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

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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*

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INTRODUCTION

As much as insurance products for transferring weather risks appear to hold great promise, the practical realization of sustainable and scalable products in developing country contexts necessitates constant innovation, which requires understanding the underlying reasons for participation in and use of specific financial innovations. Financial innovation decisions should, to some extent, reflect the interests of various stakeholders, such as customers, farmers, and government policymakers (Fanconi & Scheurle, 2017). 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).

Rendering to the United Nations Development Programme (UNDP) Sustainable Development Goals (SDGs) (UNDP, 2021), goal number one (1) talks about the complete eradication of poverty globally by the year 2030 (GSDR 2019). However, 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), which is already grappling with low productivity-enhancing technology and beneficial market prospects, compounded by the current COVID-19 outbreak (Siankwilimba et al.,2021; World Bank 2021; Osakwe 2021).

According to the World Development Report, 2.5 billion people live "in households involved in agriculture" in low-income and developing nations (World Bank, 2020), which are notably less industrialized, putting them in danger from climate change(Clark et al., 2020; Nima et al. 2020; Oko 2018). 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, 2017; World Bank,2016).

Weather index insurance (WII) (or interchangeable referred as 'weather index-based insurance') ensures a weather risk highly correlated with agricultural production losses, frequently reliant on rainfed 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 design compared to traditional insurance instruments. This financial innovation appears to be better suited for smallholder farmers in Zambia, as the other conventional insurance covers have conditions and terms that prevent smallholder farmers from accessing and participating in them. Over the years, even the insurance companies have failed to promote their insurance policies in rural areas because of the non-inclusive design and conditionality attached. Yet, smallholder farmers continue to suffer from many risks associated with climate change effects.

Even though smallholder farmers are excluded from the WII, repeating weather extremes appear to be linked to risk-aversion tactics such as limited adoption of productivity-enhancing inputs and technology (Dercon and Christiansen 2011; Sibiko 2018; Mukasa 2016; Fisher 2019). Agricultural insurance appears to have the ability to help, though, and it is almost non-existent in most developing nations due to institutional constraints, such as high business costs and moral hazard and adversative selection concerns (De Janvry et al. 2014; Jensen and Barrett 2016; Nshakira 2021; Ankra 2021).

Through the world food program (WFP), multilateral institutions such as World Bank (WB) and United Nations (UN) 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, weather index-based insurance may give farmers confidence to invest in their products while accruing other benefits. On the other hand, benefits such as providing a safety net for vulnerable households and providing price signals regarding weather risk appear that climate change increases insurance prices due to improved weather risk (Opiew et al., 2021). Furthermore, there is improbability about the enormous regional consequences, which adds to pricing challenges (Barnette et al., 2014).

This paper investigates why weather insurance index adoption and uptake is exhibited among smallholder farmers and the extent of uptake in the district of Choma in Zambia. It is contemplated as a financial instrument to help farmers manage risk. In addition, for some time, the paper will investigate the effectiveness of the weather insurance index as a climate and financial mitigation instrument. Therefore, the report will help inform policymakers and practitioners about the impact of the weather insurance index and, to some extent, issues related to WIII marketing, distribution, insurance education, and product design.

Research question

According to Sweet and Grace-Martin (2003), it is clear that the research question emphasizes a lack or absence of understanding about an issue that should be addressed. It refers to the gap that the researcher in this study is addressing. Therefore, this study attempted to answer the following questions:

Specific objective

To address this main problem, the study employed the specific objective that hinges on:

- To describe the extent of weather insurance index uptake among smallholder and emergent farmers in the Choma district of Zambia

RESEARCH METHODOLOGY

Primary data from 252 farmers in the sample of rural areas of Choma district in Zambia was collected using well-structured and carefully designed questionnaires. Five local enumerators were trained, and the questionnaire was pretested to ascertain its suitability to expose the enumerators to the study. The enumerator supervision ensured the collected data was provided during all data collection periods. Data was collected from the 252 farmers' sample size using face-to-face interviews. The study used quantitative method similarity to safeguard the farmers understood the underlying reasons why the study used the qualitative method to ensure a clear understanding of reality or ontology. Therefore, the study decided to use the mixed-method approach. It was essential to understand both the spread and underlying reasoning of what was obtained with the farmers on WII uptake. Thus, supporting and agreeing with the approach chosen and according to theory, the mixed-method system is a research inquiry that uses qualitative and quantitative techniques in research work for breadth and depth of understanding and to establish relationships between the different connotations (Schoonenboom & Johnson,2017; Dawadi et al.,2021). According to Creswell and Plano Clark (2011), Timmons et al. (2019; Noyes et al.,2018), the important proposition of the mixed-method design was that using qualitative and quantitative methods in the relationship would offer an enhanced understanding of the research problem than using either technique alone in a study. This is argued to be one, if not the majority, of the central premise of pragmatic philosophical reasoning in contemporary research (Guetternan et al., 2015; Rai &Bahadur, 2018; Gunasekera, 2013). The practical approach stresses that in each specific provision, numerous realities exist. The research question determines the researcher's paradigm that the study attempts to answer (Saunders et al., 2009; Katri, 2020; Raimo, 2021).

The pragmatic approach collects data and investigates complex social and environmental phenomena using qualitative and quantitative research approaches (Creswell, 2009; Kaushaki & Walsh, 2019; Kelly & Cordeiro, 2020). Therefore, the pragmatic research philosophy allows the adoption of mixed methods as the data collection method, which helps to be objective and not subjective in analyzing the participants' points of view (Brierley, 2017). Both quantitative and qualitative paradigms were used in the study to help understand and interpret the different phenomena. It took both the positivism and interpretivism or constructivism philosophical standpoints. In this case, the mixed approach allowed the study to conceptualize precisely what was happening with the farmers in the Choma district on WII. Further, triangulation was used to gain meaning from the multiple respondents that various tools will target, including interviews, questionnaires (closed and open), focused group discussions, and surveys. The financial diffusion and technology adoption theories will help theorize the different inquiry issues.

Study District

Choma district is situated in the Southern Province of Zambia, approximately 300km from Lusaka. The district has a population of 180,673 according to the 2010 census, with agriculture households of 30,778. The district is predominantly agricultural, with a total of 7,296 Km^2. The annual growth rate of the district is 6.8% (CSO, 2010) and is the highest rate in the province. It is also a provincial headquarter for the Southern Province of Zambia. 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 district is predominantly a Tonga speaking area that mainly depends on agriculture to sustain their daily livelihood.

The researcher picked Choma district as a study area because it was used by the government as a pilot district on weather index insurance scheme in 2014. Since then, the district has remained on a weather index insurance scheme giving leveraging points against other districts in the country. Choma district is subdivided into five agricultural blocks, divided into 37 agricultural farming camps (areas). An agricultural block is responsible for 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. This study was carried out in 18 out of 37 camps. The purposive sampling method was used to select the 18 camps in which 252 farmers were randomly selected. This was the case because there was need to target pilot areas where WII was done before or is ongoing through the government driven Farmer Input Support Program (FISP). Three independent enumerators were engaged to remove the chance of biasness, which could come into being if government extension officers were utilized. The enumerators were locally based ensuring they understood the local context and language as well as cost effectiveness.

LITERATURE REVIEW

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 climate smart tools. 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 rainfall dependent areas, of which the majority of farmers are part. Indeed, growing evidence suggests historical food insecurity globally because of climatic influence (Niles and Salerno, 2018; Ngoma et al., 2021). Chinseu et al. (2019) and 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 (Mulenga and Kabisa 2021). 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 (Ali 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). Many 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 (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 and Miranda, 2015). However, there is insufficient scientific proof about the real effects, making it less appealing for farmers to embrace (Ali et al., 2021; Singh et al., 2018; Carter et al., 2006). 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 (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, Barnett 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). In addition, roughly 70% of the labour force in Zambia works in agriculture, where there are approximately 1.6 million smallholder 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 the majority of 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 sparsely distributed smallholders in remote rural areas. Moreover, the non-existence of farmer aggregation presents 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 (Carlo, 2016; Syroka &Reinecke, 2015).

How does weather index insurance work?

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 settlement. If the weather has been terrible enough to trigger a settlement as per the product criteria, a settlement is expected with weather index insurance. In the event of drought or excessive rain, insured farmers can replant due to the early settlement 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).

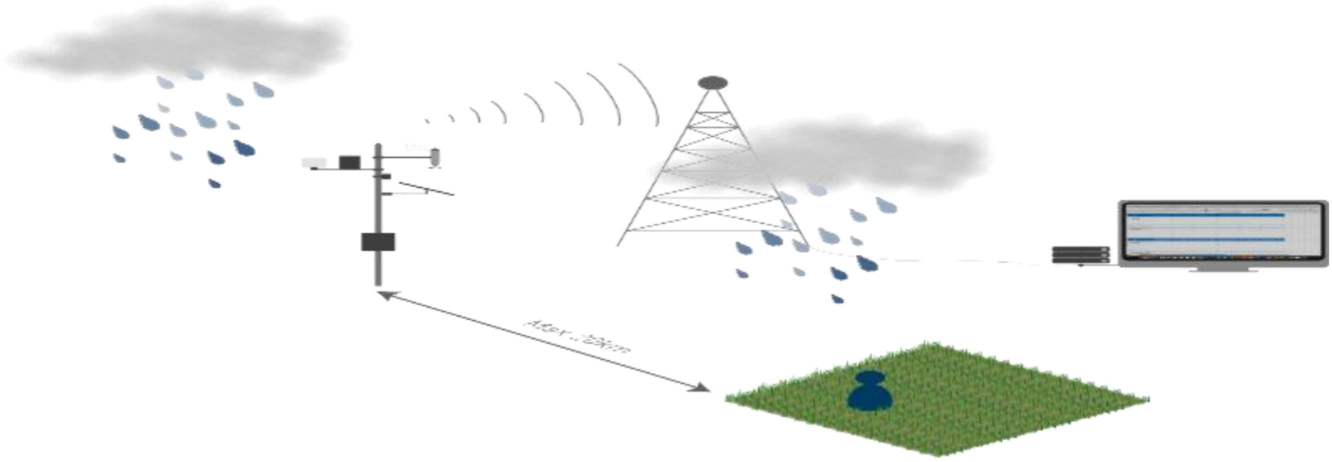

Figure 1; Showing the simple set up for Satellite estimation of rainfall over farmers' fields (aggregated) for different locations in Zambia, based on GPS coordinates of reference points

Source: (Musika, 2017)

The information collected by the satellite is used to compute the insurance settlement Index 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).

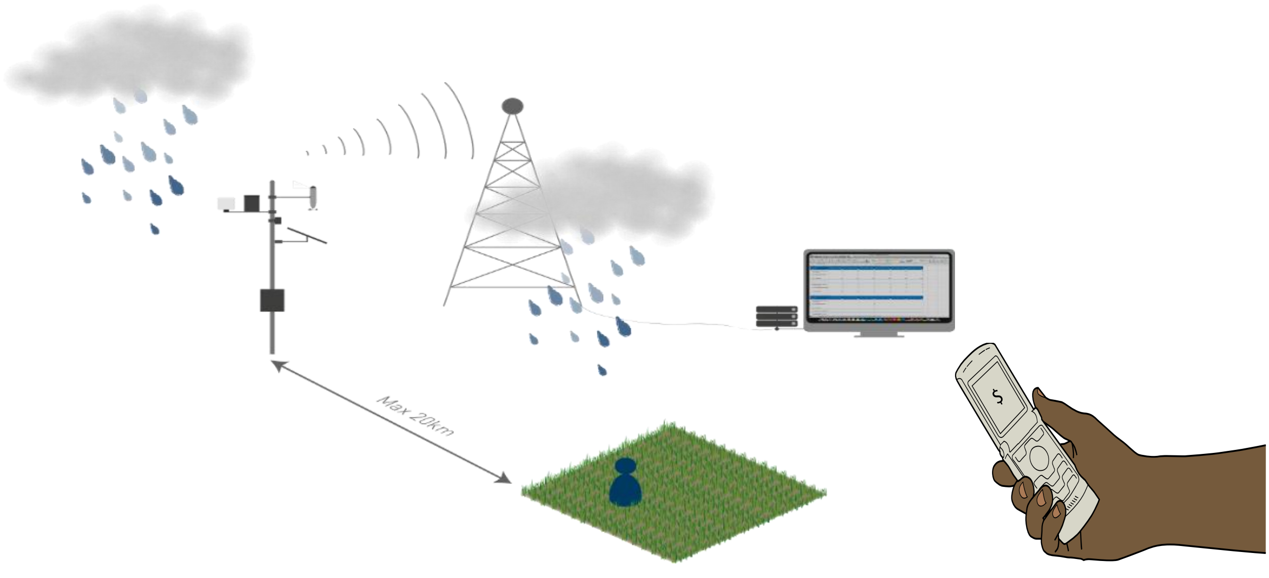

Figure 2: Showing simple illustration of how WII works

Source: (Musika, 2017)

1. 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 settlement is provided automatically based on the weather events (e.g., droughts, dry spells). Typically, a settlement 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 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).

2. If satellite rainfall data indicates a settlement is required in the area, the same percentage settlement is paid to all farmers registered at that weather station, and no field visit or assessment is required (Matt and Mehta 2018; FAO 2021). The weather insurance index occurs based on historical data, 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).
3. The rewards are provided automatically when an index goes above or below a pre-determined threshold. (Kalvin and Federico, 2020). The farmer does not need to fill in any documentation to get payments (CNAAS,2020).

   - The higher the payoff, the more complex the weather; however, the settlement 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).

Critical Points for Weather-based Index Insurance:

1. The weather is not easy to be observed and objectively measure the insurance settlements (Nick Miller, 2020). 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; Antwi-Agyei & Stringer, 2021; Swiss Re corporate solutions,2019).
2. 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)
3. Settlements 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 settlement even if he experienced a drought or excess rain that damaged his crop (FAO, 2021). However, if approved, settlements 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 (Njagi.,2022; Rishi & Priebe.,2020; He et al.,2019) and to develop livestock productivity and child health for pastoralists in Kenya (Karlan et al. 2014; Jensen, Barrett, and Mude 2016a).
4. Weather insurance can improve the sustainability of crop production by using the settlement to purchase inputs after a poor season (FAO, 2021). In addition, farmers can expand investments in higher-risk, higher-yield agricultural technologies, such as enhanced seeds and information, because insurance removes a portion of income risk from the household's portfolio (Barret et al., 2016; He et al., 2019).

Weather insurance index in Zambia

As climate change continues to threaten agriculture production, the most vulnerable are the smallholder farmers, who are approximately 1,500,000 and reliant on rain-fed agriculture production (WFP, 2021). From appeal, it appears that weather index-based insurance enables several opportunities to smallholder farmers against adverse weather events such as drought and excess rain. Smallholder farmers have previously failed to participate in general traditional insurance policies due to associated costs and conditions. Nonetheless, by using weather-based - index insurance that utilizes weather stations using the pre-defined index, such as rainfall, to determine pay-outs instead of farm inspections to monitor crops, if well done, index insurance can drastically reduce per-farmer transaction costs (Rose, 2012; WFP, 2021).

In the case of Zambia, there are several insurance companies that offer weather index insurance such as Mayfair, Professional Insurance, with several others starting to provide the service. The weather index-based insurance (WII) piloting for smallholder farmers on the government-supported program was conducted earlier in the 2013–2014 farming seasons. However, noticeable coverage increased exponentially in the 2017–2018 farming season. The number of policies sold and the sum insured increased from less than 20,000 farmers and the $2 million in the 2016/17 farming season to over 1 million farmers and $176 million respectively in the 2017/18 farming season. The average premium rate was approximately 6% of the sum insured (World Bank, 2018); however, today's status is not the case. This increase was primarily due to the government subsidies through the Farmer input support program (FISP) programs (Simukanga et al., 2018).

Significant challenges in agriculture insurance in Zambia

The technical capacities needed to develop the technology are critical to developing and promoting weather index insurance. However, Zambia has limited local technical ability for index insurance design, implementation, and supervision. In addition, it lacks a comprehensive agricultural, specifically weather index insurance framework in which the roles of the different parties are established (World Bank 2018).

FISP-linked Weather Index Insurance

Continuous failure to make any settlement in 2017-18 and 2019/2020 to smallholder farmers poses significant risks to future uptake and is a potential issue in farmers' awareness and understanding of how the FISP index insurance scheme work. In addition, the lack of an independent third-party calculation agency that can verify the accuracy of insurance settlements without fully developed transparent payments systems when it triggers need to be put in place (World Bank, 2018). As a result, from 2013 to 2018, the number of WII policies sold and the aggregated sums insured increased, as did claims and losses.

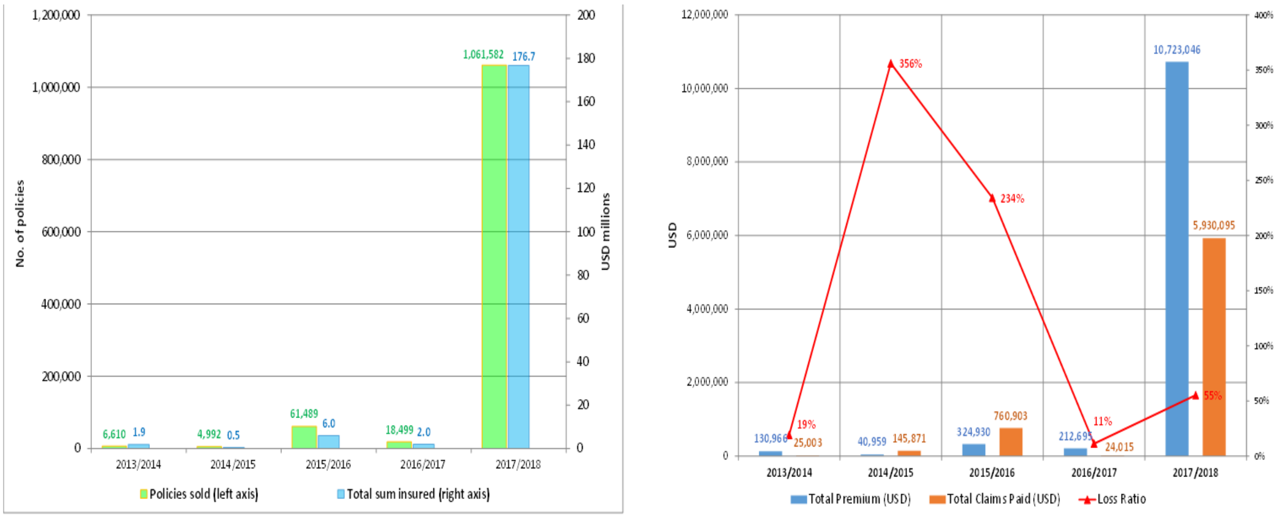

Figure 3:Showing WII performance

Source: Adopted from pension and Insurance Authority, personal communication report

1. The graphs indicate how the weather insurance index worked started in 2013. It shows a poor diffusion/adoption rate on the instruments away from the FISP induced subsidies, though even with them, their overall contribution to the national aggregated number of hectares under smallholder farmers is far below the smallholder farmers' exposure to weather-related risks. For example, in the Mumbwa district, the total population of farmers is 63,435, but only 16,925 are on FISP. Similarly, in the Choma district, the total population of farmers is 45,000; only 25,464 are on Farmer Input Support Program (FISP). There is a clear need to investigate the amount of diffusion of the instrument by smallholder farmers in the sector. Hence, this study will try to understand this situation and develop models to enhance WII uptake among smallholder farmers.
2. Corresponding results found in a study on 252 farmers in the Choma district of Zambia showed that in highly rain-fed dependent farming communities' uptake of WII was deficient but dependent on the government's highly subsidized compulsory insurance scheme. To some extent, the poor uptake of WII results from several factors that similarly present apparent disparity between the continuous weather challenge the farmers are facing and uptake of WII, which can help increase resilience. The discrepancy between expected and actual demand among smallholder farmers, on the other hand, is linked to cash restrictions during planting season, a lack of trust, and an absence of insurance understanding (Ali, 2021; Kaelab et al. 2019; Giné et al., 2008; Cole et al. 2013;). Therefore, education/ capacity building is crucial if WII is to be recognized and appreciated by the smallholder farmers.
3. Solving the uptake puzzle will also require fixing the infrastructure, such as weather data, design challenges, moral challenges, and marketing (RSM,2022). According to Carlos 2016, several development problems have not been solved to contribute and agree to this. These include technical barriers (especially with the availability and reliability of data and the accuracy of indexes), a lack of demand among farmers, a lack of logistical support, and a lack of profitability of the products (Carlos,2016; RSM,2022).
4. With the slow pace of growth around WII, insurers do not regard it as a profitable line of business; they have displayed little interest in investing in market development, which is vital for farmer uptake (Carlo,2016). As obtaining, evidence broadly supports this conclusion. For example, Finbarr Toesland (2021) indicate that by 2019, Africa total insurance penetration stood at 2.78%, far below the global average of 7.23%, says the African Insurance organization. To appreciate the technology, they need to be fully aware and experience it. However, it looks like most smallholder farmers in developing countries have simply no experience with the concept of insurance (Singh et al.,2018). Weather insurance index, for example, was a foreign notion for farmers in China until around 2010, when the public People's Insurance Company of China tried it with hefty subsidies (Cai et al., 2014). Therefore, the farmers may need to experience WII to improve uptake.

The extent of WII uptake by the rural smallholder farmers

We begin by looking at WII's attractiveness and, indeed, uptake concerns. The traditional role of agriculture insurance is to advance the recovery pillar of resilience, with the insurance delivering financial security against extreme weather events (Hudson et al., 2020; Will et al.,2021). As obtained, the appeal is clear. Farmers can employ index-based weather insurance to protect themselves against irregular rainfall jeopardizing agriculture production.

Index-based weather insurance is based on the occurrence of an accurately dignified weather variable (e.g., rainfall) that is interconnected with production losses (IFAD,2011; Sibiko et al., 2018; CNAAS,2020). As a result, information asymmetry and moral hazards are reduced since neither the insured farmer nor the insurer can falsify rainfall readings (Snaebjom,2016). Furthermore, rather than lowering effort to enhance compensation odds, WII farmers have a motivation to make the most significant farming decisions possible (IFAD 2010). WII is also less expensive than traditional insurance, resulting in more inexpensive contracts and speedier settlements to farmers, who often need the funds for early planting the following season (Rao 2010; World Bank 2018).

Notwithstanding the theoretical advantages of index-based rainfall insurance, it looks like the smallholder farmers have been slow to adopt it as a standalone product. Mkhize (2012); agrees with this viewpoint, claiming that voluntary penetration of index insurance products is far lower than anticipated (Binswanger-Mkhize 2012; Akter,2016). Underprivileged families, particularly risk-averse ones, ideally should benefit the most from innovative micro-insurance products(World Bank, 2016). Nevertheless, they are unforthcoming to use WII unless governments subsidize premiums donations or bundle them with other benefits, effectively making insurance quasi-compulsory (Clarke et al. 2012; Miranda and Farrin 2012; Micheal Carter et al.,2014; Makaudze,2018). As a result, it seems that WII goods have yet to catch on with smallholder farmers (Binswanger-Mkhize, 2012; Cole et al., 2013). The primary unanswered question is whether a government-subsidized product can provide a cost-effective safety net in high-risk situations (World bank,208). Despite almost a decade of pilot testing in low-income countries, the penetration of many weather index insurance products has been substantially below expectations. Furthermore, index insurance had only gained widespread acceptance in a few instances when provided either free or significantly subsidized. Farmers who obtained subsidized insurance tended to engage in riskier agricultural operations than those who were uninsured in some circumstances (Tadesse, 2015).

Many researchers have conducted investigations to try and understand the underlying causes of low uptake (Ankrah, 2021). Agreeing to this, Kibiko (2016) indicates that several field experiments have been conducted better to understand farmers' insurance demand and its causes. Here we shall try to understand the gaps between the demand and supply-side failures of uptake by farmers that have rarely been investigated and the underlying causes of the farmers' inability to pay for insurance. It would be essential to understand the real underlying issues stopping farmers from adopting WII. The study is done in the light of the continuous weather challenges, economic losses, social stress, and breakdown in their actual financial losses resulting from crop failure, which results in 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 conditions with few interactions with the farmers, agreeably reducing the 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 (Phiri & Zhao 2010) to showcase real-time happenings and rainfall data on which the decisions are based. Basis risk is usually a big issue with WII, as farmers would want to understand the basis of judgment making to compensate, how much not to pay, and the settlement amounts. The rural farmers' decision-making matrix is based on trust in the systems, technology or social-economic issues. The technology adoption theory emphasizes five (5) areas: traceability, compatibility, easy to try new products, relative advantage, and complexity. Uptake of WII is a transformative issue, requiring farmers to understand and appreciate the technology. They may need to understand real-time farmers' points of view and not just the desktop analysis.

Reasons for low uptake voices from the farmers' perspectives

Prominent scholars have documented generic reasons for low uptake. However, regardless of the enormous losses that smallholder farmers continue to face, listening to and paying attention to farmer voices on the reasons for low uptake of technologies, including WII, may help unlock the puzzle. Getting close to technology adoption and uptake by farmers will need considerations of the farmers' perspectives and why the status quo is the way it is today from an economic, social, and systems point of view. This requires different stakeholders to actively listen to the farmers' real-time, practical, and philosophical underpinnings. The uptake puzzle is a multi-facet that may need multiplayer and multifunction approaches as applied in the market systems with considerations of the inner voices of the farmers. Designing products and delivery mechanisms that do not consider the farmers' representatives will not solve the low uptake of technology by the poor rural farmers. Boardroom and workshop solutions to farmers' challenges are by far not the answer. Many studies have been done indicating several factors that affect the uptake of WII amongst smallholder farmers. Still, they keep missing the inner voices that are simple and require clear solutions that consider the social and economic aspects. Recognizing the importance of local context is critical (Born et al.,2019) because it demonstrates that there is no one-size-fits-all answer — what is acceptable in one location may not be in another, resulting in personal insurance market development (Surminski et al., 2015; Tadesse et al.,2015)

Some generic reasons for low uptake include but are not limited to;

Cost issue of insurance

Edging mechanisms are increasingly crucial with global climate challenges, though cost issues are also a concern. Weather-based index insurance in developing countries benefits smallholder farmers. The simplified process where payments are made based on a weather index rather than measurement of crop loss in the field may appear to reduce the cost of WII products, thereby providing opportunities for many farmers to participate. The weather-based index is selected to represent, as closely as possible, the crop yield loss likely to be experienced by the farmer so that it is equitable and inclusive (World Bank,2021). For example, payments are triggered when rainfall stays below a certain pre-defined minimum level in a specified period or exceeds a pre-determined maximum level (Below et al., 2021).

Nonetheless, in the farmers' eyes, less interaction with existing payment systems matters a lot because they do not have to prove actual crop losses to receive the payment (Sibiko et al.,2018; IFAD,2016). This means that administrative costs are lower since no physical claims-investigation process is needed to assess crop damage and must work to the advantage of the farmers. As a result, payments to farmers are usually made more quickly. Therefore, lower administrative costs may appear to suggest lower premiums for farmers. Index-based crop insurance, on the other hand, has significant drawbacks. One is that actual losses will differ from an insurance settlement, known as the basis risk. For example, this occurs when rainfall on the insured plot differs from regional estimates. Furthermore, it may seem that this kind of insurance does not protect farmers from losses caused by other reasons, such as diseases or crop pest infestations (FAO,2021; World Bank 2011). Finally, current studies indicate that weather index-based insurance, particularly rainfall-based insurance is highly price-sensitive, suggesting high insurance prices contribute to low demand (Di Marco, 2021)

Capacity building of WII (extension training)

Farmers' adoption of WII technology will depend on the investments made around making them aware of and experiencing the product. It is well known that farmers cannot adopt complex technologies without concerted efforts and capacity-building by different stakeholders. This needs the government's involvement, the private sector's and donor agencies to ensure sustainable extension systems are in place to provide learning opportunities to the farmers (Siankwilimba et al., 2022). The findings by Cole et al. (2013) support this from a financial literacy and weather insurance marketing field experiment. Cole et al. (2013) indicated that financial education with suitable training strategies, including demonstrations, testimonies from fellow farmers (peer to peer learning), and actual training modules could positively affect rainfall insurance adoption. Therefore, building the capacity of the local insurance staff, delivery agents, government officials are key in making farmers confident to purchase weather index insurance (Wigwe et al.,2021). It appears this needs a multiplayer multifunction approach.

Relationships between stakeholders (trust issues)

In particular, market development and WII involve a trust-based transaction between the farmers and the insurance companies. For the transaction to be considered, insurance companies require an up-front payment of premium by a customer. The payout is based on meeting the necessary conditions set within the contract coupled with satellite report for that specific period under. Therefore, trust in the insurer is a critical consideration in a customer's decision, particularly for rural farmers purchasing insurance. In addition, insurance is complicated, but once the farmers understand it, it builds their trust, thereby increasing confidence in the fairness and usefulness of a policy (Jha et al., 2020).

Therefore, the instrument/technology also needs to be something that cannot lie or be manipulated. To achieve this, instruments like a fully-automated weather station or a satellite are used for weather index insurance (WII training manual; CNAAS,2020). Index-based agricultural insurance products settlement based on the value but without physical verification by the farmers themselves or the companies, but determined by data recorded by the satellite. If the results show a settlement, all farmers insured under the same reference point will be paid regardless of the situation on individual farms (Ianchovichina & Lundström, 2009; CNAAS,2020; FAO,2021). This is good but requires that the farmers be fully aware of the process and the details to build the farmer's confidence and trust (Vahouny, 2021)

Finally, trust issues arise over the actual farmer's payment modalities. In some cases, the product (WII) has been introduced to farmers without direct payment. Moreover, payment methods appear to differ depending on the insurance company, necessitating clear explanations to farmers. Methods available are direct bank transfer and cheques. These are either paid through the cooperatives or by individual farmers. In the case of Zambia, the insurance companies and government are studying to see if payment can be made through the e-voucher that farmers have (under the farmer input support program).

Global Perspectives

Climate change continues to be a global problem, threatening agriculture production and food security and requiring different mitigation strategies (Siankwilimba, 2019). In recent years, there has been enthusiasm among academia and practitioners about the prospects of introducing weather index insurance to manage smallholder farmers' risks in developing countries. Several pilot programs have been demonstrated in some countries, including India, Kenya, Malawi and Ethiopia (Awel and Azomahou, 2014; Cole & Vickery, 2013). The results have shown that WII works well for smallholder farmers as it gives them financial protection in times of weather calamities.

We begin by appreciating the background of weather index-based insurance. Weather index-based insurance appears to have begun from the international weather derivative market, in which corporations hedge weather risks.

According to Matei and Voica (2011) and Zhan Jang (2014), the foremost weather derivative transaction linked to temperature variation was piloted in the United States of America (USA) way back in 1997. By 1999, weather index-based insurance was deliberated in academic papers as an alternative solution for developing agricultural economies. In 2002, the World Bank embarked on a weather index insurance agenda and expended substantial loans and a component of technical support for crop-specific insurance in India for the demonstration, testing and piloting stage (USAID, 2007; Zhang Jang et al.,2021).

Case of India

India's weather index insurance market is the world's most extensive agricultural insurance after the United States and China, transitioning from small-scale and scattered pilots to a large-scale weather-based crop insurance program covering more than 9 million farmers (Rao et al., 2019). The massive number of farmers encourages many more farmers to observe and uptake the technology. Moreover, India has a solid claim to have been the birthplace of the idea of weather index insurance, with Chakravarti having outlined a detailed proposal for rainfall index cover to be sold transversely to India as early as 1920 (Chakravarti 1920; Mahul and Stutley 2010). For example, the national crop insurance scheme (Pradhan Mantri Fasal Bima Yojana) is an area-based yield insurance scheme launched in 2016. Although it covers the most area under crop insurance, the weather-based index insurance scheme had an area coverage of 1.7 million hectares in the country in 2016. Under this scheme, claim payments were tied around weather based parameters like rainfall, humidity, and temperature (Rao et al., 2019).

Ghana's Case

For Ghana, weather index-based insurance was introduced by the Ghana Agricultural Insurance Pool (GAIP) in 2011 to help decrease the monetary risk of crop failure and support farmers to invest more in their farms to increase production (Miranda &Mulangu 2016). The weather insurance product targets smallholder farmers with less than 20 hectares of farm sizes. In 2011, it covered over 3000 farmers in the three northern regions and was scaled up to six areas during the 2012 cropping season (GAIP admin 2017).

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 (Musika, 2017).

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.

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 (Teye & Quarshie,2021; Capitanio,2011). Thus, 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 (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. As a result, this amalgamation of knowledge from multiple players creates a more thorough understanding (Allaire,2001; Sissy et al.,2019) of where and how the disaster impacts materialize, which may not be available if market players that include farmers were not encouraged to act organized (Slavková et al.,2020). Further, farm-level verification is not needed when we look at the WII design, which helps avoid both moral hazards and adverse selection issues, high costs and lengthy delays of claims verification. But this could present puzzles with farmers if not explained (Leah bridle, 2020)

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.

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 it is sustained and has informed demand (IFAD,2011). However, demand 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 (Sitko & Chamberlin, 2016; Daka,2020). According to Mulenga & Kabisa (2021) and Ngoma et al. (2021), 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 drastically since the early 1980s. The rainy season has been altered and many times starting late while the rains have been withdrawing early than expected whearas on the other hand, the temperature has been increasing by one degree Celsius (Siankwilimba,2019; Ngoma et al.,2021; Irish Aid Zambia,2018). 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. According to the World Bank (2006), 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 agricultural 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.

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. However, even with these clear indications of climate change challenges, confusion on uptake continues.

FINDINGS AND ARGUMENTS

Farmer social-economic characteristics

It is indispensable to begin by understanding the farmers' demographics in the Choma district. The ontology of WII has to be presented as indicated by what is obtained on the ground. The majority of the participants were male-dominated, with 83.3% of households being male-headed compared to 16.7% of female-headed households. Could this have a bearing or influence on the uptake of WII?

Are you the Household Head?

Table 1: Indicates the household head proportions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	210	83.3	83.3	83.3
	No	42	16.7	16.7	100.0
	Total	252	100.0	100.0	

Source: (Authors, 2021)

Gender of the Household Head

Table 2: Indicates gender disaggregation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	216	85.7	85.7	85.7
	Female	36	14.3	14.3	100.0
	Total	252	100.0	100.0	

Source: (Authors, 2021)

Age of the Household Head

Table3: Indicates household age distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15-20	6	2.4	2.4	2.4
	21-35	62	24.6	24.6	27.0
	36-50	117	46.4	46.4	73.4
	above 50	67	26.6	26.6	100.0
	Total	252	100.0	100.0	

Source: (Authors,2021)

The farmers were asked their ages to appreciate the different perspectives and combinations of the farmers. Table 3 shows that most respondents were between the ages of 36 and 50, accounting for 73.4 percent of the whole group, with the youngest being between the ages of 15 and 20, accounting for 2.4%. Does increasing youth participation in agriculture production help revolutionize and change the appeal and outlook of the sector? This analysis shows that agriculture production is still being done by the late youth and most old farmers.

No. of Farmers with WII out of 10

Table4: Indicates the level of awareness of WII

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	113	44.8	44.8	44.8
	1	2	.8	.8	45.6
	2	9	3.6	3.6	49.2
	3	28	11.1	11.1	60.3
	4	5	2.0	2.0	62.3
	5	42	16.7	16.7	79.0
	6	5	2.0	2.0	81.0
	7	4	1.6	1.6	82.5
	8	8	3.2	3.2	85.7
	9	5	2.0	2.0	87.7
	10	31	12.3	12.3	100.0
	Total	252	100.0	100.0	

Source: (Authors, 2021)

Further, to appreciate the level of awareness at the farmer's group, the farmers were asked how many community members were aware of and or utilizing WII in their villages on a scale of 0-10. Table 4 indicates one hundred and thirteen farmers (113) 44.8% indicated that 0 out of 10 farmers would be aware of or use WII, 42 farmers (16.7%) indicated that 5 out of 10 farmers would be aware of and use WII, and 31 farmers indicated that 10 out of 10 farmers would be mindful of WII in their villages.

How many farmers have received training from stakeholders?

Table 5: Indicates the proportion of farmers receiving pieces of training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	46	18.3	18.3	18.3
	No	206	81.7	81.7	100.0
	Total	252	100.0	100.0	

Source: (Authors, 2021)

The key to adopting WII is information provision, training, and capacity building through stakeholders. This new technology requires a lot of extension training, information provision, marketing, and demonstrations on what WII is, how it works, benefits, costs, and why. However, table 5 indicated that 81.7% of the farmers had not received any training from stakeholders, and only 18.3% had received training.

Do You Know Weather Insurance Index (WII)?

Table 6: indicate the level of extent the farmers understand WII

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	166	65.9	65.9	65.9
	No	86	34.1	34.1	100.0
	Total	252	100.0	100.0	

Table 6 shows the number of new WII farmers by establishing the reality on the ground (ontology). The government and other stakeholders have supported and promoted WII for many years. However, to what extent do farmers understand or know about WII? The study indicated that 65.9% knew about the WII, and 34.1% indicated they did not know about the WII.

CONCLUSIONS

Climate change challenges will be around for a long time to come. 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. It appears that weather index insurance is but one tool among many that can address the impacts of climate change (Matsaba et al.,2021; Tabsoba et al.,2021). 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.

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. Though government-driven incentives will support the uptake of the WII, this has to 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. The 34.9% number of farmers found to be unaware of the weather insurance index provision in the government initiatives is worrisomely low.

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 (Maulu et al.,2021). 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 (Han et al.,2021). 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.

RECOMMENDATIONS

1. **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 value WII. This is the cheapest option that would allow poor farmers to mitigate their weather risks.
2. **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.
3. **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 viz-vi farmer uptake of WII.

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