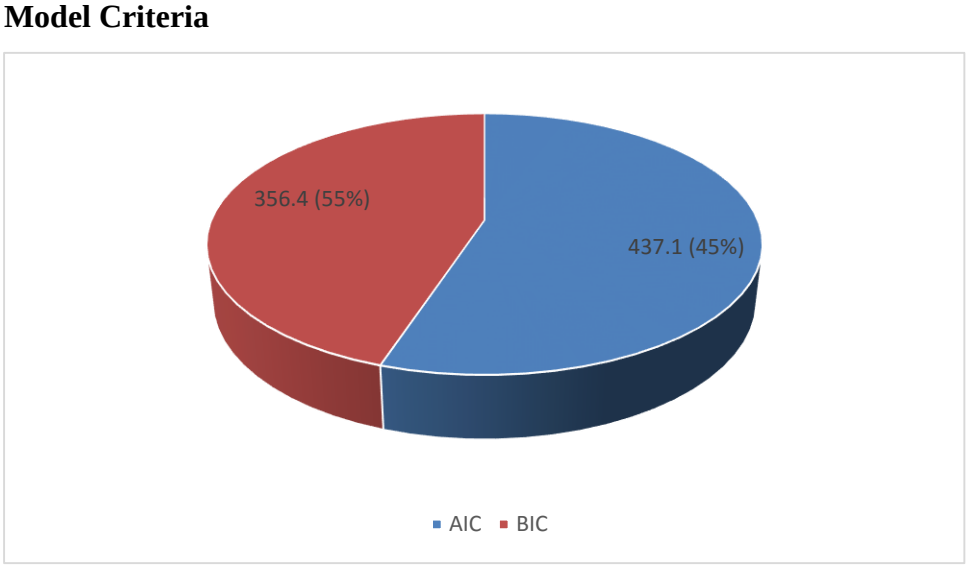


Figure 4. 8: *Model selection criteria*

To select the best models, or the best predictor model, the Akaike information criteria and Bayesian information criteria were used. With the AIC being 437.1 and BIC 356.4, thus the BIC was used to select the model as it had the smallest number.

Table 4. 12 : Nested logit model of predicators of WII

Variable		Odds Ratio	P>z	[95% Conf.	Interval]
Is it easy to use WII	No	Ref	Ref	Ref	Ref
	Yes	14.52	0.000	7.34	28.73
Paid through corporative	No	Ref	Ref	Ref	Ref
	Yes	3.66	0.024	1.19	11.23
Do you know whether Wii	No	Ref	Ref	Ref	Ref
	Yes	1.13	0.047	1.03	1.32

To select the best models, or the best predictor model, the Akaike information criteria and Bayesian information criteria were used. With the AIC being 437.1 and BIC 356.4, thus the BIC was used to select the model as it had the smallest number.

4.5 Objective 4: To demonstrate an implementation plan for the proposed model.

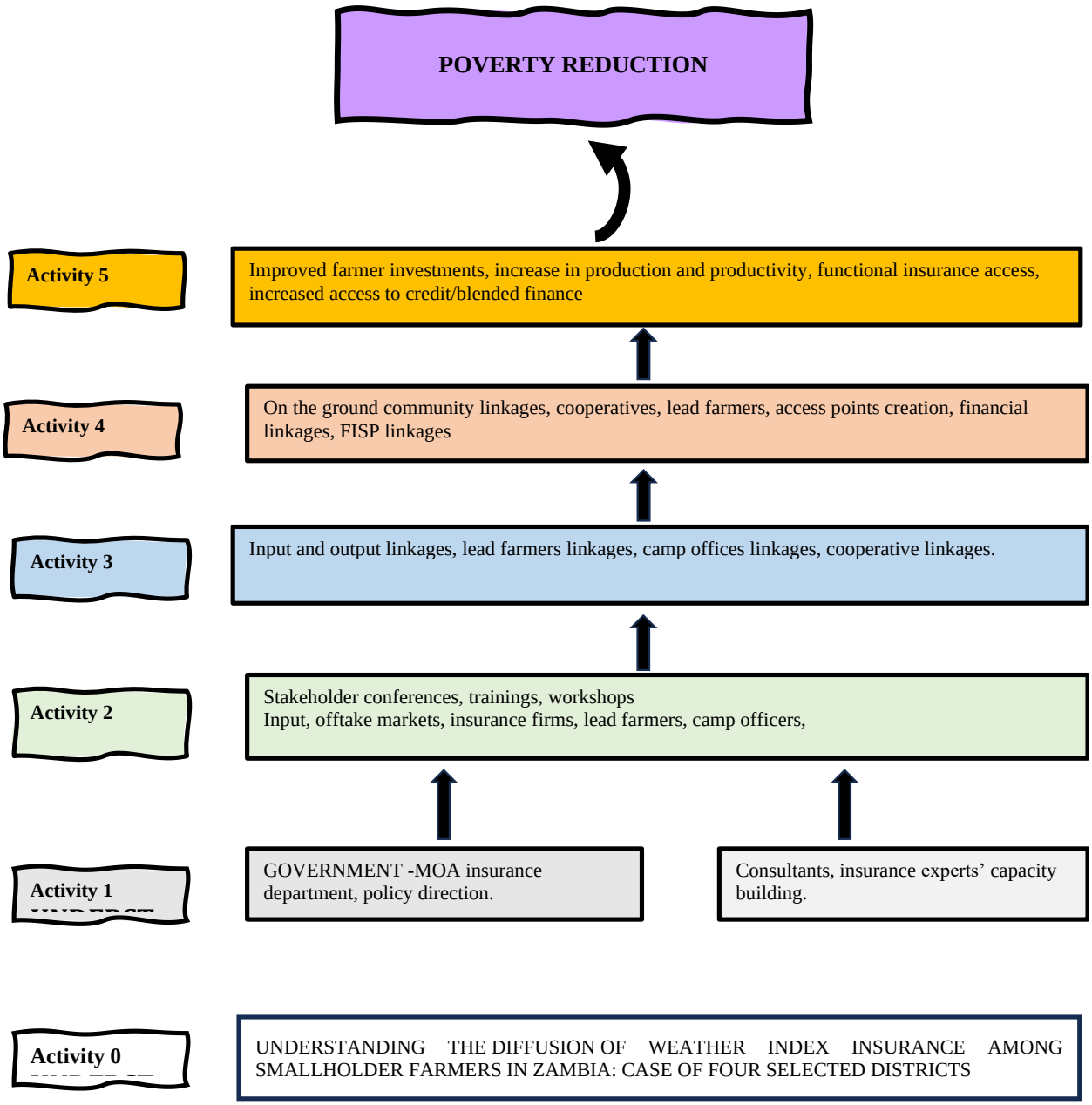


Figure 4. 9: *Implementation plan for the model*

4.6 Summary of the Chapter

Chapter 5 presented the results as obtained from the field both descriptive and quantitative statistics, bivariate and multivariate analysis to indicate significance to the findings. This chapter gives insights for chapter 6 to discuss, interpret and attach meaning to the results presented.

CHAPTER 5

DISCUSSION OF RESEARCH FINDINGS

5.1 Overview

This chapter presents the answers to the research questions and provides a contextual analysis of the findings. This is in relation to pieces of previous research done, coupled with the rendering of a critical appraisal from the researcher's field observations. It will further base the analysis on the other relevant literature. Practical example as was obtained on the ground will be added.

5.1 Objective 1: To assess the extent of diffusion of WII among the smallholder farmers.

The majority 77% of the smallholder farmers were males and the minority 22% were females. This meant that most farmers in the study catchment areas were male farmers, hence indicating agriculture as a male dominant sector in the rural parts of Zambia though in some value chains such as groundnuts the status quo is different. This could be because of culture and coupled with high vulnerability of females in rural areas. Most females in the rural areas do not have many assets to use for agricultural production, harvesting and packaging. Since males are dominant in the sector, they own most of the agricultural production assets, hence earn more income from agricultural production than female counterpart.

The 68% of the respondents were monogamously married families and 18.69% were single or not married with majority being women households. This means most of the smallholder farmers were married and the minority were single: that could be widowed, not married before. In most rural economies that depend on agrarian economy, most farmers are married because wives and their children and dependents provide farm labour for the family. The widowed have their children and dependents as well to provide farm labour for the family.

The majority, 42% of the smallholder farmers, were between the age range of 36-50 years old, followed by 29% of above 50 years; below 35 or the youthful age accounted for 28%. The majority of farmers were above youthful age that is above 35 years. In most developing countries, the majority of them are involved in white- and blue-collar jobs in urban areas, not in agricultural production. Mostly, agriculture has been a job for the elderly ones, including those who retire from white- and blue-collar jobs who have productive agricultural assets to use.

With regard to education, the majority 59% of the respondents reached up to primary educated, followed by 28% reaching secondary education, followed by 9% tertiary and the least 4.92% indicated that they had not attained any education at all. The empirical results revealed positive and significant impacts of farmers' ability to read and write given an assignment that requires skulls in writing, reading and arithmetic.

Indeed, some studies have not indicated influence positively of some of the demographics' variables to the uptake of WWW. Berber Kramer (2019) did not found gender differences in the propensity to purchase index-based insurance; though in some cases there were no significant differences between women and men farmers regarding insurance adoption (Bageant & Barrett, 2017). Findings from a financial literacy and weather insurance marketing field experiment conducted in 2009 indicated that financial education can have a positive and significant effect on rainfall insurance adoption (Cole-Et-Al-2013)

In the problems faced in agribusiness: the majority 83% found significant problems on bad and challenging weather and the minority 17% found insignificant; access to agricultural inputs was found to be significant at 83%; Market information was found to be significant at 68%; commodity output markets were found to be significant at 54%; and extension services was found to be significant at 64%.

This meant that smallholder farmers face problems of bad and challenging weather in the course of agricultural production with some few problems accounting to 27% in accessing agricultural inputs; market information at 32%; commodity output markets at 46% and extension services at 26%.

From the study results 83% of the farmers indicated bad weather and challenging weather as significant. Climate change weather is becoming a big threat to agriculture production and productivity more especially in the Sub-Saharan region that is most characterized by smallholder producers that depend on rain fed agriculture. Climate change continues to be one of the critical challenges to achieving this goal globally. First, it seems climate change will affect agricultural production (Frank *et al.,* 2021) through higher mean temperatures and more frequent weather extremes (Daryanto *et al.,* 2016; Lesk *et al.,* 2016). Climate distresses can thus generate and continue poverty traps in the small agricultural sector if they are not alleviated (World bank, 2021; Osakwe, 2021),

Agreeing to this, climatic stresses and many other factors can cause sudden losses in farmer production and production capacity, resulting in highly volatile returns coupled with inferior market opportunities, predominantly in the rain fed dependent areas, of which most farmers are part. Indeed, growing evidence suggests historical food insecurity globally because of climatic influence (Niles & Salerno, 2018; Ray *et al.*, 2015; Ngoma *et al.*, 2021). Chinseu *et al.*, (2019); Rosen *et al.*, (2021), submitted that extensive climatic and socio-economic vulnerability challenges the wellbeing and livelihoods of low-income agriculturalists that make up the majority of rural populations in developing nations (Duwenu *et al.*, 2020).

Further 64% of the farmers indicated extension services was significant for agriculture production which is consistent with many studies and indeed a prerequisite for farmer adoption of good agriculture practices, innovation or technology adaption that is critical for farmers to adapting and adopt new means of production and or mechanisms that would help or edge the productivity per unity area.

Similarly, 38.96% of farmers indicated access to agriculture inputs was very significant and 44.24% indicated it was significant this is consistency with other studies. Access to agriculture inputs is very important for the farmers to increase their production and productivity. These may include seed varieties that are suitable to climate challenges, fertilizers, irrigation facilities. For uptake of WII may need the availability of the inputs to that farmer. In fact, studies have shown an increase in WII when its bundled with access to agriculture inputs as this added the value of risk to the farmers. Agricultural insurance can be combined with other products or services. Carter *et al*., 2016) made a theoretical case for combining insurance with other services such as credit (often referred to as bundling), suggesting it as one of the ways to make insurance popular. Insurance can be combined with credit services (Giné & Yang, 2009; Meyer *et al*., 2018; Ahmed *et al*., 2020) or inputs such as drought-tolerant seeds, high yielding seeds or fertilisers (Leblois *et al*., 2014b; Lybbert & Carter, 2015; Awondo *et al*., 2020; Visser *et al*., 2020).

31.25% of farmers indicated that commodity markets were significant for agriculture production. This is very consistent with market development principles, the push and pull effects are very necessary for the agriculture markets to indicate growth and similarly for the weather index insurance to improve uptake of the innovation. Farmers will require well-structured markets that would allow to build confidence in the farmers to build confidence in

purchasing WII as result of assured and available incomes through the commodity markets. The commodity markets play a vital role in unlocking the farmers' adoption to technologies. Mostly the rural farmers suffer from lack of markets to sell their products too and hence lack incomes to pay premiums at the right time. Therefore, structured, futures commodity output markets would play a key role in the uptake of WII for the farmers. (The commodity and derivative markets gives confidence to the farmers but also to a wider range of stakeholders that include the financial institutions that are very avers of investing into smallholder agriculture production systems, the private sector companies that are able to provide extension service, inputs and technologies but most importantly this will give confidence for the insurance institutions at different levels that include the insurers , and the agriculture insurance focus on the smallholder farmers). Low productivity and production concerns may have implications for everyone. Keeping the cost of purchased inputs low, on the other hand, helps to minimize financial loss in years with bad weather when crop yields are already poor. Nevertheless, everyday input use also constrains results in good years and thus hampers average farm productivity and income growth (Williams *et al*., 2021). It, therefore, seems that crop insurance that compensates farmers for low yields in bad years could promote higher input use (Hansen *et al.*, 2019).

Market information is critical for the smallholder farmers to adapt and adopt to new technologies that would both help production enhancement but also risk management and mitigation agriculture been averse to climate change. 40.53% of the farmers indicated it was significant whilst 27.15% indicated it was very significant. Information is key for farmers; studies have attributed the low uptake of technologies due to poor information distribution to the farmers on the WII products and services. Findings from a financial literacy and weather insurance marketing field experiment conducted in 2009 indicate that financial education can have a positive and significant effect on rainfall insurance adoption (Cole-Et-Al-2013). Not only do stakeholders have to design and market products, but also, education and capacity building among local insurance staff, delivery agents, government officials and consumers are needed. These capacity-building investments likely contribute to broader financial service development; however, it is important to note that thus far, donors and/or governments have heavily supported the development of every weather index insurance market (Barry Barnett, 2014). This is a problem across many countries piloting and or promotion WII. Farmers lack

the information that would help be aware of the products and services of WII for them to make decisions.

On the percentage distribution of participant who experience bad weather, from the target group interviewed, about 66.11% of the farmers indicated had experienced bad weather and about 33.89% did not. During farmer group discussions, it was indicated that bad weather over the years has negatively crop production and productivity per unit area due to reduced rainfall amongst many factors. Most of the farmers are reliant on the rain fed crop production systems making the farmers vulnerable resulting in poor crop yields, poor incomes, and most importantly poor food security. It may appear from first values that this status core could be enough motivation for the farmers to adopt WII as a mitigation measure, but this is not the case as adoption of WII is still poor. Climate change continues to be one of the critical challenges to achieving this goal globally. First, it seems climate change will affect agricultural production (Frank *et al.,* 2021) through higher mean temperatures and more frequent weather extremes (Daryanto *et al*. 2016; Lesk *et al.,* 2016). Climate distresses can thus generate and continue poverty traps in the small agricultural sector if they are not alleviated (World bank, 2021; Osakwe, 2021).

Discussion on the percentage distribution of major challenges faced in the districts system based – biased to payout. Participants were asked about the challenges which they face with WII, 95.70% said yes that they had challenges with non-pay-out as a challenge they faced and 4.3% did not say anything about non-pay-out as a challenge. For less pay-out amounts as a challenge, 16.31% yes, it is a challenge while 83.69% did not say that it was a challenge. Respectively, for those who said how to get the pay-outs was a challenge they were 62.50% and those who did not say they were 37.50%. Further, the results show that 87.90% said how to calculate the pay-out and 10.10% did not say it was a challenge.

Lack of payout may affect demand – indications, due to the heavy rains, meant that the contract would not payout in September left several worried that without a payout soon, demand for the product would severely affect. It's clear that ensuring that clients have a solid understanding of how the product works is critical. The extension messages need to be tweaked to emphasis the downside and risk protection role (Sygenta, 2014).

5.2. Objective 2: To test whether the theory of innovation diffusion applies in explaining the diffusion of WII.

On technology characteristic – utilization (relative advantage, compatibility, trialability complexibility, relative advantage) results from the study revealed that: 82.52% of the farmers indicated they were not satisfied with the payout time of WII, only 0.98% indicated they were satisfied. However, if approved, payouts must come quickly to provide compensation when the farmers need it most in a particular season, allowing them to use resources for alternative opportunities to help increase resilience (Fanconi & Scheurle, 2017;). If not, these present serious issues if farmers are to buy -in or uptake WII. There absolutely no benefits that a farmer will get if the payouts fail too much with solving or providing the alternative solution to the farmer. The purpose and reason for a farmer to insure is totally misplaced and the rural farmer will lose trust and confidence in the product coupled with lack or poor information on the product. Further, 81.64% of the farmers indicated were not satisfied with the payout amounts and only 1.07% of farmers were satisfied. Though it is difficult to reach and define what levels would satisfy the farmers, it is clear the amounts the farmers got were not enough to look at the alternative solution that may include fresh seed, agrochemicals, fertilizer, or any other inputs that would provide a solution. From the results complicates the situation were both time and amounts received are not satisfying the farmers makes it impossible for the farmers to gain confidence in the WII product. As such 92.77% of farmers indicated the amount received did not manage to cover their losses and only 7.23% of the farmers indicated the amounts received helped to cover up their losses. If the farmer's compensation fails to cover part of the farmer loses uptake is nightmare by farmers. Farmers with little information will feel cheated. This agrees with evidence from other studies, both frequency of payouts, and their timing also matters. Optimising remote sensing data for instance and providing earlier payouts could allow vulnerable farmers to utilise mitigation strategies such as alternative forage sources for livestock (Vrieling *et al.*, 2016) or access to food to prevent farmers from falling below the minimum food requirements (Hochrainer-Stigler *et al.*, 2014).

This agrees with several studies. In an ideal system, the farmers must pay a pre-determined amount to the insurance firm to obtain the product. These are known as "premiums,". They are not refunded if there is a payout. If the weather has been terrible enough to trigger a payout as per the product criteria, a payout is expected with weather index insurance. In the event of drought or excessive rain, insured farmers can replant due to the early payout long before the conclusion of the growing season (Greatrex *et al.,* 2015). A pay-out is provided automatically

based on the weather events (e.g., droughts, dry spells). Typically, a pay-out is provided through distribution channels. The insurance firm will award pay-outs accordingly in the case of some pilots in India, crediting the money directly to each qualifying farmer's bank account. The farmer receives a final SMS communication stating that the settled insurance claim. Farmers can rest assured that they will be reimbursed if they wake up to discover whirling floodwaters threatening their livelihoods (Giriraj, 2017). The rewards are provided automatically when an index goes above or below a pre-determined threshold. (GSMA, 2020). The farmer does not need to fill in any documentations to get payments (CNAAS,2020). Additionally, 38.09% farmers indicated they were not confident to buy WII the next farming season, 30.96% barely confident and 17.48% were confident. This demonstrates how trust is easily lost with the farmers if products fail to meet their expectations and indeed address their needs. From the study the farmers suggested some ideas to improve on uptake of WII, 61.62% indicated that more education and training to farmers on WII was the most important activity to the farmers. Farmers indicated lack of education and information as a major hindrance to uptake of the technology. 13.48% felt bundling insurance with other services such as credit, inputs, off take markets was important and could increase the farmers' confidence to invest to WII due to the increased assurances. 5.66% of the farmers indicated policy interventions from the government were necessary to both create an enabling environment as well confident to both the service providers and the farmers. Government has a role to create policy that should guide the intervention. Additionally, 12.66% of the farmers indicated that increased participation of the insurance companies in engaging the smallholder farmers on the insurance services. These suggestions are in line with several studies. Insurers generally have a low presence in rural areas in SSA. Agricultural insurance is generally new and has not proliferated in rural areas. Rural farmers are less likely to trust institutions that they do not have a previous relationship with and do not know well. With this bottleneck, insurance providers could use channels of higher trust such as community-based groups. We expand on this issue in sub-sections. Other channels might include well-known financial institutions, such as banks and microfinance organizations, and input retailers (World Bank, 2018) or farmer organizations (Patt *et al*., 2009).

As compared to the insurance products 36.75% of the farmers' felt WII was effective, 10.00% said it was very effective, but 28.75% thought it was poor and 24.50% indicated it was very poor. For market penetration WII should be up to date with the needs of the farmers because

this status core indicates a lot of mistrust on the product by the farmers more marketing and promotions are needed. The farmers were asked if WII was profitable, 64.44% of the farmers indicated it was not all profitable whilst 4.39% indicated it was very profitable. 19.63% and 11.52% indicated it profitable and averagely profitable respectively. This has implication of poor uptake of the WII as it does not have a relative advantage as why a farmer per for the product should. Farming is a business a farmer expects value out of investing into WII.

Therefore, it will take coordinated efforts to create an equilibrium between supply and demand in the small business insurance program. when farmers purchase insurance, they tend to increase investments in inputs such as fertilizer and enterprises with higher risks (Cai, 2016; Karlan *et al.,* 2014). Taking up agricultural insurance not only led to increased incomes, but also decreases income fluctuations (de Nicola, 2015).

On technology characteristics -utilization (relative advantage, compatibility, complexibility, trialability and observability, the study's findings were: 81.64% of the farmers indicated WII could be easily understood if they were given adequate information. The product can be understood by the farmers as long as training and farmers are allowed to participate in the process assessment, trigger time, as well as explanations payouts calculations and systems. Awareness of insurance programs shows a positive effect, confirming the proposition that farmers with knowledge on insurance are more likely to participate in crop insurance programs (Gine´ *et al*., 2008). However, 18.36% indicated WII was very difficult to understand by the farmers because of lack of information including marketing campaigns. How easy to use, 78.22% of the farmer's indicated WII was difficult to use as most of the activities are very technical for the rural farmer to easily understand without proper orientation whilst 21.78% indicated they had good experiences with WII and indicated it was very easy to use in their farming business. 19.68% of farmers indicated that WII in the rural areas is not accessible.

Analysing the above data means that most rural farmers are not only illiterate but also unaware of new technologies such as insurance. An assessment in Ethiopia found that 49 per cent had never heard of insurance, 41 per cent did not know how it worked, and 25 per cent did not know where to find it (World, Bank, 2018). More educated farmers and pastoralists portray higher demand and the less educated portray lower demand (Giné & Yang, 2009; Patt *et al*., 2009; Hill *et al*., 2013; Okoffo *et al*., 2016; Takahashi *et al*., Reference Takahashi, Ikegami, Sheahan and Barrett, 2016; Abugri *et al*., 2017; Bishu *et al*., 2018; Fonta *et al*., 2018;

Amare *et al*., 2019; Janzen and Carter, Reference Janzen and Carter, 2019; Vasilaky *et al*., 2019.

The insurance companies are mostly town based and have no networks in the rural areas for farmers to access the products from. 20.80% indicated WII was not consistent, 16.02% indicated it was complicated; 7.26% indicated it was too risk and 4.30% indicated it was expensive – all these issues are based on the design of the products, does it carry the smallholder needs, perspectives, risk profile to ensure all these fears are handled at design stage. On improving WII information, 91.21% indicated the increase in awareness campaigns through increase farmer sensitization and 4.88% indicated timely payouts of the payouts as this will act as a marketing tool itself. If timely payouts are done the good information will quickly spread to most of the farmers thereby encouraging uptake of WII. Basis risk is a major issue with WII 16.21% indicated that clear information on the basis risk will help the farmers understand WII and up take WII. This is agreeing with several studies.

Most non- participants in crop insurance lack understanding of the insurance products (Gine´ et al., 2008) and, as Garrido and Zilberman (2008) rightly point out, the non-awareness of the benefits from crop insurance may limit farmers' participation in these programs. The general level of trust, may be associated with farmers' trust in receiving payments from insurance agents in the event of crop failure, is expected to have a positive effect on farmers' willingness to participate in the insurance program.

Most of the farmers under the government Farmer input support programme (FISP) indicated they did not understand clearly the payout systems and indeed 17.97% farmers indicated that whilst 19.82% indicated they were conversant with payout system through the MoA. 5.76% indicated they were using the cooperatives to get their payouts and only 1.78% indicated they were using the insurance companies' payout systems directly to them. Without clear payout systems to farmers' uptake will be compromised. The fears of the farmers to invest their little resources into the system they do not trust is a nightmare.

On the percentage distribution of WII knowledge among participants, the study revealed summarized statistics below and its analysis: 38% of the farmers indicated they received some information on WII whilst 62% of farmers indicated they did not receive any information on WII. The trouble is that most of the farmers were part of the government farmer input support program. One would expect that the majority of farmers got the information through the

government and private sector information channels, but the study indicated otherwise. Information and communication dissemination strategies is needed such as through the community radio stations, pictorial brochures, televisions, community promotion and advertising meetings and most importantly feasibility studies to understand the underlying causes. Literacy is not only important in order to know about insurance but also to correctly understand insurance contracts. When farmers are not able to understand concepts like basis risk, demand remains low (Stoeffler & Opuz, 2020).

Education and information tend to run concurrently. While insurance providers might not change the literacy skills of the farmers, they can provide more information. The evidence shows that where information has been provided, farmers and pastoralists increase their understanding of insurance as well as demand (Patt *et al*., 2009; Lybbert *et al*., 2010; McPeak *et al*., 2010; Takahashi *et al*., 2016; Belissa *et al*., 2019; Vasilaky *et al*., 2019; Ali *et al*., 2020a). Information might be provided through games (McPeak *et al*., 2010; Vasilaky *et al*., 2019), information brochures (Takahashi *et al*., 2016), or training sessions (Dercon *et al*., 2014).

On the percentage distribution of how the participants knew WII, the study revealed summarized statistics below and its analysis. 69.70% knew insurance through the FISP from the MoA where this has been used as an aggregator. 13.64% indicated they knew WII through fellow farmers which is a good thing for the rural communities as they trust their fellow farmers more this will have risk of misplacements of facts of the system. Insurance companies are extremely important in making uptake of the product enhance with the farmers as they are the ones at the center of the innovation. However, for this study only 9.85% of the farmers knew through insurance companies. This means the companies are doing very little to promote WII to the farmers in the rural areas. In fact, most of the companies were not even known by the farmers even when they were part of the FISP WII project. The media, which include televisions, print media only 9.34% of the farmers new WII through them. Media is key to disseminate the information of WII which should be used for example phone discussion program at local radio station in local language will allow farmers to learn about WII equally with the print media. Therefore, it seems that a functional insurance market can facilitate adaptive capacity as the various risk management stakeholders contribute different areas of expertise. This combination of knowledge creates a more detailed understanding of where and

how the disaster impacts materialize, which would not be available if stakeholders were not encouraged to act in concert (Slavková *et al.*, 2020).

On the awareness and utilization of WII by participants, the study revealed summarized statistics below and its analysis. From the study on the use of WII, 77.02 indicated they did and 22.98% had not. Exposure needs to be consistent to nudge demand. Previous experience also matters in that farmers who have previously insured are more informed and hence more likely to purchase insurance again (Karlan *et al*., 2014; Castellani and Viganò, 2017; Belissa *et al*., 2019). This is largely to the FISP program that government is piloting the product through which is a compulsory initiate for all the farmers on the program.

On whether the farmer received any training or orientation from the MoA 83.20% indicated they did not and only 16.80% received some training and or orientation before paying the premiums. In terms of the training that the farmers are receiving 11.82% if coming from the MoA extension staff, 3.61% from the insurance companies, 1.17% from the input firms which is important though very low engagements and 0.39% from the NGOs – one could expect donor could have been used much more around training to the farmers rather than on subsidies. 2.25% indicated they got training from fellow farmers which may have risk of missing the correct information.

On the percentage distribution of reasons why participants did not know about WII, the study revealed summarized statistics below and researcher' analysis. About 73.1% indicated information was not available for them to make decisions to either uptake or not. From the results, the information gap was the major reason farmers felt they didn't adopt WII. The diffusion theory clearly indicates that knowledge is the first step even before the influence of the technology characteristics influence the farmer's decision. Distrust in insurance products and insurance providers reduces agricultural insurance demand among farmers and pastoralists (Patt *et al*., 2009; Suarez & Linnerooth-Bayer, 2010; Karlan *et al*., 2014; Tadesse *et al*., 2017). Low trust is partly related to education and inadequate knowledge and information about formal insurance. Farmers are therefore not able to understand how new technologies such as insurance work (McPeak *et al*., 2010; Bryan, 2019).

On the distribution of participant's who were trained (capacity building and training), the study revealed summarized statistics below and researcher' analysis. From the study 84.18% farmers were not trained on WII by the various stakeholders that included the government extension

and insurance companies and only 15.82 were trained. This raises a lot of questions on how the program is running. WII is just mentioned to farmers during the process of FISP registration and not necessarily consistent training to farmers. Uptake by farmers with this low extension training to farmers will be compromised.

On the percentage distribution of insurance companies' participants were insured with, the study revealed summarized statistics below and researcher' analysis. The percentage number of participants insured through Mayfair was found at 2.25%, Pula insurance 0.22%, professional insurance 0.07% and NGOs indicated 1.57%. 95.2% of the farmers do not receive any training from the insurance companies and only 4.8% received training. This is a worrisome situation for product adoption.

Insurance companies are key in changing the mind-set, promotion, and adoption of WII by smallholders' farmers. Intensive interactions between the insurance companies are necessary to allow the farmers to understand the products clearly. WII is a new financial instrument very necessary today as a response to challenging weather and edging risk associated with it. Distribution channels are well-positioned to participate in educational efforts, as they interact with farmers regularly. However, in some cases, aggregators' agents have little knowledge about index insurance concepts. In other cases, they may understand index insurance but fail to convey information understandably to a target audience that is unfamiliar with this service.

A functioning insurance market can contribute towards creating a more adaptively capable society by acting as an information generation and dissemination platform. For example, insurers require diverse portfolios of policy holders who undertake different strategies for extreme weather event risk management. The insurer can aggregate these experiences and see which measures are more likely to be successful and can share this information with policyholders. Additionally, a functional insurance market can facilitate adaptive capacity, as the various risk management stakeholders contribute different areas of expertise. This combination of expertise creates a more detailed understanding of where and how the disaster impacts materialize, which would not be available if stakeholders were not encouraged to act in concert (Slavíková, *et al*., 2020).

In some case, the political buy in have been cited as another reason that trigger the uptake level of WII insurance in some developing countries such as Bangladesh , Angola and Kenya(Global Hunger Index, 2021; Janzen *et al.*, 2021). It, therefore, requires and calls for different

practitioners in the sector to re-think the workable solutions that offer continued hope for smallholder farmers to increase their agriculture production and productivity while mitigating the challenges of climate change.

On testing the theory of innovation diffusion if it applied in explaining the uptake of WII using a bivariate analysis with baseline characteristics analysis, the study revealed summarized statistics below and researcher' analysis. The study results showed that, there was no association between utilization of the WII and age groupings, even if it shows that the majority who utilized WII were of the age grouping between 36-50 years 137(44.92%) compared to 31(34.07%) who did not utilize. Those who were above 50 years of age, and utilized WII were 99(32.36%) while those who did not utilize were 39 (42.86%). However, the differences in the age groupings and utilization of the WII were not significant p=0.234.

For gender, there were more males 237 (77.70%) that utilized WII compared to females 68 (22.30%), despite there was no significant association between gender and utilization of WII p=0.875, suggesting no evidence of significant differences. Across education level, the findings show that, most of the users of the WII were those attended primary school level, 158 (51.80%) followed by those who attended secondary level of education 107(35.08%), those who did attend any education were 15 (18.89%) as the minority. However, there was no evidence of significant association p-0.975. Marital status shows that, most of the participants who used WII were monogamously married 208 (68.20%) compared to those who were single, 57 (18.69%) and polygamous married 40 (13.11%). Marital status had no significant association with utilization of WII p=0.585.

From the study the baseline characteristics had not much influence on the uptake of WII. This is not consistent with many studies that indicate age, education has positive influence on the uptake of technologies. However, from the group discussions and interaction with the farmers, those that had reached tertiary education were more knowledgeable about WII and participated or engaged with the insurance companies.

On the technology characteristics using bivariate analysis – utilization (trialability, relative advantage, compatibility, complexibility, observability), the study revealed summarized statistics below and researcher' analysis. From the results obtained it clear that adoption of WII has a relation with the characteristics of the technology 50.82% of the farmers that utilized WII indicated that it was not consistent with p-value of <0.001 which indicated very strong

relationship between WII adoption and its advantage in terms of consistence. Similarly, the payment systems where not clear to the farmers as the relationship between the farmers and the insurance companies was not there but the systems where between the Ministry of agriculture in terms of the source of payment systems with the P-value of -,0.001c indicting strong relationship as opposed to p-value of 0.068 through the insurance companies indicating very weak relationships with the farmers in-terms of an established and transparent payment systems. Similarly, the farmers indicated 0.001f p-value indicating a stronger relation amongst farmers as opposed to the insurance companies indicating a totally weak system with the insurance companies themselves in the eyes of the farmers. A clear and transparent payment system driven by the insurance companies is more appealing to that farmer and hence may attract more farmers. In as long as the payment system seem to be complicated the farmer adoption is highly compromised just as the theory of technology adoption is indicating. Insurance requires an up-front payment by a customer to obtain a state-contingent—uncertain—claim that would pay out in the future. Trust in the insurer is therefore an important consideration in a customer's decision to purchase insurance. In addition, insurance is complicated, and trust also increases confidence in the fairness and usefulness of a policy (cloe-ET-2013)

The study as well indicated that 76% of the farmers indicated the need for increased information of WII which is critical if farmers are to appreciate and understand the WII. Lack of increased information has implications of farmers failing to understand firstly the benefits of WII, access, how it is used, what parameters WII considers, how other farmers have utilized WII and the cost structures making it difficult for sound decision for farmers.

The study established huge gaps in terms of information on WII. Regardless of the government driven supported program that interacts with farmers, only 49.84% farmers indicated receiving information from the ministry of agriculture camp officers and indeed not even WII focused information. 91% farmers indicated the need to improve WII and that there was need to increase information provision to the farmers As the adoption theory indicates for the farmers to adopt the technology demonstrated experiential learning, demonstrated information provision , information of clear operative systems are extremely important if farmers are to adopt the technology 33% of the farmers indicated that there was no clear know payment system to the farmers which raises a lot of doubt for the majority farmers more especially the

vulnerable farmers who are the target for such programs making them completely or impossible to adopt WII. 63% of the farmers indicated that WII was a complicated system that makes it difficult for them to adopt though the relationship with adopting was weak with a p-value of 0.681 which brings in the social dynamics and or the lack of clear understanding of information. Clearly the farmers need to understand the technology characteristic if adoption is to be enhanced. The process needs to take a process of pursuing strategies that allows the farmers learn, understand, try, or experiment, believe, and finally buy -in the technology.

On the technology characteristics analysis utilization (trialability, relative advantage, compatibility, complexibility, observability), the study revealed summarized statistics below and researcher' analysis. From the result 49.13% farmers indicated they were not satisfied with WII, 33.11% partially satisfied and 2.3% very satisfied with p-value of 0.0001 that indicated a greater relationship with adoption of WII. This is indicating that for the farmers to adopt and uptake WII, it must demonstrate real benefits that are addressing the farmer needs. Many households may not be aware of the monetary cost of their production risk, making the appeal of WII unappealing to them it appears that many families have never been exposed to this way of thinking (Wigwe *et al.,* 2021). If the advantages are not experienced by the farmers, this proves the theory of adoption that the innovation should have relative advantage for the farmers to adopt. If only 2.3% farmers saw benefits and 49.13% never saw any benefits adoption of WII in Zambia will take several years. This agrees with the theory of technology diffusion. However, 78.69% of farmers indicated that they did not see any benefits from the payout they got. Most of the farmers indicated the payout was not sufficient to cover their resources and that they were given at the wrong time of the season, meaning they could not re-invest into agriculture production. This has serious implication for the farmers to adopt any technology including WII regardless of the incessant failure of weather patterns.

Influence around profitability of WII with the p-value of <0.0001 demonstrate the stronger relationship between adoption of WII and the perceived profits and or benefits the farmers will get because of buying WII. If this is not clearly demonstrated adoption of innovations is next to impossible. 33.49% of farmers indicated that compared to other insurance packages WII is very poor agreeing with the status core of poor WII adoption in the 4 districts. The technology characteristics needs to demonstrate relative advantage over the other offerings for the farmers to willing adopt the innovation. WII insurance to farmers becomes very ideal for example this must be a package that include information, inputs, offtake markets or commodity markets as

bundled service providing a well-rounded solution to the farmers. From the study results 40.00% of the farmers indicated the need for bundled services with a p-value of <0.001 indicating strong relationship of uptake of WII. The solution needs to take care of inputs and offtake or commodity markets that would help the farmers build confidence to invest into WII. Agricultural insurance can be combined with other products or services. (Carter *et al*.,2016) made a theoretical case for combining insurance with other services such as credit (often referred to as bundling), suggesting it as one of the ways to make insurance popular. Insurance can be combined with credit services (Giné & Yang, 2009; Meyer *et al*., 2018; Ahmed *et al*., 2020) or inputs such as drought-tolerant seeds, high yielding seeds or fertilisers (Leblois *et al*., 2014b; Lybbert & Carter, 2015; Awondo *et al*., 2020; Visser *et al*., 2020).

Government policy on adoption of WII indicated a p-value of 0.0001 which indicated significant need for the policy holder's government and ministry of agriculture in this case to provide clear policy direction on WII in the agriculture sector and specifically the smallholder markets which governments supports through the subsidized input support programs.

On the types of insurance purchase and stakeholders influence (effects of capacity building /training), the study revealed summarized statistics below and researcher' analysis. From the study results, we could see that training done by the insurance companies and the MoA of extension system had some positive influence on the farmers with P-values <0.0001 and 0.002 respectively that are below 0.005. This is in line with and consistent with other studies that indicate training as a key driver for uptake of WII. However, the influence of the input companies is crucial though from the quantitative results indicate not significant, from the group discussions with the farmers indicated that having the inputs companies participate in the trainings of WII would make them have access to inputs, increase the value of their risk portfolio and therefore would increase their appetite to cover the valuable inputs that may include fertilizers, seeds and agro chemicals. WII training to farmers is costly and the donor resources should be used to leverage this cost by investing more in trainings than on premium subsidies which has been the case for most of the pilot programs. The influence premium subsidies on uptake of WII appears not as was expected. Many farmers continue to depend on the subsidy programs as opposed to uptake WII by themselves. The scale continues to be based on the subsidy programs which is supposed to be just for demonstration purposes to allow the farmers taste the technology and see many more farmers adopting and replicating it by

themselves. Understanding household and community systems and how they interact with each other and other systems can be important for achieving development objectives (Dean Hunter, 2018; Fogelberg & Psi, 2020).

On the analysis of the key constraints influences to uptake; the study revealed summarized statistics below and researcher' input analysis. Climate exerts a profound influence on the lives of rural populations, particularly the rural poor, who depend on agriculture for livelihood and sustenance, who are unprotected against climate-related diseases, who lack secure access to water and food, and who are vulnerable to hydro meteorological hazard. Climate shocks such as drought and flooding lead not only to loss of life, but also long-term loss of livelihood through loss of productive assets, impaired health and destroyed infrastructure. The uncertainty associated with climate variability is a disincentive to investment and adoption of agricultural technologies and market opportunities, prompting the risk-averse farmer to favour precautionary strategies that buffer against climatic extremes over activities that are more profitable on average. Weather index insurance is one of several promising interventions for overcoming the negative impacts of climate risk on rural livelihoods and food security. This coupled with a lack of markets for both inputs and outputs, market information and most importantly extension services. Though quantitatively the key constraint did not show the strong relationship, qualitatively they indicated these key constraints were very significant for the farmers to adopt and uptake WII.

At a group discussion in the Choma district of the southern province in Macha village, respondents indicated that they did not know how the payout system works. According to the respondents, payouts were not enough and did not match the timing of the farming season. *Yes, 'payouts should be explained to us, the farmers, how they work because what we expected from the WII investment did not come true'.* Similar views came out in the Mumbwa district.

On information, some farmers in Mupengu village in Choma district indicated that insurance companies should train more agents that include headmen and lead farmers in the community to sensitize more farmers beyond the FISP farmers. *'We used WII on FISP without knowing it embedded weather index insurance in it'.* Farmers suggested that WII should be run independently and not embedded in the government's FISP system.

Anomalous farmers in Nagoma and Mumbwa indicated that the cooperatives were a good model to receive payouts, information, and training. One farmer at the meeting in Chongwe

said that he had just heard about WII at the group discussion. Further, the farmers in the Petauke group discussion indicated that beyond WII, farmers are supposed to be supported with other services such as output markets and credit facilities. Lastly, in all the districts, the farmers indicated that WII insurance should be promoted through intense promotions, monitoring by the insurance companies in the communities, and having commercial access points locally through the agents and lead farmers.

5.3 Objective 3: To develop a model that will enhance the diffusion of WII by smallholder farmers.

On the recommending a model that enhances the Uptake of WII in the Agriculture Sector by Smallholder Farmers, a model of the multivariable analysis was first used. The study revealed summarized statistics below and researcher' input analysis. Results for a full model of the multivariable analysis of factors associated with utilization of WII among participants in Choma, Petauke, Chongwe and Mumbwa from the study findings adjusting for all variables such as age, gender, marital status, education background to mention but a few, those who were paid through corporative had 6.39 odds more than those who paid through MoA and other payment modes, the estimates could be as low as [1.16-35.14, 95% CI; $p<0.033$] suggesting enough evidence to argue that those who paid through cooperatives had a significant high chance of utilizing WII than those who paid through other modes of payments. Whereas the odds ratio of using WII for individuals who claimed to know controlling for other covariates was approximately (7.11; 95% CI, 2.18, 20.30; $p<0.001$) Participants who stated it was easy to use WII were 7.11 more likely to use WII services than participants who said no, with a range of 2.18 to 28.21 at 95% confidence intervals (CI). This finding provides sufficient evidence that people who find WII easy to use are more likely to use WII services.

On the select the best models, or the best predictor model, the Akaike information criteria and Bayesian information criteria were used. The study revealed summarized statistics below and researcher' input analysis. The study found AIC with 437.1 and BIC with 356.4, thus the BIC was used to select the model as it had the smallest number. This is because the smallest value shows little variance in predications.

On the predictors of utilization, the study revealed summarized statistics below and researcher' input analysis. A few variables were selected, which were significant in a full model. Adjusting

for other factors, participants who said it was easy to use WII was 14.52 more likely compared to those who said no, of which it could be as low as 7.34 to as high as 28.73 at 95% CI, $p<0.001$, suggesting enough evidence that one who finds it easy to use WII is likely to utilize WII services. Those who said yes, they paid through corporative, were 3.66 more likely to use WII compared to those who said no, and the estimates could be as low as 1.19 and as high as 11.23 at 95% CI, $p<0.024$. While those who said they had knowledge adjusting for other variables had the odds ratio of utilizing WII of about (1.13; 95% CI, 1, 03, 1.32; $p<0.047$).

5.3.1 Proposed WII Model

Proposed framework emerging from the study findings, the researcher constructed the conceptual model to be adopted in understanding diffusion of WII uptake among smallholder farmers in Zambia. WII will keep struggling to attract the smallholder uptake of the innovation. This is because of several reasons that need a collaborative strategy to attract the farmers' appetite to invest into the product. From the study three critical areas are deduced that need consideration if uptake is to be enhanced.

i. The distribution channel which suggested the cooperative model was a better channel for farmers to access the product as well as the payout.
ii. Access to information and awareness was significant for uptake of WII.
iii. The easiness of the product for the farmers to use was another factor for consideration.
iv. Theoretical considerations that included the diffusion technology characteristics that need and call for persuasion, perceived needs, stages of technology adoption by different sectors of the farmers laggards, early and late adopters, perceived usefulness, consideration of the social systems, knowledge, communication, perceived ease of use.

Taking into consideration these four factors, theoretical consideration and other insights and observations from the study this model has been suggested. The illustration is framed below on figure 38. The stakeholders' responsibilities are illustrated.

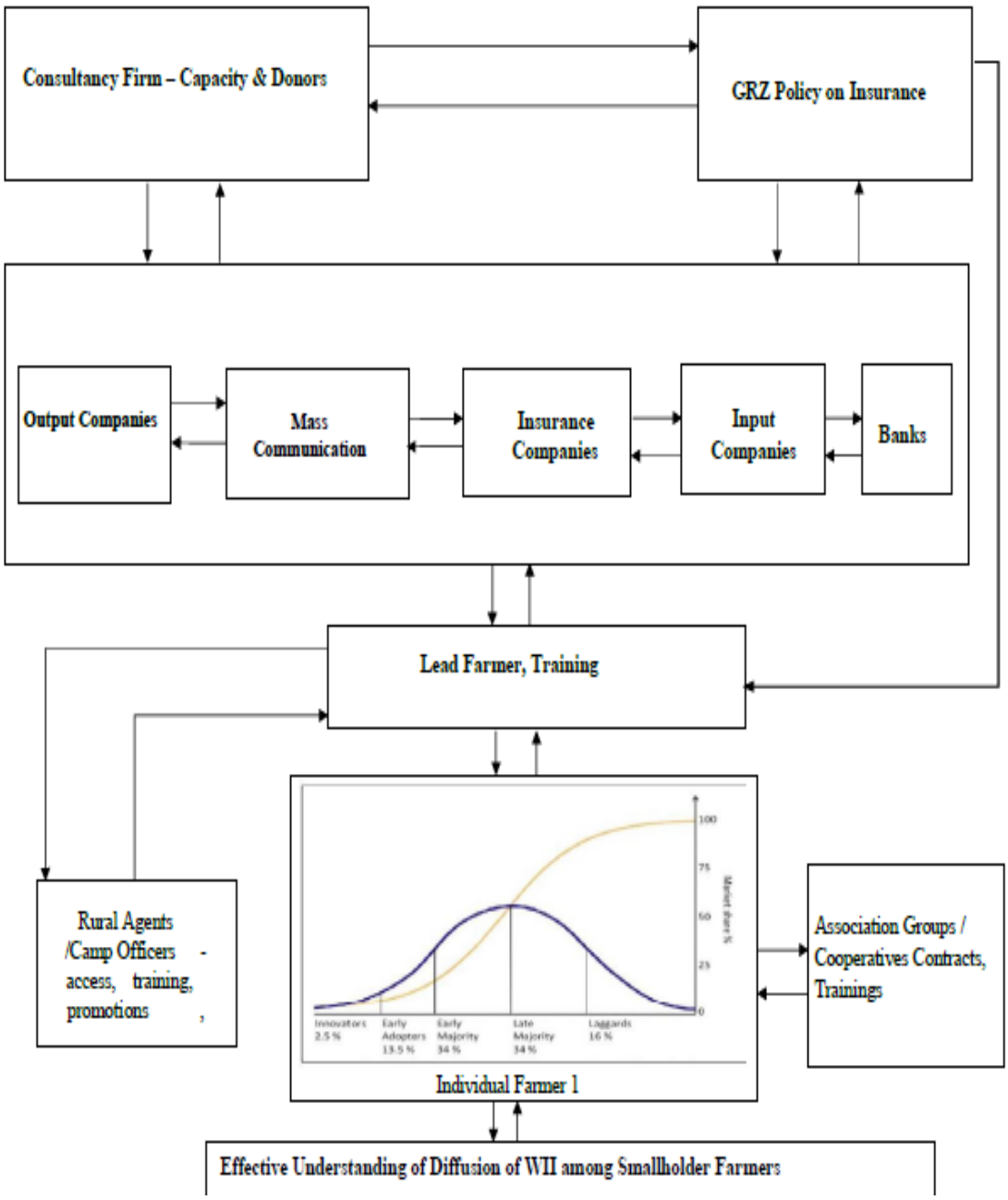


Figure 5. 1: Proposed Model.

Figure 5.1: Proposed Model Emerging from the study. **Source:** Author' WII framework.

In considering the frame for diffusion of WII among smallholder farmers in Zambia, several stakeholders must be recognized. Stakeholders must be engaged in the decision-making process. This will strengthen and provide the support for long term sustainable development.

The Zambian government must recognize the importance of insurance arising from the day-to-day agricultural risks. The Zambian government must identify the stakeholders in the agricultural insurance. The following have been identified. The donors, consultancy firms, mass communication institutions, input companies, output companies, insurance companies and banks. Others include lead farmers, Association Groups / Cooperatives; and rural agents /camp officers among others. These stakeholders will impact the farmers' diffusion process.

5.4 Objective 4: To demonstrate an implementation plan for the proposed model.

The Zambian government is the first stakeholder in the diffusion of WII. The government must first provide an enabling environment in the country. The government must set up a system of policies and tools right once to encourage private sector investment in the industry. To protect both businesses and farmers, there should be legal frameworks for insurance. The focus should be on advancing the distribution channel through innovation, with limited reliance on the extensive premium subsidy schemes. However, some research contends that subsidies aid in the earliest stages of a product's demonstration to let farmers evaluate it.

The government, in setting up a system of policies and tools right to encourage private sector investment in the industry, it needs to have an input of donors, consultancy firms among many. Their input is more important for various reasons. Once the policy is pronounced by the government, many institutions will be interested in the policy document for various opportunities.

Institutions interested in the policy document for various opportunities are mass communication institutions, input companies, output companies, insurance companies and financial institutions as shown on the diagram. The mass communication institutions will be interested in news gathering and disseminating to the masses.

The insurance companies will provide capacity-building organizations that should focus on product creation, adaptive research that is market-oriented, and capacity-building to the stakeholders (government, input insurance, banks, and off takers). As a result, the stakeholders will feel more confident and be able to boost their investments in the insurance markets, as most businesses might not be aware of insurance products or how to incorporate them into their company plans, including insurance providers who might view the customers.

These level of insurance companies, input companies, financial institutions, offtake markets (meso level). A collaborative strategy -Farmers would feel more confident investing in WII if different stakeholders worked together to recommend packaged services to them. According to research in the literature review, providing farmers with additional services like finance and fertilizer increases their desire to participate in WII. A well-organized commodity market, for instance, could have a big impact thanks to things like the warehouse receipt system, structured markets, and derivative markets, which would entice banks and input suppliers to invest due to the secured arrangements. Farmers would then easily purchase WII products to protect themselves from unpredictable weather. If WII adoption is to increase, the market functioning is crucial. Diffusion theory, according to simply Rodger (2003), suggests diffusion theory suggests the innovation or technology needs to have relative advantage for it to be adopted. The pull and push effects need to be present on the markets (supply and demand concepts)

Once the mass communication institutions, input companies, output companies, insurance companies and financial institutions have taken their roles from government policy on insurance and provided the enabling environment, the uptake of WII should begin by considering the micro level where the farmers are and the support systems that exits at this level. At micro level-rural based, first clients considered are the lead farmers, general farmers, agents, agricultural camp officers. The lead farmer structure, private sector agents stationed in the communities, government agriculture camp officers, and farmers themselves. These stages interact directly with the farmers and, in some cases, continue to do so, which helps to increase the farmers' credibility. Farmers may need some time to develop confidence in a product that is purely being marketed by people outside of their local community who are seen as acceptable. These buildings may connect with farmers in a natural way to provide information, demonstrations, capacity building, and confidence building. The majority of investments should go toward increasing this level's capacity for a variety of innovative and supportive business partnerships, both financial and non-financial. Input aggregation, offtake, and other services can be connected to these structures.

Secondly, at micro level, clients considered are farmer aggregation into farmer groups, cooperative or possibly associations. For WII adoption, farmer aggregation becomes crucial. It becomes crucial to invest in and identify organizations that can serve as conduits for delivering insurance goods. Individual centered insurance strategy for the farming community is costly

especially in a country like Zambia with a sparsely population especially the rural areas. The individual target of individual farmers becomes very costly and unsustainable only can last as long as subsidy support programs exist without which can never be attractive. The cooperatives, farmer groups, and/or associations can function as aggregations for trainings, awareness-raising campaigns, marketing campaigns, premium payment systems, payment systems for inputs, finance (credit), and offtake aggregations that would give farmers stable markets and increase their confidence. However, the groupings should choose themselves to be depending on the need for sustainable engagements with agriculture markets. Wrong cooperatives that are focused on handouts will not add any value to the uptake of WII.

As a result, this level will interact and engage with the various service providers to ensure that insurance is included in their offers. It should be noted that this has already been attempted, albeit with improperly motivated partners who frequently lacked expertise in WII goods and services. In this situation, a team made up of many stakeholders would need to continuously increase this structure's capability for it to be responsive.

Once all the above-mentioned institutions have taken their roles, vis a vie government, consulting firms, donors, mass communication institutions, input companies, output companies, insurance companies and financial institutions, lead farmers, private sector agents stationed in the communities and government agriculture camp officers; smallholder farmers will adopt WII. By this way, effective understanding of diffusion of WII among smallholder farmers will be enhanced.

5.5 Summary of the chapter

This chapter discussed the research findings from the questionnaires, supplemented by qualitative findings from key informants in relation to the research objectives which were presented earlier in chapter one and provided a contextual analysis of the findings. It discussed the various kinds of problems experienced by smallholder farmers in the uptake of WII. This was in relation to pieces of previous research done, coupled with the rendering of a critical appraisal from the researcher’s field observations. This was coupled with a discussion on the significance and limitations of the study. The chapter depicted both the descriptive results and quantitative results interpretations and discussions. It is clear this study needed a mixed approach to ensure quantitative statistics in some cases are supplemented meaning from the qualitative data that was collected. The study was complicated as most of the participants in

the WII were from the government WII support program which a compulsory arrangement to the farmers this meant in some cases the farmer did not really decide to purchase WII as such could not be well informed about the product hence qualitative method was able to pick these scenarios during the group and individual discussions with farmers. key determinants of the uptake of WII is the clear pay out systems that should be easy to use by farmers, access to information, correct payout channels such as the cooperatives that are already compatible with the local systems. Hence from these findings, this agreeing with the theory of technology diffusion that every innovation should consider the 5 variables -trialability, compatibility, complexibility, relative advantage and observability.

Lastly, the researcher constructed the conceptual model to be adopted in understanding diffusion of WII uptake among smallholder farmers in Zambia. The chapter that follows discusses the conclusion and recommendations of the study.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Overview

This chapter provides the conclusion and recommendations of the study. The conclusion strives to confirm the final status of the study viz-a-vis the problem statement that was earlier set out. This is by evaluating the findings of the study in relation to the research questions. Thereafter, the study puts forth recommendations for policy action and suggestions for future research.

6.2 Conclusions

Understanding the reasons why smallholder farmers do not use financial instruments to protect themselves against losses brought on by climate change concerns is currently a subject of rising relevance. Getting to the bottom of the underlying issues contributing to this status is important for future designs of financial innovations like a weather index insurance (WII) that can help farmers hedge their losses. Therefore, this study considered testing the 5 technology characteristics that Rodgers identified for uptake to take place.

Regardless of various interventions by various stakeholder's vis a vie government through the Ministry of Agriculture and private sector interventions in the insurance industry, since the introduction of WII, the diffusion of WII among smallholder farmers is by far below expectations in the target districts sampled. This has been confirmed from various sources during the undertaking of the study. Both qualitative and quantitative data triangulated during the course of the study confirmed the low diffusion of WII among smallholder farmers through various technology characteristics analysis utilization vis a vie trialability, relative advantage, trialability compatibility, complexibility and observability.

In drawing conclusions from the first technology characteristic called trialability, it is important to highlight the fact that smallholder farmers have been experiencing various challenges in the diffusion of WII since its inception. Since such challenges are various, they are responsible for the broad or multifaceted nature of the problem of diffusion of WII. Such challenges have been partly the cause or reason for the undesired diffusion experienced.

In concluding a study on the understanding of the diffusion of weather index insurance among smallholder farmers in Zambia, barriers and challenges hindering the diffusion of weather index insurance were found to have slowed the rate of diffusion of weather index insurance.

This included issues related to awareness, trust, affordability, and many other factors identified in the research findings.

6.2.1 Relative Advantage

Farmers must understand the advantages of WII over other insurance products in order for them to adopt it. It is evident from the study that farmers can use WII because it keeps proving to be a true additional advantage in their farming operation. The necessity to package WII with other items like financing, inputs, and offtake marketplaces was mentioned by farmers.

6.2.2 Compatibility

Through the study, the farmers identified WII requirements that are compatible with the current commercial environment and should work with their farming operations. If farmers are to use WII, it is crucial to comprehend the farmer cycle and how it works. The payout stems must be consistent with the losses that the farmers actually endure. Farmers may not be interested in the product if this does not support the farmers' losses at the appropriate moment. For the farmers to understand the basis issues, they should be made simple.

6.2.3 Complexibility

Based on the findings and the farmers' first-hand accounts, adoption of WII must be included into the farmer's fundamental thinking. Project designs should include images of the farmers who will use them. In fact, farmers understood WII as a fairly innovative technology once explanations were given to them during the focused group discussion, but at first glance it might appear confusing**.**

6.2.4 Observability.

The study makes it obvious that farmers will need to learn about and experience WII in order for adoption to rise. For instance, it was evident at the local level that the farmers were unaware of their neighbors who went out and retrieved the losses. Farmers think that advancements should be felt and experienced**.** What the brain does not know cannot be seen or appreciated by the farmers. Visible clear benefits, experimental learning, cost benefit position and socially, economically accepted.

6.2.5 Trialability

According to the study, it's critical to bring innovation to farmers by giving them the opportunity to test it out, learn about it, and get a feel for how it functions. Because they were unaware of or had no experience with the program, the farmers displayed ignorance even though they were covered by the government support program FISP. Training demonstrates how crucial it is for farmers to embrace and value innovation.

The technology characteristics are important to consider enhancing uptake of WII for farmers Clearly, we cannot predict the future but can plan for it. The financial instruments such as WII need to be considered today as never before if marginalized smallholder farmers are to increase their agricultural production and productivity, and similarly if poverty in developing countries is to be managed. Weather index insurance is but one tool among many that can address the impacts of climate. However, at this point, the technology seems to respond to a range of concerns about agriculture insurance focused on smallholder agriculture production, such as cost issues, moral hazards, and the problem of scale.

Though government-driven incentives will support the uptake of the WII, this must be done carefully so as not to disturb the actual uptake by the farmers and jeopardize climate change mitigation strategies. The government's subsidy programs have pulled millions of dollars from WII programs. However, it appears the uptake of the WII technology is still way behind, and poor farmers continue to be exposed to extreme weather conditions, remaining in the poverty trap. If progress is to be made, inner drivers for the uptake of WII by farmers must be identified.

As much as cost is essential to WII uptake, information is critical in adopting technologies by smallholder farmers. Communication builds up farmers' confidence to invest in their production, including systems that can help hedge against losses for various reasons, including climate challenges. Capacity building programs need to be designed that are community-driven and led by private and public sector players, including insurance companies, agriculture input suppliers, government extension officers, financial markets, technology developers (ICT), and community agents. Finally, failure to develop a viable and commercially oriented insurance market backed up by innovations around the different challenges may hamper the uptake of the weather insurance index. We can conclude that innovations in financial markets have led to a renewed interest in the search for alternatives to help farmers in developing countries manage their risk exposure. Weather insurance is among the several proposals being suggested against

weather events. Therefore, it is essential to keep looking for suitable strategies that will allow and fit the farmers' expectations of the weather insurance index.

It appears regardless of the vulnerability appeal of climate change and the threats it presents; the uptake of WII is by far below expectation. It is clear and agreeing with the theory of innovation adoption that the technology characteristics as indicated by Rodgers matters if the farmers are to adopt the technology. From the findings, farmers' adoption of the innovation is dependent on information, seeing the benefits visibly, experiential learning, accruing benefits of the technology and having a well-rounded solution that allows for both inputs and offtake arrangements that builds in the confidence of farmers to invest into their own production. If the commercial mind is not developed, farmer adoption of technologies or innovations may remain a nightmare.

The technology characteristics appeal to the farmers is very critical for adoption. The study agreed with the diffusion of innovation theory by Rodgers though this will happen overtime in stages. However, we can suggest an addition consideration of the commercial markets' interactions to the theory. The farmers need to have or develop a commercial orientation for them to easily consider innovation uptake.

6.3 Recommendations

6.3.1 Farmer WII adoption Model suggested.

For increased farmer adoption of WII, the developed model is recommended for program and projects to utilize. The model emphasises the multi-player -multi function approach, aggregation models and information provision. The study strongly recommend the adoption of the model if uptake of WII is to be enhanced.

6.3.2 Regulatory framework

Index insurance needs a regulatory framework to provide standards for consumer protection. This framework should include standard insurance regulations, such as minimum capital-to-liability holdings requirements for insurer and reinsurers, clear index certification processes, and a process for speedy and accessible disputed settlement resolutions.

6.3.3 Responsive market engagements

i. A continuous approach of engagements that is based on market principles is required if companies involved in WII are to adopt and adapt this business. Donor dependent

approaches continue to disturb the organic growth of the innovation which is otherwise very important for the agriculture sector especially the majority poor farmers in sub-Sahara Africa and Zambia in specific.

ii. Education campaigns need to be aggressive and indeed persuasive enough to allow the farmers make decisions based on knowledge and not on handouts through subsidies that provided more especially to the poor countries. Knowledge should be the target rather than the handouts approach. It must be appreciated that the process of innovation adoption takes time and in stages.

6.3.4 Responsive distribution model

i. Farmer social networks and farmer organizations – this is an important aspect if farmers are to adopt technologies -well organized and aggregated farmers are easily reached. Though the cooperatives around the farmer input support program supported by the government of Zambia have not proven this case.
ii. The aggregator model is recommended as way to easy the operation of the projects as well as aggregating leveraging learning, capacities and attaining economies of scale.
iii. Group or cooperative model for the farmers is recommended to make the operations and resolve the challenge of individual claims that are a nightmare in the current situation of non-availability of proper historical data.

6.3.5 Donor support

Donors and government should invest their resources more on understanding the underlying cause of non-adoption of WII rather than on premium subsidies. Incentive mechanisms that encourage farmer's participation should be included with caution without creating dependence syndromes of the farmers.

6.3.6 Policy direction

The government should rethink and reconsider the strategies around climate change mitigation, particularly WII strategies. Earlier pronouncements were helpful, but more needs to be done if smallholder farmers are to value WII. This is the cheapest option that would allow poor farmers to mitigate their weather risks.

6.3.7 Private sector and insurance companies

The industry players are not doing much with farmer engagements on WII, and they need to develop a model that should be responsive to the farmer's challenges and needs. What kind of incentives should the private sector push to allow smallholder farmers to uptake WII? The challenge is clear. A multiplayer, multi-functional approach will be required to promote WII to poor rural farmers. It involves a basket of measures that include policy interventions, farmer incentive structures, and market incentive measures that should drive private sector insurance companies, input suppliers, and public sector support systems such as extension services. It is crucial to consider market-led incentive mechanisms to support farmers' understanding of the opportunities amidst climate change challenges.

6.3.8 Risk Assessment

Detailed risk assessment has been done in the past, but there is a need to update and appreciate the current risks more, especially with the continued weather challenges vis-a-vie farmer uptake of WII. Consideration for the multi-year facility for the farmers is necessary to carter for the different assessments and weather outlook of the country. Recommendations are supposed to be specific to the regions.

6.3.9 Capacity holding of the system. -Technical consulting

Trainings and capacity issues are essential if farmers are to use WII. To assist the various stakeholders in terms of technical capacity and ability to execute WII, special purpose institutions such as consulting firms must be in place. All stakeholders, including farmers, will be included in the design, critical analysis, and implementation processes under the direction of the technical capacity**.**

6.4 Validation

The study employed a mixed method in which it combined qualitative and quantitative data. Although it was a mixed method, it leaned more toward qualitative research. The enumerators that were used were those residing in the study districts of Choma, Mumbwa, Petauke and Chongwe who were familiar with the topic under investigation. It therefore followed that before data collection, the questionnaire was tested to take out any parts that were wrong. After that, a quantitative questionnaire was given out and analysed with the SPSS package to make sure it was valid and consistent. Also, the quantitative data was combined with qualitative data

from focus group discussions and key informants to get a complete picture. The researcher trained, prepared and participated in the entire process with the enumerators. Additionally, the results were presented at the first Australian international conference held on December 20-21,2022 and the 1st BASC international research "fostering adaptability and excellency in research and innovation among the pandemic" December 2021 conference where they were criticized by many scholars. The corrections and comments from the conference's proceedings were added to the study.

From this study results the process of uptake of technologies need to consider the characteristics of the innovation or technologies as prescribed by Rodgers 2003. This forms the basis and foundation for uptake of technologies, the five variables all indicated positive influence on farmers' decision making to uptake WII. However, personal factors, characteristics of the innovation, and influences of the individual's context will all shape the ultimate decision and persistence with a technology. Information is key in the process of innovation uptake across gender, age, and education. What the brain does not know cannot be seen or appreciated by the farmers. Visible clear benefits, experimental learning, cost benefit position and socially, economically accepted.

6.5 Future suggested studies

From the study gaps, there is need for future studies to focus on.

1. Increased empirical evidence for the status uptake of WII in Zambia by farmers (Quantitative study).
2. Concentration on the underlying factors that should allow private sector investment in market development for WII in Zambia.
3. Market systems driven influence on the uptake of WII in Zambia -systems dynamic analysis.
4. What are some of the cultural aspects hindering uptake of WII -qualitative research?
5. Suggest a study ethnography study to understand the farmer perspectives on technology adoption.

6. Is the policy environment right on index insurance?

6.6 Summary of the chapter

The chapter captured the conclusion and recommendations of the study, suggesting further areas of research. The uptake of WII is still low in most developing countries, including Zambia. This chapter has provided future areas of consideration for WII uptake in Zambia. The model provided is key to helping the farmers uptake WII. Similarly, the model can help the government and the private sector increase participation and influence the uptake of WII. According to these study results, the process of uptake of technologies needs to consider the characteristics of the innovation or technology as prescribed by Rodgers (2003). This forms the basis and foundation for the uptake of technologies; the five variables all indicated a positive influence on farmers' decision-making to uptake WII. However, personal factors, characteristics of the innovation, and influences of the individual's context will all shape the ultimate decision and persistence with a technology. Information is key in the process of innovation uptake across gender, age, and education. What the brain does not know cannot be

REFERENCES

Abugri, SA, Amikuzuno, J., Daadi, E.B. (2017). Looking out for a better mitigation strategy: smallholder farmers' willingness to pay for drought-index crop insurance premium in the Northern Region of Ghana. Agriculture and Food Security 6, 1–9.10.1186/s40066-017-0152-2CrossRefGoogle Scholar

ACRE Africa (2020). Our products: Picture based insurance (PBI). Available at https://acreafrica.com/our-products-picture-based-insurance-pbi/.Google Scholar

Aditya Chaturvedi. (2020). How satellite imagery is crucial for monitoring climate change

Akter, T.,Kruprik, Rosi,K.(2016).The influence of gender and product design on farmers' preferences for weather-indexed crop insurance https://doi.org/10.1016/j.gloenvcha.2016.03.010

Aheeyar, M., Sanjiv, F., Niroshini, D. (2021). Can Weather Index Insurance be a win for all?

Ahmed, S., McIntosh, C., Sarris, A. (2020). The impact of commercial rainfall index insurance: experimental evidence from Ethiopia. American Journal of Agricultural Economics 102, 1154–1176.10.1002/ajae.12029CrossRefGoogle Scholar

Allen, J.E, IV (2018). Are agricultural markets more developed around cities? Testing for urban heterogeneity in separability in Tanzania. Food Policy 78, 199–212.CrossRefGoogle Scholar

Ali, W, Abdulai, A., Mishra, A.K. (2020 *b*). Recent advances in the analyses of demand for agricultural insurance in developing and emerging countries. Annual Review of Resource Economics 12, 411–430.CrossRefGoogle Scholar

Ankrah, D.A., Kwapong, N.A., Eghan, D. et al(2021). Agricultural insurance access and acceptability: examining the case of smallholder farmers in Ghana. Agric & Food Secur10, 19 . https://doi.org/10.1186/s40066-021-00292- y

Arthur, K. N. A. (2017). The emergence of financial innovation and its governance-a historical literature review. Journal of Innovation Management, 5(4), 48-73.

Amadou, B. (2021). Market Efficiency Theory in African Markets. Young African Leaders Journal of Development, 3(1), 34.

Aslam, F., Hunjra, A. I., Ftiti, Z., Louhichi, W., & Shams, T. (2022). Insurance fraud detection: Evidence from artificial intelligence and machine learning. Research in International Business and Finance, 62, 101744.

Appiah-Twumasi, M., Donkoh, S. A., & Ansah, I. G. K. (2022). Innovations in smallholder

agricultural financing and economic efficiency of maize production in Ghana's northern region. Heliyon, 8(12).

Awondo, S.N., Kostandini, G., Erenstein, O .(2020). Multi-site bundling of drought tolerant maize varieties and index insurance. Journal of Agricultural Economics 71, 239–259.CrossRefGoogle Scholar

Balafoutis, A., Beck, B., Fountas, S., Vangeyte, J., Van Der Wal, T., Soto, I., Gómez-Barbero, M., Barnes, A., Eory, V. (2017). Precision agriculture technologies positively contributing to ghg emissions mitigation, farm productivity and economics. Sustainability (Switzerland), 9(8). https://doi.org/10.3390/SU9081339

Bageant, E.R., Barrett, C.B. (2017). Are there gender differences in demand for index-based livestock insurance? Journal of Development Studies 53, 932–952.10.1080/00220388.2016.1214717CrossRefGoogle Scholar

Baethgen, W., Hansen, J. W., Ines, A. V. M., Jones, J. W., Meinke, H., & Steduto, P. (2008). Contributions of agricultural systems modeling to weather index insurance. In a workshop on 'Technical Issues in Index Insurance', held (pp. 7-8

Barnett, B.J., Mahul. O. (2007). Weather index insurance for agriculture and rural areas in lower-income countries. American Journal of Agricultural Economics 89(5): 1241–1247.

Barnett, B. (2014). "Multiple-peril crop insurance: successes and challenges", Agricultural Finance Review, Vol. 74 No. 2, pp. 200-216. https://doi.org/10.1108/AFR-11-2013-0040.

Barrett Christopher and Nathaniel Jensen (2016). Agriculture index insurance for development https://doi.org/10.1093/aepp/ppw022

Belissa, T., Bulte, E., Cecchi, F., Gangopadhyay, S., Lensink, R .(2019). Liquidity constraints, informal institutions, and the adoption of weather insurance: a randomized controlled trial in Ethiopia. Journal of Development Economics 140, 269–278.CrossRefGoogle Schola

Berber Kramer (2019). Can weather index insurance help farmers adapt to climate change?

Barry Barnett Benjamin Collier and Jerry Skees (2009). Weather Index Insurance and Climate Change: Opportunities and Challenges in Lower Income Countries Agricultural Economics, University of Kentucky, 1008 S. Broadway, Lexington, KY 40504, USA agricultural Economics, Mississippi State University, Starkville, MS, USA.

Bishu, KG., Lahiff, E., O'Reilly, S., Gebregziabher, M. (2018). Drivers of farmers' cattle

insurance decisions: evidence from smallholders in northern Ethiopia. Agrekon 57, 40–48.CrossRefGoogle Scholar

Binswanger-Mkhize, H.P. (2012). Is there too much hype about index-based agricultural insurance? The Journal of Development Studies 48(2): 187–200.

Bogale, A. (2015). Weather-indexed insurance: an elusive or achievable adaptation strategy to climate variability and change for smallholder farmers in Ethiopia. Climate and Development 7.

Born, L., Spillane, C., Murray, U. (2019). Integrating gender into index-based agricultural insurance: a focus on South Africa. Development in Practice 29, 409–423.10.1080/09614524.2018.1556608CrossRefGoogle Scholar

Branca, G., and Perelli, C. (2020). ‘‘Clearing the Air’: Common Drivers of Climate-smart Smallholder Food Production in Eastern and Southern Africa’. Available at:https://www.sciencedirect.com/science/article/pii/S0959652620319478?via%3Dihub.

Brigg, A.R. J., Coleman, M., Morrison, M. (2012). Research methods in educational Leadership and Management (3rd Ed.). SAGE publications

Bryan, G. (2019). Ambiguity aversion decreases the impact of partial insurance: evidence from African farmers. Journal of European Economic Association 17, 1428–1469.CrossRefGoogle Scholar

Brown, C., Shaker, R. R., & Das, R. (2018). A review of approaches for monitoring and evaluation of urban climate resilience initiatives. Environment, development and sustainability, 20, 23-40

Bucheli, J., Dalhaus, T., Finger, R .(2022). Temperature effects on crop yields in heat index insurance. Food Policy, 107, 102214. https://doi.org/10.1016/j.foodpol.2021.102214,

Building Blocks student handout (2022). What is insurance What is insurance (fhi360.org)

Bulte, E., Cecchi., F, Lensink, R., Marr, A., Van Asseldonk, M. (2019). Does bundling crop insurance with certified seeds crowd-in investments? Experimental evidence from Kenya. Journal of Economic Behavior & Organization 180, 744–757.10.1016/j.jebo.2019.07.006CrossRefGoogle Scholar

Cabot, C. (2017). Climate Change, Security Risks and Conflict Reduction in Africa (Vol. 12). https://doi.org/10.1007/978-3-642-29237-8

Casaburi, L., Willis, J. (2018). Time vs. state in insurance: experimental evidence from contract farming in Kenya. American Economic Review 108, 3778–3813.CrossRefGoogle Scholar

Cai, J. (2012). The impact of Insurance Provision on households' production and financial decisions

Carlos E. Arce (2016). Comparative Assessment of Agricultural Weather Index Insurance Strategies in Sub-Saharan Africa, DFID Vuna project

Carter, M.R., and C.B. Barrett. (2006). The economics of poverty traps and persistent poverty: An asset-based approach. The Journal of Development Studies 42(2): 178–199.

Carter, M.R., C.B. Barrett, S., Boucher, S., Chantarat, F., Galarza, J., McPeak, A. Mude., Trivelli,C. (2008). Insuring than ever before insured: Explaining index insurance through financial education games. BASIS Brief 2008-07, Madison: University of Wisconsin.

Carter, M.R., Cheng, L., Sarris, A. (2016). Where and how index insurance can boost the adoption of improved agricultural technologies. Journal of Development Economics 118, 59–71.CrossRefGoogle Scholar

Chapoto, A., Subakanya, M. (2019). Rural Agricultural Livelihoods Survey 201 Report. In IAPRI (Vol. 1, Issue). https://doi.org/10.1017/CBO9781107415324.004

Chengyi Pu., Yueyun (Bill) Chen., Xiaojun Pan. (2018). Weather indexes, index insurance and weather index futures. Insurance Markets and Companies, 9(1), 32-40. doi:10.21511/ins.09(1).

Chakravarti, J.S.(1920.) Agricultural insurance: a practical scheme suited to Indian Conditions, Government Press, Bangalore

Chinseu, E., Dougill, A., & Stringer, L. (2019). Why do smallholder farmers dis-adopt conservation agriculture? Insights from Malawi. Land Degradation and Development, 30(5), 533–543. https://doi.org/10.1002/LDR.3190

Choi, J., & Shim, Y. (2022). Technology adoption and late industrialization. Available at SSRN 4308957.

Clark, A., Jit, M., Warren-Gash, C., Guthrie, B., Wang, H. H. X., Mercer, S. W., Sanderson, C., McKee, M., Troeger, C., Ong, K. L., Checchi, F., Perel, P., Joseph, S., Gibbs, H. P., Banerjee, A., Eggo, R. M., Nightingale, E. S., O'Reilly, K., Jombart, T., … Jarvis, C. I. (2020). Global, regional, and national estimates of the population at increased risk of severe COVID-19 due to underlying health conditions in 2020: a modelling study. Lancet, 8(8), e1003–e1017. https://doi.org/10.1016/s2214-109x(20)30264-3

Clarke, D.J., O. Mahul, K.N. Rao, and N. Verma. (2012). Weather-based crop insurance in India. Policy Research Working Paper No. 5985, Washington DC: The World Bank.

Cole, S., X. Giné, J. Tobacman, P. Topalova, R. Townsend, and J. Vickery. (2013). Barriers to household risk management: Evidence from India. American Economic Journal: Applied Economics 5(1): 104–135.

Cole, Bastern, Vyas, Stein (2012). The effectiveness of index-based microinsurance in helping smallholders manage weather-related risks. London: EPPI-Center, Social science research unit, institute of education, University of London, London

Collier, B., Skees, J. & Barnett, B. (2009). Weather Index Insurance and Climate Change: Opportunities and Challenges in Lower-Income Countries. Geneva Pap Risk Insur Issues Pract 34, 401–424 (2009). https://doi.org/10.1057/gpp.2009.11

Cresswell, K. M., Slee, A., Coleman, J., Williams, R., Bates, D. W., and Sheikh, A. (2013). Qualitative analysis of round-table discussions on the business case and procurement challenges for hospital electronic prescribing systems. PLoS ONE, 8(11). https://doi.org/10.1371/journal.pone.0079394,

Creswell, J. W. (2012). Educational Research: Planning, conducting, and evaluating qualitative and quantitative Research. Pearson Education.

Danso-Abbeam, G., Ehiakpor, D.S. & Aidoo, R. Agricultural extension and its effects on farm productivity and income: insight from Northern Ghana. Agric & Food Secur 7, 74 (2018). https://doi.org/10.1186/s40066-018-0225-x

Daryanto, S., L.X., Wang, and P.A. Jacinthe. (2016). Global synthesis of drought effects on maize and wheat production. PLOS ONE 11(1): e0156362.

Dalhaus, T., Musshoff, O. & Finger, R. (2018). Phenology Information Contributes to Reduce Temporal Basis Risk in Agricultural Weather Index Insurance. Sci Rep 8, 46 (2018). https://doi.org/10.1038/s41598-017-18656-5

De Janvry, A., V. Dequiedt, and E. Sadoulet. (2014). The demand for insurance against standard shocks. Journal of Development Economics 106: 227–238.

Delavallade, C, Dizon, F, Hill, RV and Petraud, JP (2015). Managing Risk with Insurance and Savings: Experimental Evidence for Male and Female Farm Managers in West Africa. Washington D.C.: International Food Policy Research Institute (IFPRI).Google Scholar

Dube, C., and Gumbo, V. (2017). Adoption and Use of Information Communication Technologies in Zimbabwean. URL: http://dx.doi.org/10.11114/aef.v4i1.1860

Dercon, S., Christiansen. (2011). Consumption risk, technology adoption, and poverty traps: Evidence from Ethiopia. Journal of Development Economics 96(2): 159–173.

Dercon, S., Hill, R.V., Clarke, D., Outes-Leon, I., Seyoum Taffesse, A. (2014). Offering rainfall insurance to informal insurance groups: evidence from a field experiment in Ethiopia. Journal of Development Economics 106, 132–143.CrossRefGoogle Scholar

Di Marco, M., Pacifici, M., Maiorano, L., Rondinini, C., Barral, M. P., Villarino, S., Levers, C., Baumann, M., Kuemmerle, T., Mastrangelo, M., Fujimori, S., Krey, V., van Vuuren, D., Oshiro, K., Sugiyama, M., Chunark, P., Limmeechokchai, B., Mittal, S., Nishiura, O., … Mastrangelo, M. (2021). Systems thinking in practice: Participatory modeling as a foundation for Integrated Approaches to Health. Journal of Applied Ecology, 57(12), 1–11. https://doi.org/10.1111/ecog.05414

Di Marcantonio, F., Kayitakire, F. (2017). Review of Pilot Projects on Index-Based Insurance in Africa: Insights and Lessons Learned. In: Tiepolo, M., Pezzoli, A., Tarchiani, V. (eds) Renewing Local Planning to Face Climate Change in the Tropics. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-59096-7_16

Dillon, B., Barrett, C.B. (2017). Agricultural factor markets in Sub-Saharan Africa: an updated view with formal tests for market failure. Food Policy 67, 64–77.CrossRefGoogle ScholarPubMed

Elabed, G., Carter, M.R .(2015). Compound-risk aversion, ambiguity and the willingness to pay for microinsurance. Journal of Economic Behavior & Organization118, 150–166.CrossRefGoogle Scholar

Evers, N., Cunningham, J., & Hoholm, T. (2014). Technology entrepreneurship: bringing innovation to the marketplace. Palgrave Macmillian, 394. https://books.google.pl/books?id=_PYcBQAAQBAJ&pg=PA23&lpg=PA23&dq=low+earlystage+innovator's+performance+poland&source=bl&ots=75ffigGTgn&sig=ACfU3U0WCCb52QqOziu2Rb26t2Z_ZX8HJg&hl=pl&sa=X&ved=2ahUKEwjahoW92dnpAhWHw4sKHQtdAJEQ6AEwAnoECAUQAQ#v=onepage&q=low

Farm radio international (2021) Warehouse receipt systems: Security and better prices for grain farmers

FAO. (2011). Farming systems Report

FAO. (2021). Protecting livelihoods – Linking agricultural insurance and social protection. Rome. https://doi.org/10.4060/cb2690en

Fanconi, P., & Scheurle, P. (2017). Small Money - Big Impact. In Small Money - Big Impact. https://doi.org/10.1002/9781119351481

Fava, F., Upton, J., Banerjee, R., Taye, M., Mude, A. (2018). Pre-Feasibility Study for Index-

Based Livestock Insurance in Niger (ILRI Research Report 51). Nairobi, Kenya: International Livestock Research Institute.Google Scholar

Fernando, A., M., Fitzgeral, M. (2005). The theoretical approach to study SME e-business progression. Journal of computing and information technology-CIT13,2,123-136, Brunel University, Uxbridge UK.

Fernado, E., Thin, S. W. (2021). Proposed Model to Measure the Influence Factor of Adoption for Online Investment Application. In 2021 International Conference on Computer Science and Engineering (IC2SE) (Vol. 1, pp. 15). IEEE.doi:10.1109/IC2SE52832.2021.9792113.

Feyen, E., Frost, J., Gambacorta, L., Natarajan, H., & Saal, M. (2021). Fintech and the digital transformation of financial services: implications for market structure and public policy. BIS papers.

Flatnes, J.E., Carter, M.R., Mercovich, R. (2018). Improving the quality of index insurance with a satellite-based conditional audit contract. Unpublished Working Paper. Available at https://basis.ucdavis.edu/sites/g/files/dgvnsk466/files/2018-11/Flatnes Carter conditional audit Tanzania.pdf.Google Scholar

Frank Bannor., Dikgang Johane., Gelo Dambala. (2021). Agricultural total factor productivity growth, technical efficiency, and climate variability in sub-Saharan Africa, ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg.

Friedrich, T., Derpsch, R., Kassam, A. (2017). Overview of the global spread of conservation agriculture. In Sustainable Development of Organic Agriculture: Historical Perspectives (Issue Vol. 8, pp. 53–68). https://doi.org/10.1201/9781315365800

Fisher, M., Carr. E. R. (2015) The influence of gendered roles and responsibilities on the adoption of technologies that mitigate drought risk: the case of drought-tolerant maize seed in eastern Uganda. Global Environmental Change 35, 82–92.CrossRefGoogle Scholar

Fisher. H, E., Hansen, J., Hellin, J., Rosenstock, T., Cairns, J., Stirling, C., Lamanna, C., Van Etten, J., Rose, A., & Campbell, B. (2019). Climate risk management and rural poverty reduction. Agricultural Systems, 172, 28–46. https://doi.org/10.1016/j.agsy.2018.01.019

Fonta, W.M., Sanfo, S., Kedir, A.M., Thiam, D.R. (2018) Estimating farmers' willingness to pay for weather index-based crop insurance uptake in West Africa: insight from a pilot initiative in Southwestern Burkina Faso. Agricultural and Food Economics 6, 11.CrossRefGoogle Scholar

Fuchs ,A., Wolf, H. (2012) Concept and unintended consequences of weather index insurance: The case of Mexico. Am J Agri Econ 93(2):505–511

Giller, K.E., Delaune, T., Silva, J.V. et al. The future of farming: Who will produce our food?.Food Sec. 13, 1073–1099 (2021). https://doi.org/10.1007/s12571-021-01184-6

Giné, X., R. Townsend, J., Vickery. (2008). Patterns of rainfall insurance participation in rural India. The World Bank Economic Review 22(3): 539–566.

Giné, X and Yang, D (2009) Insurance, credit, and technology adoption: field experimental evidence from Malawi. Journal of Development Economics 89, 1–11.CrossRefGoogle Scholar

Giller, K. E., Hijbeek, R., Andersson, J. A., & Sumberg, J. (2021). Regenerative agriculture: An agronomic perspective. Outlook on Agriculture, 50(1), 13–25

Giller, K. E., Delaune, T., Silva, J. V., Descheemaeker, K., van de Ven, G., Schut, A. G., ... & van Ittersum, M. K. (2021). The future of farming: Who will produce our food?. Food Security, 13(5), 1073-1099

Global insurance facility (2023). What is insurance? What is index insurance? |Index Insurance Forum

Giriraj Amarnath.(2017). Satellite-based insurance protects farmers from destructive floods.

Gisela, L., Silbernagel, R., Stamer, F., & Sautter, B. (2022). Successful Collaboration in Global Production Networks-Fair, Secure, Connected. https://doi.org/10.5445/IR/1000144272

Greatrex, H., Hansen, J., Garvin, S., Diro.,R, Blakeley, S, Le, Guen, M et al. (2015) Scaling Up Index Insurance for Smallholder Farmers: Recent Evidence and Insights (CCAFS Report No 14). Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security.Google Scholar

Gupta, R., Somanathan, E., & Dey, S. (2017). Global warming and local air pollution have reduced wheat yields in India. Climatic Change, 140(3–4), 593–604. https://doi.org/10.1007/S10584-016-1878-8

Global Hunger Index (2021). Global Hunger Index: Hunger and Food Systems in Conflict Settings.

GIIF.(2022). Lesson learned and guidance note on Zambia-the adoption, perception and understanding of agriculture index insurance.

Ghosh Ranjan Kumar., Gupta.S., Vartika Singh., Patrick S. Ward,(2020). Demand for Crop

Insurance in Developing Countries: New Evidence from India,

GSDR (2019). The future is Now: Scienchttps://doi.org/10.1111/1477-9552.12403,e for achieving sustainable development. Related goal 17

Gommes R., Gobel ,W. (2013) Beyond simple, one station indices. In: Gommes R, Kayitakire F (eds) Proceedings of the challenges of weather index insurance for food security in developing countries. Organized by the EC Joint Research Centre (JRC) and the International Research Institute for Climate and Society (IRI, Earth Institute, Columbia University), Milan, 2013

Gujarati, N. D. (2006). Essentials of Econometrics (3rd Ed.). Mc Graw Hill Edition. Boston Burr Ridge

Haanyika, C. M., Mulanda, J. L., Kirschke, S., Borchardt, D., Newig, J., Zhang, L., Meyer, K., Marczak, D., Lejcuś, K., Grzybowska-Pietras, J., Biniaś, W., Lejcuś, I., Misiewicz, J., Maulu, S., Hasimuna, O. J., Mphande, J., Mertens, D. M., Sumaila, U. R., Walsh, M., … Zhang, J. (2021). Mapping Complexity in Environmental Governance: A comparative analysis of 37 priority issues in German water management. Nature Communications, 26(1), 3–6. https://doi.org/10.3390/resources7040067

Hasin, A., Smith, S., and Stieren, P. (2014). Illinois Farmers Markets Using EBT: Impacts on SNAP Redemption and Market Sales. Journal of Agriculture, Food Systems, and Community Development, 5(1), 179188https://doi.org/10.5304/jafscd.2014.051.015,

Helder, F., & João A., S. (2018). Vineyard mulching as a climate change adaptation measure: Future simulations for Alentejo, Portugal. Agricultural Systems, 164, 107–115.

Hellmuth, M.E., Osgood, DE, Hess, U., Moorhead.; Bhojwani, H. (eds) (2009). Index Insurance and Climate Risk: Prospects for Development and Disaster Management. Climate and Society No. 2. New York: International Research Institute for Climate and Society (IRI), Columbia University.Google Scholar

Hess, U., Hazell, P. (2016). Innovations and Emerging Trends in Agricultural Insurance: How Can We Transfer Natural Risks out of Rural Livelihooods To Empower and Protect People? Bonn and Escborn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).Google Scholar

Hennink, M.M. (2007). International focus group research: A handbook for the health and social sciences. Cambridge: Cambridge University Press.

Hill.V., Neha Kumar Nicholas Magnan , Simrin Makhija ., Francesca de Nicola , David J. Spielman , Patrick S. Ward. (2018). Ex ante and ex post effects of hybrid index

insurance in Bangladeshhttps://doi.org/10.1016/j.jdeveco.2018.09.003

Hudson, P. De Ruig, M.C.Ruiter,O.J.Kuik,W.J.W.Bostzen,X.Le Den. (2019) An assessment of best practices of extreme weather insurance and directions for a more resilient society

Ianchovichina, E., & Lundström, S. (2009). Inclusive growth analytics: Framework and application. World Bank Policy Research Working Paper, 4851. https://doi.org/10.1596/1813-9450-4851

IAPRI (2012). Agricultural Transformation in Zambia: Alternative Institutional Models for Accelerating Agricultural Productivity Growth and Commercialization

IFAD (2010). The potential for scale and sustainability in weather index insurance for agriculture and rural livelihoods. Rome: International Fund for Agricultural Development and World Food Program

Janzen, S., Magnan, N., Mullally, C., Shin, S., Palmer, I. B., Oduol, J., & Hughes, K. (2021). Can Experiential Games and Improved Risk Coverage Raise Demand for Index Insurance? Evidence from Kenya. American Journal of Agricultural Economics, 103(1), 338–361. https://doi.org/10.1111/AJAE.12124,

Janzen, SA and Carter, M.R .(2019) .After the drought: the impact of microinsurance on consumption smoothing and asset protection. American Journal of Agricultural Economics 101, 651–671.CrossRefGoogle Scholar

Kahan,D.(2013).Managining risk in agriculture ;FAO farm management extension guide 3.

Karlan, D, Osei, R, Osei-Akoto, I and Udry, C (2014). Agricultural decisions after relaxing credit and risk constraints. Quarterly Journal of Economics 129, 597–652.CrossRefGoogle Scholar

Karuho, O., & Collins, K. (2020). Improving African Grain Markets for Smallholder Farmers.

Kaunda, S., Chowa, T. (2023). An Analysis of Factors Influencing Uptake of Agriculture Index Insurance among Smallholder Farmers—A Case of Kasama District in Zambia. Open Journal of Business and Management, 11, 184-209. doi:10.4236/ojbm.2023.111011.

Kenton, W. (2023). Financial Instruments Explained: Types and Assert Classes Financial Instruments Explained: Types and Asset Classes (investopedia.com)

Jensen, N.D., and C.B. Barrett. (2016). Agricultural index insurance for development. Applied Economics Perspectives and Policy. https://doi.org/10.1093/aepp/ppw022

Jeehye K, Parmash Shah, Joanne Catherine Gaskell, Ashesh Praisan, Akanksha Luthra (2020). Scaling Up Disruptive Agricultural Technologies in Africa, World bank group

Jha, S., Kaechele, H., Lana, M., Amjath-Babu, T. S., & Sieber, S. (2020). Exploring farmers' perceptions of agricultural technologies: A case study from Tanzania. Sustainability (Switzerland), 12(3), 1–21. https://doi.org/10.3390/su12030998

Jianjun, J., Yiwei, G., Xiaomin, W., & Nam, P. K. (2015). Farmers' risk preferences and their climate change adaptation strategies in the Yongqiao District, China. Land Use Policy, 47, 365–372. https://doi.org/10.1016/j.landusepol.2015.04.028

Johnson, L., Wandera, B., Jensen, N., Banerjee, R. (2019) Competing expectations in an Index-Based Livestock Insurance Project. Journal of Development Studies 55, 1221–1239.CrossRefGoogle Scholar

Krueger, R. A., & Casey, M. A. (2000). Focus groups: A practical guide for Applied Research (3rd Ed.). Thousand Oaks, CA: Sage Publications Development Network. Washington DC: World Bank.

Khan, D. (2008). Managing risk; Farm management extension guide. FAO.

Karlan, D., Osei, R.D., Osei-Akoto, I. and Udry, C (2014) Agricultural decisions after relaxing credit and risk constraints. The Quarterly Journal of Economics, 129, 597–652. https://doi.org/10.1093/qje/qju002,

Kimura, S., Wehrhahn, R., Lin, W., & Zhang, L. (2022). Developing a Sustainable Agricultural Insurance System in the People's Republic of China.

Kiwanuka, A. A. (2015). Acceptance Process: The Missing Link between UTAUT and Diffusion of Innovation Theory." American Journal of Information Systems, vol. 3, no. 2 40-44.doi: 10.12691/ajis-3-2-3

Lybbert, T.J., Carter, M.R. (2015). Bundling drought tolerance and index insurance to reduce rural household vulnerability to drought. In Balisacan, A, Chakravorty, U and Ravago, M-L (eds), Sustainable Economic Development: Resources, Environment, and Institutions. Kidlington, Oxford: Academic Press, pp. 401–414.CrossRefGoogle Scholar

Leblois, A., Quirion, P., Sultan, B. (2014 b). Price vs. weather shock hedging for cash crops: ex ante evaluation for cotton producers in Cameroon. Ecological Economics101, 67–80.CrossRefGoogle Scholar

Linnerooth-Bayer J, Mechler R, Pflug G (2005). Refocusing disaster aid. Science 309:1044–1046

Loo,A(2023) What are Derivatives: Explore the types and uses of these financial contracts.

Corporate financial institute.

Matsuda, A, Takahashi, K and Ikegami, M (2019). Direct and indirect impact of index-based livestock insurance in Southern Ethiopia. The Geneva Papers on Risk and Insurance – Issues and Practice 44, 481–502.CrossRefGoogle Scholar

McIntosh, C, Sarris, A and Papadopoulos, F (2013). Productivity, credit, risk, and the demand for weather index insurance in smallholder agriculture in Ethiopia. Agricultural Economics 44, 399–417.CrossRefGoogle Scholar

McPeak, J, Chantarat, S and Mude, A (2010). Explaining index-based livestock insurance to pastoralists. Agricultural Finance Review 70, 333–352.CrossRefGoogle Scholar

Mahul, O and Stutley, C.J, (2010). Government Support to Agricultural Insurance: Challenges and Options for Developing Countries. Washington, DC: The World Bank.CrossRefGoogle Scholar

Madan, N. (2020). A review of access to finance by micro, small and medium enterprises and digital financial services in selected Asia-Pacific least developed countries.

Makaudze E.M.(2012). Weather Index Insurance for Smallholder Farmers in Africa: Lessons Learnt and Goals for the Future. Stellenbosch: African SUN Media

Makungu,F.(2015). The 2015 Multiyear expert meeting on Commodity and development. How to use weather index insurances to address agricultural price volatility? (unctad.org)

Maynard, T., Ranger, N. (2012). What Role for "Long-term Insurance" in Adaptation? An Analysis of the Prospects for and Pricing of Multi-Year Insurance Contracts. Geneva Pap Risk Insur Issues Pract 37, 318–339. https://doi.org/10.1057/gpp.2012.10

Maulu, S., Hasimuna, O. J., Mutale, B., Mphande, J., & Siankwilimba, E. (2021). Enhancing the role of rural agricultural extension programs in poverty alleviation: A review. Cogent Food & Agriculture, 7(1), 1886663.

Michael Carter., Alain de Janvry., Elisabeth Sadoulet., and Alexandros Sarris (2014) Index-based weather insurance for developing countries: A review of evidence and a set of propositions for up-scaling – working paper development policies

Miranda, M. J., and K. Farrin.(2012). Index insurance for developing countries. Applied Economic Perspectives and Policy 34(3): 391–427.

Moder, K., Kabala, E., Yiwombe, A., Yiwombe, A., Moder, K., Siankwilimba, E., Yiwombe, A., Chiyesu, D., Hambulo, R., Bwalya, O., Siankwilimba, E., Shimilimo, M., Yiwombe, A., & Chiyesu, D. (2019). Young Zambia Between Poverty and Abundant Resources.

1(1).

Mukasa, A.N. (2016). Technology Adoption and Risk Exposure among smallholder farmers: Panel Evidence from Tanzania and Uganda

Musika (2017). Weather Index Insurance Training Manual, Musika, Lusaka, Zambia-Unpublished training manual

Musika(2017).Weather Index-Based Insurance Training Manual, Ministry of Agriculture Republic of Zambia

Musshoff, O., M. Odening, and W. Xu.(2011). Management of climate risks in agriculture: Will weather derivatives permeate? Applied Economics 43(9): 1067–1077.

Muhammad, A. L. İ., Man, N., Abd Latif, I., Muharam, F. M., and Omar, S. Z,. (2018). The use of information and communication technologies in agricultural risk management by the agricultural extension services in Malaysia. International Journal of Agriculture Environment and Food Sciences, 2(1), 29-https://doi.org/10.31015/jaefs.18005.

Munkombwe, J., Phiri, J., and Siankwilimba, E.(2022). Financial Innovation among Smallholder Farmers: Enhancing the uptake of Weather Index Insurance through a Pragmatic Approach. Journal of Social Sciences Advancement, 3(1), 01–19. https://doi.org/10.52223/JSSA22-030101-27,2022

Mwanza, J. (2017) Research Design Matrix. Research Methods. Lecture Notes. University of Zambia. Lusaka

Mweberi, S. A. (2020). Food Insecurity in Africa-the Role of Agribusiness (Doctoral dissertation, University of Nairobi).

NAPA (2007). Climate change in Zambia impacts adaptation

Nara, B. B., Lengoiboni, M., and Zevenbergen, J.(2021). Assessing customary land rights and tenure security variations of smallholder farmers in northwest Ghana. Land Use Policy, 104 https://doi.org/10.1016/j.landusepol.2021.105352.

Ngoma, H., Angelsen, A., Jayne, T. S., and Chapoto, A. (2021). Understanding Adoption and Impacts of Conservation Agriculture in Eastern and Southern Africa: A Review. Frontiers in Agronomy, https://doi.org/10.3389/FAGRO.2021.671690, 2021.

Ndegwa, M. K., Shee, A., Turvey, C., & You, L. (2022). Sequenced crop evapotranspiration and water requirement in developing a multitrigger rainfall index insurance and risk-contingent credit. Weather, Climate, and Society, 14(1), 19-38.

Njeu,E., Kirimi,L., Mathange.(2021). Uptake of crop insurance among smallholder farmers: Insights from maize producers in Kenya, https://www.researchgate.net/publication/349029194_Uptake_of_Crop_Insurance_among_Smallholder_Farmers_Insights_from_Maize_Producers_in_Kenya

Norton, M., D. Osgood, M., Madajewicz, E. Holthaus, N. Peterson, R. Diro, C. Mullally, T. Teh, and M. Gebremichael. (2014). Evidence of demand for index insurance: Experimental games and commercial transactions in Ethiopia. The Journal of Development Studies 50(5): 630–648.

Nshakira-Rukundo, E., Kamau, J., & Baumüller, H. (2021). Determinants of uptake and strategies to improve agricultural insurance in Africa: A review. Environment and Development Economics, 26(5-6), 605-631. doi:10.1017/S1355770X21000085

Nyambo P., Thengeni, Cornelius Chiduza & Tesfay Araya (2021). Tillage, crop rotation, residue management and biochar influence on soil chemical and biological properties, South African Journal of Plant and Soil, 38:5, 390-397, DOI: 10.1080/02571862.2021.1962421

Obour P.B., Owusu, K. (2021). Climate Change Adaptation and Transformation of Smallholder Farming System in Mid- Ghana. In: Leal Filho W., Luetz J.M., Ayal D. (eds) Handbook of Climate Change Management. Springer, Cham. https://doi.org/10.1007/978-3-030-57281-5_25

Olorunfemi., Oluwasogo David, Temitope Oluwaseun Olorunfemi, Oladimeji Idowu Oladele, and James Olorunfemi Malomo (2021). "Knowledge of extension agents on climate smart agricultural initiatives in South-West Nigeria." Journal of Agricultural Extension 25, no. 4.

Osakwe, P. (2021). Covid -19 and the challenge of Developing productive capacities in Zambia -UNCTAD

Onwuegobuzie, J., Nancy, L. (2007). A Typology of mixed methods research designs. Journal of springer science and business media

Paresh, S., Shalika,V., Promod,A., Rao.(2019). Designing weather index insurance of crops for the increased satisfaction of farmers, industry and the government. Journal on climate risk management, volume 25,100189.

Patt, A., Peterson, N., Carter, M, Velez, M, Hess, U., Suarez, P. (2009). Making index

insurance attractive to farmers. Mitigation and Adaptation Strategies for Global Change 14, 737–753.CrossRefGoogle Scholar

Pelser, A. S., & Meintjes, A. (2023). Success framework to improve emerging farmer entrepreneurship. Journal of Contemporary Management, 20(2), 287-314.

Perrone, A., Inam, A., Albano, R., Adamowski, J., & Sole, A. (2020). A participatory system dynamic modeling approach to facilitate collaborative flood risk management: A case study in the Bradano River (Italy). Journal of Hydrology, 580. https://doi.org/10.1016/J.JHYDROL.2019.124354

Perez, C., Jones, E.M., Kristjanson, P., Cramer, L., Thornton, P.K., Förch, W and Barahona, C. (2015) How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. Global Environmental Change 34, 95–107.CrossRefGoogle Scholar

Peters, W.G, Vishnia, G.R (2018).Handbook of Blockchain, Digital Finance, and inclusion, Volume2, Financial Instrument - an overview | ScienceDirect Topics

Platteau, J.P., De Bock, O and Gelade, W. (2017) The demand for microinsurance: a literature review. World Development 94, 139–156.CrossRefGoogle Scholar

Pramod K. Mishra. (1995). Is Rainfall Insurance a New Idea? Pioneering Work Revisited. Economic and Political Weekly, 30(25), A84–A88. http://www.jstor.org/stable/4402912

Preetha, R., Priyadarsini, M. J. P., & Nisha, J. S. (2023). Comparative Study on Architecture of Deep Neural Networks for Segmentation of Brain Tumor using Magnetic Resonance Images. IEEE Access.

Rabiee, F. (2004). Focus group interview and data analysis. Proceedings of the Nutrition Society, 63, 655-660.

Rao, K.N. (2010). Index-based crop insurance. Agriculture and Agricultural Science Procedia 1: 193–203.

Rapsomanikis.G.(2015). The economic lives of smallholder farmers. An analysis based on household data from nine countries Food and Agriculture Organization of the United Nations Rome

Rasmussen, L. V. (2018). Re-Defining Sahelian ‘Adaptive Agriculture’ when Implemented Locally: Beyond Techno-fix Solutions. World Development, 108, 274–282.

Rehman, J., Sohaib, O., Asif, M., & Pradhan, B. (2019). Applying systems thinking to flood disaster management for a sustainable development. International Journal of Disaster Risk Reduction, 36, 101101. https://doi.org/10.1016/j.ijdrr.2019.101101

Rishi Raithatha and Jan Priebe.(2020). GSMA AgriTech Programme, Agricultural insurance for smallholder farmers

Rodgers, E. M,(2003). Diffusion of innovations (5th ed.). New York..

Rose Gaslinga. (2012). Kilimo Salama Experience from Kenya FARM, Syngenta foundation.

Rosema, A., De Weirdt, M., & Foppes, S. (2010). Monitoring and Early Warning. In Applied Agrometeorology (pp. 1005-1012). Berlin, Heidelberg: Springer Berlin Heidelberg.

Skees J., Murphy A., Collier B,. McCord M, Roth J (2007) Scaling up index insurance: what is needed for the next big step forward? Technical Report, prepared for Kreditanstalt für Wiederaufbau (KfW) [German Financial Co-operation].

Shumba, D. S. (2022). Bundling Weather Index Insurance with Microfinance: Trekking the Long Road between Expectations and Reality–A Study on Sub-Saharan Africa. In Food Systems Resilience. IntechOpen.

Stoeffler, Q and Opuz, G .(2020). The index insurance take-up puzzle: new experimental and quasi-experimental evidence from Burkina Faso. Unpublished Working Paper. Available at https://www.stjohns.edu/sites/default/files/uploads/The%20index%20insurance%20take-up%20puzzle%20new%20experimental%20and%20%281%29.pdf.Google Scholar

Stoeffler, Q., Carter, M., Guirkinger, C., & Gelade, W. (2022). The spillover impact of index insurance on agricultural investment by cotton farmers in Burkina Faso. The World Bank Economic Review, 36(1), 114-140.

Stringer, L. C., Fraser, E. D., Harris, D., Lyon, C., Pereira, L., Ward, C. F., & Simelton, E. (2020). Adaptation and development pathways for different types of farmers. Environmental Science & Policy, 104, 174-189.

Siankwilimba,E. (2019). Effects of Climate Change induced electricity load shedding on smallholder agricultural enterprises in Zambia: The case of Five Southern Province Districts. IJRDO - Journal of Agriculture and Research (ISSN: 2455-7668), 5(8), 01-151. Retrieved from http://www.ijrdo.org/index.php/ar/article/view/3184

Siankwilimba, E., Mwaanga, E. S., Munkombwe, J., Mumba, C., & Hang'ombe, B. M. (2021). Effective Extension Sustainability in the face of COVID-19 Pandemic in Smallholder Agricultural Markets. International Journal for Research in Applied Science & Engineering Technology (IJRASET). ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429. Volume 9 Issue XII Dec 2021- Available at www.ijraset.com. https://doi.org/10.22214/ijraset.2021.39403

Sibiko, N. J., & Chamberlin, J. (2016). The geography of Zambia's customary land: Assessing the prospects for smallholder development. Land Use Policy, 55, 49

Sibiko, K. W., Veettil, P. C., & Qaim, M. (2018). Small farmers' preferences for weather index insurance: insights from Kenya. Agriculture & Food Security, 7, 1-14.

Suarez, P., Linnerooth-Bayer, J.(2010). Micro-insurance for local adaptation. Wiley Interdisciplinary Reviews: Climate Change 1, 271–278.Google Scholar

Slavíková, L., Hartmann, T., & Thaler, T. (2020). Financial schemes for resilient flood recovery. Environmental Hazards, 19(3), 223-227. https://doi.org/10.1080/17477891.2019.1703624

Swiss Re corporate solutions. (2019). What is parametric insurance? Private Sector Support to Climate Resilience in Zambia

Syngenta Foundation (2023). Agricultural Insurance Solutions |The Syngenta Foundation for Sustainable Agriculture

Syngenta (2014). Foundation for Sustainable Agriculture. Kilimo Salama.Available at: http://www.syngentafoundation.org/index.cfm?pageID=758. Accessed on 18 Nov 2015

Syroka, J.(2007). "Index-Based Weather Insurance for Indian Farmers: Recommendations for Ratemaking", Washington DC: World Bank.

Syroka,J.Reinecke,E.B,(2015).Weather_Index_Insurance_and_Transforming_Agriculture_in _Africa.pdf (afdb.org)

Tadesse, M.A., Shiferaw, B.A., Erenstein, O.(2015). Weather index insurance for managing drought risk in smallholder agriculture: lessons and policy implications for sub-Saharan Africa. Agric Econ 3, 26 . https://doi.org/10.1186/s40100-015-0044

Takahashi, K., M. Ikegami, M. Sheahan, and C.B. Barrett. (2016). Experimental evidence on the drivers of index-based livestock insurance demand in Southern Ethiopia. World Development 78: 324–340.

Tromp, L.A.D and Kombo, D.K. (2006). Makuyu: Proposal and Thesis Writing: An Introduction. Paulines Publications Africa.

Tay, A., Lafont, F., Balmat, J. F., Pessel, N., & Lhoste-Drouineau, A. (2021). Decision support system for Western Flower Thrips management in roses production. Agricultural Systems, 187. https://doi.org/10.1016/j.agsy.2020.103019

Till Below., Nkumbu Nalwimba (2021). Crop insurance and weather forecasting are closely linked.

Timu, A. G., & Kramer, B. (2023). Gender-inclusive,-responsive, and-transformative

agricultural insurance: A literature review. Global Food Security, 36, 100672.

Todaro, M. P., & Smith, S. C. (2015). Economic development: The Addison-Wesley series in economics (Twelfth ed). Pearson.

UKEssays. (November 2018). Definitions & Functions of Micro Finance. Retrieved from https://www.ukessays.com/essays/economics/definitions-and-functions-of-micro-finance-economics-essay.php?vref=1

Unterberger, C., Olschewski, R. (2021). Determining the insurance value of ecosystems: A discrete choice study on natural hazard protection by forests. Ecological Economics, 180. https://doi.org/10.1016/J.ECOLECON.2020.106866

United Nations (2015). Adopted by the general assembly on 25 september 2015.70/1 transforming our world. The 2030 agenda for sustainable development. United nations general assembly.

United Nations (2020). World Population Prospects: The 2019 revision. Department of economic and social affairs. Population division.

UNDP (2021). United nations development program report

Vasilaky, K., Diro, R., Norton, M., McCarney, G., Osgood, D. (2019). Can education unlock scale? The demand impact of educational games on a large-scale unsubsidised index insurance programme in Ethiopia. Journal of Development Studies 56, 361–383.CrossRefGoogle Schol

Visser, M., Jumare, H., Brick, K. (2020). Risk preferences and poverty traps in the uptake of credit and insurance amongst small-scale farmers in South Africa. Journal of Economic Behavior & Organization 180, 826–836.CrossRefGoogle Scholar

Vidal-González, P., & Nahhass, B. (2018). The use of mobile phones as a survival strategy amongst nomadic populations in the Oriental region (Morocco). GeoJournal, 83(5), 1079–1090. https://doi.org/10.1007/S10708-017-9823-6

Vollset, S., E., Goren, E., Yuan, C., W., Cao, J., Smith, A. E., Hsiao, T., ... & Murray, C. J. (2020). Fertility, mortality, migration, and population scenarios for 195 countries and territories from 2017 to 2100: a forecasting analysis for the Global Burden of Disease Study. The Lancet, 396(10258), 1285-1306.

Wamuyu, P, K.(2017). Bridging the digital divide among low-income urban communities. Leveraging use of

Community Technology Centers, School of Science and Technology (SST), United States

International University, Nairobi, Kenya; https://doi.org/10.1016/j.tele.2017.08.004,

Walter Leal Filho., Anabela Marisa Azul, Luciana Brandli. (2021). No Poverty, in Encyclopedia of the U.N. Sustainable Development Goals

WFP (2021). Technical report on FISP index insurance product improvement, Lusaka, Zambia

Wheeler, T., and J. von Braun. (2013). Climate change impacts global food security. Science 341(6145): 508–513.

Willig, C, (2001). Introducing qualitative research in psychology: Adventures in theory and method. New York: Open University Press.

World Bank (2010). World development report: Development and climate change. Washington DC: The World Bank

World Bank (2011). Weather index insurance for agriculture: Guidance for development practitioners. Washington DC: The World Bank.

World bank group (2019). An analysis of factors influencing uptake of agriculture index insurance among smallholder farmers. Washington DC

World Bank (2019). Agriculture Finance Diagnostic – Zambia. Washington, DC: The World Bank.Google Scholar

World Bank. (2021). GFDRR Strategy 2021-2025: Scaling Up and Mainstreaming Resilience in a World of Compound Risks (English). Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/955811620194170587/GFDRR-Strategy-2021-2025-Scaling- Up-and-Mainstreaming-Resilience-in-a-World-of-Compound-Risks

World bank group (2018). Zambia agriculture finance diagnostic. A stakeholder's consultation meetings

World Bank (2018) What People Want: Investigating Inclusive Insurance Demand in Ethiopia. Washington, DC: The World Bank.Google Scholar

World Bank group. (2018). Realising the full potential of social safety nets in Africa.

Wright.H, Sonja Vermeulen, Gernot Laganda,Max Olupot,Edidah Ampaire, M.L,Jat(2014). Farmers, food and climate change: ensuring community-based adaptation is mainstreamed into agricultural programmes.

Yiran, G. A. B., Stringer, L. C. (2016). Spatio-temporal analyses of impacts of multiple climatic hazards in a savannah ecosystem of Ghana. Climate Risk Management, 14, 11–26.

ZDA (2011). Zambia development agency report

APPENDICES

Appendix 1 Questionnaire

THE UNIVERSITY OF ZAMBIA: Graduate school of business:

QUESTIONAIRE (FARMERS)

FINANCIAL INNOVATION AMONG SMALLHOLDER FARMERS: ENHANCING THE UPTAKE OF WEATHER INDEX INSURANCE USING A PRAGMATIC APPROACH**.**

The University of Zambia as part of the fulfilment will use the information collected by the survey for the PhD in business administration. The results will be strictly for academic purposes.

INSTRUCTIONS

1. **Introduction**

My name is Joshua Munkombwe I am from the University of Zambia and would like to conduct a survey pertaining to your farming business and climate resilience strategies you are coping with. You have been selected to participate on this survey on weather index insurance uptake study. The evidenced based results will help to improve the adoption and uptake of the insurance and help develop frameworks that would enhance adoption of the instrument thereby directly benefit you as farmers by mitigating the risk of weather in your farming business.

The information collected by this study will be strictly used for academic purposes and the results will help develop frameworks that would enhance adoption of Weather insurance index that will help increase the farmer resilience and risk mitigation to weather and support the growth of the agricultural sector. All information provided will be kept COMPLETELY CONFIDENTIAL.

This survey will take 15 minutes.

You indicate your voluntary consent by taking part in this survey.

Interviewer:	**Date of interview:**
Start time of interview:	**End time of interview:**

1a. Province:

1b. District

1c. Village:

1d. Agriculture Camp:

1e. Name of the Respondent:

1f. Are you the household head? Yes ☐ No ☐

1g. What is the name of the household head: ……...

1h. Gender of the household head: M ☐ F ☐

1i. Age of the household head: 15-20 ☐ 21-35☐ 36-50☐ above 50☐

1j. Marital Status of the household head: Single ☐ Monogamously married ☐ polygamous married ☐

1k. Household size: 1-5 ☐ 6-10 ☐ above 10 ☐

1l. Education attained: Tertiary ☐secondary ☐ primary ☐ no education☐

1m. Size of the farm: 1-5ha☐ 5-10ha ☐ 10-20ha☐

1n. Crops grown: Maize ☐ Cotton☐ Soya☐ Groundnuts ☐ Tobacco ☐ Sunflower☐ Beans☐

1o. Mobile number:

2.What problems do you face in your Agriculture business? Rank in order of priority

	1=Very significant	2=Significant	4=Insignificant
Bad and challenging weather			
Access to agricultural inputs			
Market information			
Commodity output markets			
Extension services			
None			

3. Do you know what weather insurance index is?

1. Yes [ ]

2. No [ ] >> 10

4. If yes, how did you know about weather insurance?

1. ☐ Ministry of agriculture FISP

2. ☐ Insurance company

2. ☐ Input company

3. ☐Fellow farmer

4. ☐ NGO

5. ☐ Media i.e. radio, newspaper, TV

6. ☐ others

5. If yes, have you used weather insurance index?

1. Yes [ ]

2. No [ ] >> 10

6. What type of insurance did you purchase?

1=WII

2=Mult-peril

3=yield index insurance

4=crop insurance

5=other, specify

7. Compared to the other insurance products, how would you describe WII?

1=Very effective

2=Effective

3=Very poor

4=Poor

5=Other, specify

8. How far is the nearest purchase point of access to WII? (Km)

☐ less than 10km

2. ☐ within 20km

2. ☐ Above 20km

3. ☐ Not at all

9. Which insurance company did you insure with?

1. ☐ VIA Ministry of agriculture FISP
2. ☐ Mayfair insurance
2. ☐ Professional insurance
3. ☐ Pula insurance
4. ☐ VIA NGO
5. ☐ Others SPECIFY

10. If no, why don't you know about weather insurance index?

1. ☐ not important
2. ☐ not heard of it
3. ☐complicated
4. ☐ no information

11. Would you say WII is difficulty to understand?

1. Yes [ ]
2. No [ ]

12. What is reason for not purchasing WII insurances?

1=It is expensive 2=it is not accessible it 3=I see no benefit 4=other, specify

13. If yes, which crops did you insure and why?

	Crop	Hectares planted	Insured (tick)	Hectares insured	Reason for Insuring the crop
1	Cotton		□		
2	Maize		□		
3	Soybeans		□		
4	Groundnuts		□		
5	Beans		□		
6	…….		□		
7	Other, specify		□		

14.How did you pay your premiums?

1. ☐ Through the FISP program

2. ☐ On my own to the insurance company

3. ☐ Through an NGO

4. ☐ others, specify……..

15. How long have you used weather insurance index? ……. years

16. In the years you have used WII, would you say WII is easy to use?

1. Yes [ ]

2. No [ ]

17. Would you say WII is profitable in farming activity

1=Very profitable

2=Profitable

3= Average

4=Not at all

18. When was the first time you purchased WII?

1. ☐ 2017-2018 farming season

2. ☐ 2016-2017 season

3. ☐2015-2016 season

4. ☐ 2014-2015 season

5. ☐ One -off

19. Did you receive any training or orientation on WII from the MoA or insurance Firm?

1. Yes [ ]

2. No [ ]

20. What are the major challenges you have faced with WII?

1. ☐ Non-pay-out

2. ☐less pay-out amounts

3. ☐ how to get the pay-outs

4. ☐ how they calculate the pay-out

21. Have you experienced bad weather in this period?

1. Yes [ ]

2. No [ ]

22. If yes to Q18, did you receive any payout?

1. Yes [ ] >>24

2. No [ ]

23. What were the reasons for no payout?

1=Delays by insurance company in processing payment, still waiting

2= Insurance company did not accept the claim because it did not meet its criteria for payout

3= Other (Specify)

24. How long did it take for you to be paid your pay-outs?

1.☐ immediately payouts triggered

2. ☐ very late in the season

3. ☐ not at all

4. ☐ did not know about it

25. Were you satisfied with the pay-out time?

1=very satisfied

2=satisfied

3=partially satisfied

4=not satisfied

26.Were you satisfied with the pay-out amount you received?

1=very satisfied

2=satisfied

3=partially satisfied

4=not satisfied

27. If satisfied, would you say the pay-out amounts were able to cover some of your loses?

1. Yes [ ]

2. No [ ]

28. In terms of recovery of your loses, what percent would you say your got? ……..%

29. How do you get your pay-outs from the insurance company?

1. ☐ No clear known systems to the farmers

2. ☐ through the farmer cooperative chairman

3. ☐ through the MoA system

4. ☐ through the insurance company

30. Do you understand how the pay-outs are calculated?

1=Clearly understand

2=Understand

3=partially understand

4=don't understand

31. Did the insurance companies or government put up any support systems to explain the pay-out systems to the farmers? …. After services

1. Yes [ ]
2. No [ ]

32. How would you describe weather insurance index as a climate mitigation instrument?

1. ☐ Complicated
2. ☐ not consistent
3. ☐ expensive
4. ☐ Very risk
5. Other. Specify……

33. How would you rate the adoption of weather insurance index in your village?

1. ☐ very good
2. ☐ good
3. ☐ very poor
4. ☐ poor
5. ☐ not even known

35. Out of 10 farmers in your cooperative, how many farmers would have WII?.....number

36. With this climate change challenges, how often do stakeholders engage you on WII?

1. ☐ very often
2. ☐ often
3. ☐ very poor
4. ☐ poor
5. ☐ no engagement at all

37. Is cost/price of WII premiums a determinant of uptake?

1. =very big determinant

2. =determinant somehow

3. =not a determinant

38. Compared to information, would you say the price or cost of the WII will be less important?

1. Yes [ ]

2. No [ ]

39. How confident are you in investing more in WII?

1. ☐ very confident

2. ☐ confident

3. ☐barely confident

4. ☐ not confident

40. What are your confident levels of investing in WII?

1☐ Low

2. ☐Medium

3. ☐ High

4. ☐ None of the above

41. What are the major challenges you have faced with WII? Rank in order of priority

	1=extremely significant	2=very significant	3=significant	4=insignificant
Not affordable				
Poor information				
Poor pay-outs				
Poor or no monitoring at all by insurance companies and MoA				
Others				

42.What do you think can be done to better WII service?

1. ☐ Bundle WII with other services

2. ☐More education on WII

3. ☐ GRZ policy on climate mitigation to famers

4. ☐ Increased participation by the insurance companies

Marketing, Extension and Outreach

1. Have you ever received any trainings on weather insurance index?

    1. Yes [ ]

    2. No [ ] >>3

2. If yes, who trained you?

    1. ☐ Ministry of agriculture

    2. ☐ Insurance company

    2. ☐ Input company

    3. ☐Fellow farmer

    4. ☐ NGO

    5. ☐ others (radio, television, social media)

3. Did you own the following in fully functioning conditions as at 30th September 2019?

    1. ☐ radio

    2. ☐ television

    3. ☐smart phone

    4. ☐ others

4. How many times/months did you meet an extension worker during 2018/2019 season?

    1.☐ Once in a Month

    3. ☐ Once in a quarter

    4. ☐ Once in 6 months

    5. ☐ Not all

5. In your own opinion, is information on WII adequate for the farmers to make decisions?

    1. Yes [ ]

    2. No [ ]

6. What do you think should be done to improve information provision on WII to farmers?

    1. ☐ Increased farmer sensitization

    3. ☐ Increased rate of timely pay-outs

    4. ☐ Clear information on the base rates

    5. ☐ Any other

Thank you

THE UNIVERSITY OF ZAMBIA

QUESTIONAIRE (FARMER FOCUS GROUP DISCUSSION)

The University Zambia Graduate school of business: FINANCIAL INNOVATION AMONG SMALLHOLDER FARMERS: ENHANCING UPTAKE OF WEATHER INDEX INSURANCE A PRAGMATIC APPROACH**.** *The University of Zambia as part of the fulfilment will use the information collected by the survey for the PhD in business administration. The results will be strictly for academic purposes.*

INSTRUCTIONS

2. Introduction

My name is Joshua Munkombwe I am from the University of Zambia and would like to conduct a survey pertaining to your farming business and climate resilience strategies you are coping with. You as a group have been selected to participate on this survey on weather index insurance uptake study. The evidenced based results will help to improve the adoption and uptake of the insurance and help develop frameworks that would enhance adoption of the instrument thereby directly benefit you as farmers by mitigating the risk of weather in your farming business.

3. The information collected by this study will be strictly used for academic purposes and the results will help develop frameworks that would enhance adoption of Weather insurance index that will help increase the farmer resilience and risk mitigation to weather and support the growth of the agricultural sector. All information provided will be kept COMPLETELY CONFIDENTIAL.

This survey will take 15 minutes.

You indicate your voluntary consent by taking part in this survey.

Interviewer:	**Date of interview:**
Start time of interview:	**End time of interview:**

1a. Province:

1b. District

1c. Village:

1d. Agriculture Camp:

1e. Name of the Respondent/Group/Cooperative:

1m. Size of the farm: 1-5ha☐ 5-10ha ☐ 10-20ha☐

1n. Crops grown: Maize ☐ Cotton☐ Soya☐ Groundnuts ☐ Tobacco ☐ Sunflower☐ Beans☐

1o. Mobile number:

2.What problems do you face in your Agriculture business? Rank in order of priority

	1=very significant	2=significant	4=Insignificant
Bad and challenging weather			
Access to agriculture inputs			
Market information			
Commodity output markets			
Extension services			
None			

3. Do you know what weather insurance index is?

1. Yes [ ]
2. No [ ] >> 9

4. If yes, how did you know about weather insurance?

1. ☐ Ministry of agriculture FISP
2. ☐ Insurance company
2. ☐ Input company
3. ☐Fellow farmer
4. ☐ NGO
5. ☐ Media i.e. radio, newspaper, TV
6. ☐ others

5. Have you insured your crops before?

6. Who did you insure with?

7. If yes, how much premiums did you pay?

8.If no, why did you not insure?

9. Did you experience any bad weather

10. If yes, did you receive any payouts?

11.Was the payout systems effective?

12.How would you want the payout systems is done next time?

13.what challenges are you experiencing with WII?

14.How can these challenges be resolved?

THE UNIVERSITY OF UNIVERSITY

QUESTIONAIRE STAKEHOLDERS (Insurance Companies).

The University Zambia Graduate school of business: FINANCIAL INNOVATION AMONG SMALLHOLDER FARMERS: ENHANCING UPTAKE OF WEATHER INDEX INSURANCE A PRAGMATIC APPROACH**.** *The University of Zambia as part of the fulfilment will use the information collected by the survey for the PhD in business administration. The results will be strictly for academic purpose.*

INSTRUCTIONS

4. **Introduction**

My name is Joshua Munkombwe I am from the University of Zambia and would like to conduct a survey pertaining to your insurance business with the smallholder farmers. You have been selected to participate on the survey on a weather insurance index uptake study. The evidenced based results will help to improve the adoption and uptake of the instruments and help develop flame-works that would enhance adoption of the instrument thereby directly benefit you as farmers by mitigating the risk of weather in your farming business.

5. The information collected by this study will be strictly used for academic purposes and the results will help develop flame-works that would enhance adoption of Weather insurance index that will help increase the farmer resilience and risk mitigation to weather and support the growth of the agricultural sector. All information provided will be strictly treated confidential. This survey will take 15 minutes.

You indicate your voluntary consent by taking part in this survey.

Interviewer:	**Date of interview:**
Start time of interview:	**End time of interview:**

Name of the company:

Gender: M ☐ F ☐

Position:

Mobile number:

District:

Province:

1. Does your company offer weather insurance index services to smallholder farmer?

1. Yes [ ]

2. No [ ] >>11

2.How long have you been offering the service? ……years

3. What is the coverage of your service?

1. ☐ National wide

2. ☐ district level

3. ☐ based on out grower companies

4. ☐ based NGOs

4. If yes, what level of farmers do you target?

1☐ FISP Farmers

2. ☐ smallholder farmers

2. ☐ emergent farmers

4. ☐commercial

5.How many farmers are you serving? ……

6.How many hectares were covered under weather insurance index?

1. ☐ 2017-2018 farming season …….ha

2. ☐ 2016-2017 season …….ha

3. ☐2015-2016 season ……ha

4. ☐ 2014-2015 season ……ha

7.What was the total value covered?

1. ☐ 2017-2018 farming season ……ZMW

2. ☐ 2016-2017 season ……ZMW

3. ☐2015-2016 season

4. ☐ 2014-2015 season

8. Did you experienced bad weather in the past seasons

1. ☐ 2017-2018 farming season
2. ☐ 2016-2017 season
3. ☐2015-2016 season
4. ☐ 2014-2015 season

9.If yes, did you make any payouts?

10. If yes, how much payouts did you do?

11. In own opinion do these factors affect the uptake of weather insurance index?

1. ☐ relative advantage
2. ☐complexity
3. ☐observability
4. ☐ compatibility
5. ☐ risk

12. Do you have the marketing strategy and budgets for WII to farmers?

1. Yes [ ]
2. No [ ]

13. What are some of the challenges you face in implementing WII?

1. ☐ Low numbers of farmers participating
2. ☐ Historical data on weather
3. ☐ Bases rates
4. ☐ Government interference and policy
5. ☐ contracted insurance companies not transparent
6. ☐ Any other

14. Of your farmers, who are the majority clients by gender?

1. ☐ females
2. ☐ males
3. ☐ youths

15. What can be done by different stakeholders to encourage uptake of WII?

1. NGOs
2. MoA/GRZ

3.Insurance companies

16. Do GRZ subsidies encourage uptake of WII?

Thank you.

Appendix 2 Ethical Clearance

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

RESEARCH DEPARTMENT

APPROVAL OF STUDY

20th August, 2020

REF NO.HSSREC-2020-JUL-015

Joshua Munkombwe,
LUSAKA.

Dear Mr. Munkombwe,

RE: "FINANCIAL INNOVATION AMONG SMALLHOLDER FARMERS: ENHANCING UPTAKE OF WEATHER INDEX INSURANCE A PRAGMATIC APPROACH"

Reference is made to your protocol dated 1st July, 2020. HSSREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	**Ordinary Review**	**Approval No. HSSREC-2020-JUL-015**
Approval and Expiry Date	Approval Date: 20th August, 2020	Expiry Date: 19th August, 2021
Protocol Version and Date	Version - Nil.	19th August, 2021
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	
Number of Participants Approved for Study		

Appendix 3: Publications

3.1

J. Soc. Sci. Adv. 3 (1) 2022. 01-19

Available Online
Journal of Social Sciences Advancement
www.scienceimpactpub.com/jssa

Financial Innovation among Smallholder Farmers: Enhancing the uptake of Weather Index Insurance through a Pragmatic Approach

Joshua Munkombwe[1]*, Jackson Phiri[2], Enock Siankwilimba[1]
[1]Graduate School of Business, University of Zambia, Lusaka, Zambia
[2]Department of Computer Science, University of Zambia, Lusaka, Zambia

ABSTRACT

Advances in innovation around financial instruments over the decades have promoted a response to the improved development of agriculture products and services in the sector, allowing, to some lesser extent, the introduction and testing of these products to poor rural farmers. However, over the years, the agriculture sector has faced challenges from climate change, resulting in poor agriculture production and productivity for farmers. Therefore, the study considered the extent to which smallholder farmers were willing to uptake and adopt innovations such as the weather insurance index and financial edging technology. The uptake of innovation and technologies has several factors. According to Rodgers, the technology diffusion theory, five elements need to be considered: compatibility, relative advantage, complexity, observability, and trialability. To achieve this objective, we conducted a mixed-method study targeting 252 smallholder farmers in the Choma district of the Southern province of Zambia. Using well-structured questionnaires, a survey of 252 randomly but purposively selected farmers were interviewed. The study was a cross-section from 2014 to 2020 to help establish the impact throughout the years. An IBM statistical analysis in social science (SPSS) was used to analyze quantitative data, and thematic analysis was used to analyze qualitative data. The study established that the extent of innovation diffusion of the weather insurance index with farmers is a combination of factors that need to be implemented if farmers adapt and adopt technologies. The innovation diffusion theory explains the factors that are supposed to be paid attention to as financial innovations are pushed onto the agricultural markets. However, the study found that 34.9% of farmers were unaware of the weather insurance index provision through government initiatives or not. This research, therefore, informs national policymakers, farmers, researchers, and educators on the impact of the weather insurance index. It similarly provides evidence on the uptake as it is and suggests a way forward on issues such as "best practices for marketing, distribution, insurance education, and product design to some extent."

Keywords: *Financial diffusion; Adoption; Weather index insurance; Smallholder farmers; Uptake*
*Corresponding Author: Joshua Munkombwe, Email: mutabi.munkombwe@gmail.com

Munkombwe, J. ., Phiri, J., & Siankwilimba, E. (2022). Financial Innovation among Smallholder Farmers: Enhancing the uptake of Weather Index Insurance through a Pragmatic Approach. Journal of Social Sciences Advancement, 3(1),01–19. https://doi.org/10.52223/JSSA22-030101-27

3.2

Proceedings of the First Australian International Conference on Industrial Engineering and Operations Management, Sydney, Australia, December 20-21, 2022

Why is the Variation of Weather Insurance Index Adoption/ Uptake Exhibited as such among Small Holder Farmers: Testing the Theory of Technology Adoption if it Applies, Case of Zambia

Joshua Munkombwe
Graduate School of Business Studies
University of Zambia, Lusaka, Zambia
joshua@musika.org.zm /mutabi.munkombwe@gmail.com

Jackson Phiri
Department of Computer Science
The University of Zambia, Lusaka, Zambia
jackson.phiri@cs.unza.zm

Abstract

Understanding the reasons why smallholder farmers do not use financial instruments to protect themselves against losses brought on by climate change concerns is currently a subject of rising relevance. Getting to the bottom of the underlying issues contributing to this status is important for future designs of financial innovations like a weather insurance index (WII) that can help farmers hedge their losses. Therefore, this study considered testing the 5 technology characteristics that Rodgers identified for uptake to take place. These include trialability, complexity, compatibility, relative advantage, and observability, covering a period from 2014 to 2020. The study used a concurrent mixed-methods approach to ensure both quantitative and qualitative aspects of the study were considered, given the complexity of the inquiry. The study used purposive sampling to select 4 districts in Zambia: Choma, Petauke, Chongwe, and Mumbwa using the standard sample size table provided by Sekeran (2003), which provided for a sample size of 1024 at a concentration of 0.035 with an accuracy level of 95% confidence. The farmers were interviewed using structured questionnaires. An IBM statistical analysis in social science (SPSS) was used to analyze quantitative data, and thematic analysis was used to analyze qualitative data. From the study 50.82% of the farmer's said WII is not consistent with the p-value of 0.001, which was significant, and further, 40.8% of the farmers indicated the importance of bundling the services to have relative advantages of the product with a p-value of 0.001. 47.87% of farmers indicated they were not satisfied with the payout system, with a p-value of 0.001, which was significant. The study concluded that paying attention to the innovation characteristics as suggested by the diffusion innovation theory by Rodgers is important and that the theory can extend its views by considering the functionality of the market. Farmers do not adopt innovations at the same time, which has practical ramifications for the study's findings.

MUNKOMBWE, J., and Phiri, J., 2022, December. WHY IS THE VARIATION OF WEATHER INSURANCE INDEX ADOPTION/ UPTAKE EXHIBITED AS SUCH AMONG SMALL HOLDER FARMERS; Testing the theory of Technology Adoption if it applies. Case of Zambia. In *1st Australian International Conference on Industrial Engineering and Operations Management*, https://doi.org/10.46254/AU01.20220492.

3.3

CHAPTER -4

ENHANCING THE ROLE OF MICROFINANCE PRODUCTS AND SERVICES FOR SMALLHOLDER FARMERS IN ZAMBIA

Joshua Munkombwe,
[1]Graduate School of Business, University of Zambia, Lusaka, Zambia,
Mutabi.munkombwe@gmail.com

Enock Siankwilimba
[2]Graduate School of Business, University of Zambia, Lusaka, Zambia
enocksiankwilimba@gmail.com

Jackson Phiri
[3]Department of Computer Science, The University of Zambia P. O. Box 32379, Lusaka,
Zambia, jackson.phiri@cs.unza.zm

Mudenda Bernard Hang'ombe
[4]Microbiology Unit, Africa Centre of Excellence for Infectious Diseases of Humans and Animals (ACEIDHA), School of Veterinary Medicine, University of Zambia, Lusaka, Zambia, bhangombe@unza.zm

Corresponding Author: enocksiankwilimba@gmail.com

ABSTRACT

Smallholder farmers must be included in the market space for any microfinance model to grow swiftly, flexibly, and effectively specified models that necessitate shifting international and local enabling contexts. To overcome the issues that the agriculture sector faces, a diverse set of solutions must be developed that enable and accelerate smallholder farmers' participation in agricultural markets.

Smallholder farmers contribute a substantial amount to the agriculture sector and GDP of developing nations like Zambia, but they continue to encounter challenges in their production and productivity systems. If the issues of smallholder production and productivity are to be solved, agriculture microfinance remains crucial. This would necessitate the use of systems thinking methodologies to solve the difficulties that arise across the numerous value chains in which smallholder farmers participate and invest. Push and pull incentive mechanisms, such as the commodity-based approach, will help farmers get access to financial services. A multiplayer multifunctional approach is required to solve both the extension issues and the challenges surrounding agriculture funding in the sector. As a result, all-inclusive models must be proposed to provide pragmatic solutions to the larger industry. While microfinance is critical to the sector, it will be especially important to develop more slanted approaches toward women's access to finance, starting with financial literacy extension capabilities. Government cooperation in providing policy instruments that allow microfinance to feel secure remains crucial in increasing financial inclusion in smallholder markets. Microfinance providers and smallholder farmers will benefit from wider market systems that give opportunities for both supply and demand.

Anwar, Shaikh & Mateen, Ana & K, Dr.Shirley & Jacobi, Nijil & Siankwilimba, Enock & Munkombwe, Joshua & Phiri, Jackson & Hang'ombe, Mudenda. (2022). COVIDONOMICS AND INDIA: ECONOMY DURING COVID-19 https://www.researchgate.net/publication/359788340_COVIDONOMICS_AND_INDIA_ECONOMY_DURING_COVID-19

3.4

Journal of Namibian Studies, 38 S1 (2023): 347-375 ISSN: 2197-5523 (online)

Understanding The Variation Of Weather Index Insurance Amongst Farmers In Zambia: To Recommend A Framework That Should Enhance The Uptake Of Wii In The Agriculture Sector For Smallholder Farmers

Joshua Munkombwe*[1], Jackson Phiri[2]

[1] Graduate School of Business, University of Zambia, Lusaka, Zambia.
[2] Department of Computer Science, University of Zambia, Lusaka, Zambia.

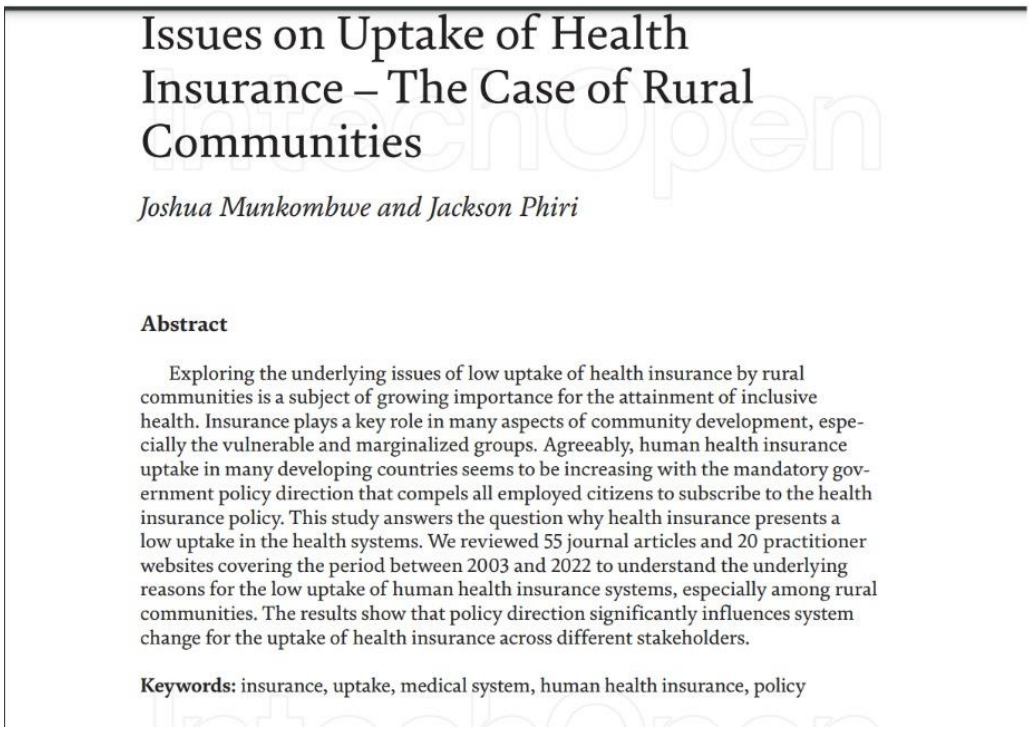
Abstract

Understanding the importance of the Weather Insurance Index (WII) as a financial tool for risk mitigation is increasingly critical to the development of sustainable agriculture. This is because the effects of climate change continue to endanger and ruin the agriculture sector, which is dominated by smallholder farmers. Among the many climate change coping mechanisms used by farmers, microinsurance remains one of the key techniques available. However, its uptake is significantly low, coupled with a lack of empirical evidence to clearly understand the underlying reasons for the status quo. The main objective of this study was to develop and recommend a framework that could enhance the uptake of WII by farmers. Results from this study were generated using a mixed-methods approach and captured from 1,024 farmers who were purposively sampled from 4 districts in Zambia. The findings showed significant and positive results of payout systems as an important enabler in the uptake of WII. Further, the cooperative systems had a significant influence as an appropriate distribution model through which the farmers got information, premiums, payouts, and aggregation. This recommended framework will be key in facilitating the uptake and scale-up of WII and other financial instruments amongst farmers.

Keywords: Uptake, Framework, Smallholder farmer

Munkombwe., J and Phiri, (202. 3)Understanding the Variation Of Weather Index Insurance Amongst Farmers In Zambia: To Recommend A Framework That Should Enhance The Uptake Of Wii In The Agriculture Sector For Smallholder Farmers. (2023). *Journal of Namibian Studies: History Politics Culture*, *38*, 347-375. https://doi.org/10.59670/gfq6hj60

3.4



Issues on Uptake of Health Insurance – The Case of Rural Communities

Joshua Munkombwe and Jackson Phiri

Abstract

Exploring the underlying issues of low uptake of health insurance by rural communities is a subject of growing importance for the attainment of inclusive health. Insurance plays a key role in many aspects of community development, especially the vulnerable and marginalized groups. Agreeably, human health insurance uptake in many developing countries seems to be increasing with the mandatory government policy direction that compels all employed citizens to subscribe to the health insurance policy. This study answers the question why health insurance presents a low uptake in the health systems. We reviewed 55 journal articles and 20 practitioner websites covering the period between 2003 and 2022 to understand the underlying reasons for the low uptake of human health insurance systems, especially among rural communities. The results show that policy direction significantly influences system change for the uptake of health insurance across different stakeholders.

Keywords: insurance, uptake, medical system, human health insurance, policy

Munkombwe, J., & Phiri, J. (2024). Perspective Chapter: Underlying Issues on Uptake of Health Insurance–The Case of Rural Communities.DOI:10.5772/intechopen.1003531