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An Analysis of Factors Influencing Uptake of Agriculture Index Insurance among Smallholder Farmers—A Case of Kasama District in Zambia

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Abstract

Kasama district is a rural farming district with a population of over 91,525 smallholder farmers. Smallholder farmers face several production risks including floods, pests and droughts which are being worsened due to climate change. To manage the impact of these risks, weather index insurance has been designed to help farmers hedge against the loss of income due to crop losses. However, the uptake of Weather Index Insurance (WII) in Zambia is low, and as for Kasama District, there is little documented information on factors influencing the uptake of WII among smallholder farmers. In this study, the Probit regression model was used to measure the expected change in the likelihood of uptake of WII given a unit change in the regressors. Data analysed were collected using a semi-structured questionnaire from 200 farmer respondents and an interview guide from 5 key informants purposively selected. The study drew participants from a population of smallholder farmers estimated to be 91,525 farmers in the district. SPSS and STATA were applied to analyse Quantitative data using the Chi-Square test at 5% and 1% levels of significance. The study concluded that age, knowledge of WII and alternative source of income were statistically significant factors influencing uptake of WII by smallholder farmers in Kasama district. In addition, whereas age and alternative income had a negative and significant effect on uptake, knowledge of WII had a positive and significant effect. Furthermore, the study concluded that education level, gender, the frequency of discussing WII during extension services meetings, perception on the price of WII, distance to the providers of insurance services from a farm, and use of traditional methods of managing production risks were not significant factors influencing

the farmer's uptake of WII. The research, therefore, recommended that policymakers, insurance service providers and multilateral partners in the sector should work to raise awareness of WII as it is critical to its uptake by smallholder farmers. It was further recommended that product design becomes inclusive of smallholder farmers in order to come up with products that meet the needs of the end users.

Keywords

Uptake, Weather Index Insurance, Probit, Smallholder Farmers, Awareness

1. Introduction

Weather index insurance (WII) is an innovative type of crop insurance that can compensate a farmer when there is an incident of crop loss caused by unfavourable weather. Unlike the traditional crop insurance which relies on farm visits to assess losses, WII does not base its pay outs on actual damage but weather events as recorded by monitoring instruments. In many cases, the relevant indexes are rainfall, temperature, area yield and satellite (Recha, 2016).

Weather index insurance has been identified as a viable option for helping smallholder farmers hedge against a range of production risks such as floods, drought, pest, disease, input supply constraints and other market-related risks which have become rampant in the last decade (Hazell, 1992). It is said that WII was introduced in several African, Asian and other developing countries because the predominantly small size and diverse nature of production systems among smallholder farmers made the mainstream agriculture insurance investment unattractive (Cole & Francis, 2019).

Whereas the product has been there for over a decade world over, uptake has varied among countries where the service is available with smallholder farmers in some counties left to cope with production risks using traditional practices such as crop diversification. For instance, as at 2017, less than 3% of the Zambian population used insurance services on account of lack of awareness about the services (IAZ, 2016, 2017). Penetration level of agriculture insurance was estimated at 2.5% of the total Written Premiums in the entire Zambian general insurance sector (Basix, 2014). In view of this, this study undertook to evaluate factors influencing uptake of Weather Index Insurance in Kasama District Zambia.

1.1. Background

Agriculture is so crucial to economic growth globally. In 2018, the sector is reported to have accounted for 4 percent of global gross domestic product (World Bank, 2019). However, the sector is inherently a risky enterprise with most of the challenges being made worse by climate change which poses a risk of cutting down crop production, especially in the world's most food-insecure regions.

Weather Index Insurance must thus be embraced to shield the smallholder farmer from these risks (Hazell, 1992).

In sub-Saharan Africa, agriculture is a key contributor to gross domestic product (GDP) forming a larger part of non-traditional exports and contributing to employment creation (Njue et al., 2018). In Kenya, the sector is dominated by smallholder farmers who contribute over two-third of the total agricultural output (Wairimu et al., 2016).

The same holds for Zambia, where the economy is dependent significantly on Agriculture and needs to be supported with index insurance to manage a myriad of challenges it faces due to uncertainty and risks of low crop production. The sector is key as mining which was the backbone of the economy faces a slump which started manifesting in the early 1990s (Jain, 2007; World Bank, 2019; Zambia Development Agency, 2011). The agriculture sector contributes about 35 percent to the country's total non-traditional exports (all the country's exports other than copper and cobalt) and about 10 percent of the total export earnings for the country. As a result, it generates about 18 percent to 20 percent of the country's Gross Domestic Product, and provides a livelihood for more than 60 percent of the population and employment to about two-thirds of the labour force in Zambia (Jain, 2007). This implies that agriculture is not merely an occupation but a livelihood for the majority of citizens, especially the rural population.

One of the rural districts in Zambia where smallholder farming is widespread is Kasama District of Northern Province. Agriculture in Northern Province consists almost entirely of small-scale subsistence rain-fed farming with maize as the main crop being cultivated together with cassava (White et al., 2005). The district is located in Zambia's Agro-Ecological Zone (III) which receives a high average rainfall of over 1000 mm and thus is susceptible to the risk of waterlogging and floods (PMRC, 2020; USAID, 2016).

The greatest challenges that smallholder farmers generally face and is being exacerbated by global climate changes in the last two decades, as a matter of emphasis, include the frequency of high surface temperatures, erratic rainfall, floods, pests, crop disease and droughts which have been on the rise (Abdulmalik et al., 2013; Jain, 2007; Ching, 2010). Analysis of the Second National Agricultural Policy 2016-2020 report 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. The USAID (2016) adds that the livelihoods of 13 million people have been adversely impacted by floods in Zambia. Njue et al. (2018) observes that these climatic risk events lead to increased food insecurity and decreased resilience of smallholder households that depend on rain-fed agriculture.

To manage these risks, smallholder farmers have in some cases employed traditional means of avoiding or reducing the risks, such as rationing application of inputs as well as planting and cultivating drought resistant crops (Hazell, 1992).

Other farmers have developed the art and skill of engaging into ecological agriculture. Ecological agriculture practices involve using natural and regenerative processes to minimise use of non-renewable inputs, such as pesticides and fertilizer (Njue et al., 2018; Ching, 2010). In addition, the farmers set up small consumer businesses to help them remain afloat with cash in case of total catastrophic loss of their crops (Hazell, 1992).

In spite of these traditional risk management measures, research has established that risks which the smallholder farmers face are not fully eliminated. In fact, Hazell (1992) observes that the measures tend to be sub-optimal, limiting the potential to earn more, and at times costly to implement.

This safety net gap existent among smallholder farmers has justified the need for introduction of a suitable crop insurance product. This need has resulted into the engineering of the innovative weather Index-based insurance (WII), to compensate farmers in case of weather-induced losses such as early or late dry spells or excess rainfall, over the past decade. The WII has been derived as an alternative to the Multi-Peril Crop Insurance (MPCI) which has always been on the market but difficult to implement among smallholder farmers (Njue et al., 2018).

1.1.1. Farmer Input Support Program (FISP) Index Insurance in Zambia

Zambia has had the FISP WII as way back as 2014 (Hamasaka & Chanda, 2021). The product has been marketed bundled with input credit under the Farmer Input Support Programme (FISP) by the Government, and some private participants such as NWK have also been participating.

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.

As at 2021, the World Food Program 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) the Zambian government 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 the field demonstrates that uptake, in general, is still low, not only in Zambia but in Africa as a whole (Basix, 2014). **Table 1** illustrates distribution of insurance in developing and middle-income countries, summarised at continental level.

1.1.2. Performance of the FISP Insurance Index

At the roll out of the pilot WII in Zambia, it is estimated that 51,000 smallholders

Table 1. Distribution of agricultural insurance coverage among smallholder farmers in developing and middle-income countries.

Farming Season	Latin America and Caribbean	Asia	Africa
Number of small farms	21,005,083	420,078,903	59,056,107
Number of insurance policies	3,315,626	194,185,463	600,975
% of Insured smallholder farmers	15.8%	46.2%	1%
Current Coverage			2039.506
% of farmers currenty insured			3.5%

Source: Nshakira-Rukundo et al. (2021).

participated (Hamasaka & Chanda, 2021). With population having been estimated at 15.9 million in 2016, of which about 60%, representing 9.2 million is in rural areas and 75% (6.9 million) of the rural population being smallholder farmers (SNDP, 2017), the 51,000 farmers (less than 1%) of the total smallholder population that had accessed the WII was low. Moreover, although the number of smallholders reportedly covered by the Ministry of Agriculture and Mayfair Insurance in 2016/2017 had increased to 602,000, the uptake level was still not adequate especially as agriculture insurance only accounted for an average of 2.5% of the total premium collected by the General Insurance sector (Jain, 2007; Basix, 2014; Recha, 2016).

In fact, the review of the WII implemented in the 2017/2018 season observed that there were remarkable product design deficiencies and delivery challenges, where the farmers who sustained losses worth $5.6 million were not compensated in monetary pay outs but were asked to redeem their payments inform of inputs for the subsequent farming season of 2018/2019 (World Bank, 2019). This design style of the insurance policy, where farmers were only indemnified by redemption of inputs for the next farming season exposed them to loss of income and livelihood during the wait period. **Table 2** summarizes the responses of the FISP weather index to the various risk exposure experienced by smallholder farmers.

With these gaps being experienced, the Zambian Government then joined the blanket sovereign cover provided by the African Risk Capacity. The objective was to strengthen the compensation of farmers hit hard with droughts and dry spells in the country (ARC, 2022).

In this arrangement, the premiums were paid from budgetary allocations from the Zambian national budget and sought additional premium financing support from the Swiss Agency for Development and Corporation and the African Development Bank to maintain the insurance policy for the 2021/22 agriculture season (ibid). This departure from the blended FISP WII saw the government receive a pay-out of US $5.3 million triggered by drought impacting crop production in the Southern and Western provinces (ARC, 2022).

Again, the joining of ARC by the Zambian government, beyond the provision of the blended FISP Index Insurance is a demonstration that generally, Index Insurance has had inherent design challenges such as basis risk, lack of granular

Table 2. Risk events and insurance responses between 2017/2018 and 2019/2020 farming seasons.

Farming Season	Risk Event	Nature of Weather Index Insurance Response
2016/2017	Dry spells and Pests	Value in evoucher cards used to redeem inputs
2017/2018	Dry spells	In kind, coupled with delays in the finalization of the compensation farmers asked to redeem crop or vet inputs on an equivalent value
2018/2019	Droughts and Pests (fall armyworms)	Average cash pay-outs of K620.00 per farmer, disproportionate to farmer initial investment

Sources: World Bank (2019); Smeulders (2021).

data for product design and pricing which make it difficult to commercialize by providers, as well as moral hazard. These challenges have led to the product remaining heavily dependent on subsidy support at different levels, failing to win the trust of consumers and being challenging to implement (Ndlovu, 2020).

As risk of crop loss continues to be evident among smallholders whose financial muscle for self-protection is less, evaluating factors that influence the uptake of Agriculture (FISP) Weather Index Insurance among smallholders in the Kasama district of Northern Zambia was pertinent. Such knowledge would benefit both policymakers and product developers in coming up with strategies and products, respectively, that will be inclusive and fit the needs of smallholder farmers.

1.2. Problem Statement

The farming enterprise is increasingly being faced with production risk factors such as droughts, floods, diseases, pests, windstorms, accidents, fire, theft, damage and several other unplanned events whose occurrence cannot be readily predicted but stifle crop production and tie smallholders to poverty (McCarthy et al., 2020). The incidents of floods and waterlogging, and an outbreak of fall armyworm pests which have been predominant in the northern region of Zambia had not spared Kasama district. It is estimated that over 13 million Zambians have suffered adverse livelihood impacts due to increasing frequency and intensity of droughts and floods over the years. In 2020, it is estimated by the World Food Program that 2.3 million people were directly affected by dry spells at the beginning of the 2018/2019 farming season (WFP, 2021). Advocates of weather index insurance assert that it is an avenue to help farmers hedge against these risks and help them to unlock other key services that can enhance productivity and improve income earnings.

However, uptake of WII remains low, not only in sub-Saharan Africa but also

Zambia. In addition, much as several studies had been undertaken to establish factors that influence uptake of weather index insurance in sub-Saharan Africa, very little has been studied on this subject in Zambia and limited study based literature is accessible for Kasama District (Njue et al., 2018; USAID, 2016; Nshakira-Rukundo et al., 2021).

As agriculture Insurance services were observably being only taken up by large scale and commercial farmers, the challenge remains to evaluate the factors influencing uptake of agriculture index insurance among smallholder farmers in Kasama district with the view of creating a body of knowledge that can inform policy on measures and product development efforts that can be deployed to improve smallholder's uptake of weather index crop insurance. This is especially important as non-uptake of Agriculture Weather Index Insurance by smallholder farmers continues to push them to cope with disasters using traditional risk minimization strategies which do not adequately cushion them from effects of reduced productivity and income losses (Hazell, 1992).

Based on the literature review, background and statement of the problem, the paper aimed to evaluate factors influencing the uptake of agriculture weather index insurance by smallholder farmers in Kasama district of Zambia, while the specific objectives were:

1) To ascertain factors influencing uptake of WII among smallholder farmers in Kasama district of Zambia.

2) To analyse the factors influencing Uptake of WII among smallholder farmers in Kasama District.

3) To establish ways to improve uptake of WII among Smallholders in Kasama District of Northern Province.

The first part of this paper gave an overview of the uptake of the available FISP Index Insurance in Zambia. The second section presents empirical and theoretical literature on factors influencing uptake of weather index insurance. The third section of this paper presents the methods of the study. The fourth segment of the paper presents the analysis and discussion of the results while last two parts give the conclusions and the recommendations of the research.

2. Literature Review

2.1. Theoretical Review

This study utilized the Rational Choice theory to understand consumer behavior when making choices. Rationality in this case as conceptualized by the rational choice theory specifically advances the thought that an individual always acts to balance the costs of an action against its benefits to arrive at an action that maximizes personal benefits (Ogu, 2013). As Beresford & Sloper (2008) argue, this would be an action in line with what appeals most to what the consumer regards as most important features of an option.

The key understanding about consumer behaviour derived from the choice theory is that at exposure to options, a consumer will form a perception of value

and embark on a screening process to choose a suitable option based on the ideal expected benefits. The rational choice contends that given knowledge of finite options and a budget constraint, an individual consumer is able to act independently to make decisions that result in optimal outcomes McFadden (1998).

2.2. Conceptual Framework

The conceptual framework offers structure to the reasoning of the researcher regarding what he believes best explains phenomenon under investigation. It shows the conceptualization of the relationship between the dependant and independent variables (Mubita, 2020). **Figure 1** below shows the conceptual framework.

2.3. Empirical Literature

Empirical literature assets that there are a number of factors that influence uptake of weather index insurance. Awareness of WII is positively related to Uptake (Sibiko & Qaim, 2017). Another research by Njue et al. (2018) made the same conclusion that farmers who were more aware tended to go for insurance services in Kenya. Tsikirayi et al. (2013) observed that the impact of low financial illiteracy in Zimbabwe resulted into low uptake of WII because the farmers were unaware of the benefits. Karthick & Mani (2013) in their study have also discovered that crop insurance purchase decisions are influenced by awareness of benefits from purchase of insurance. Similar studies by Xu & Zia (2012), and Sibiko & Qaim (2017) observe that the lack of financial literacy has an adverse bearing

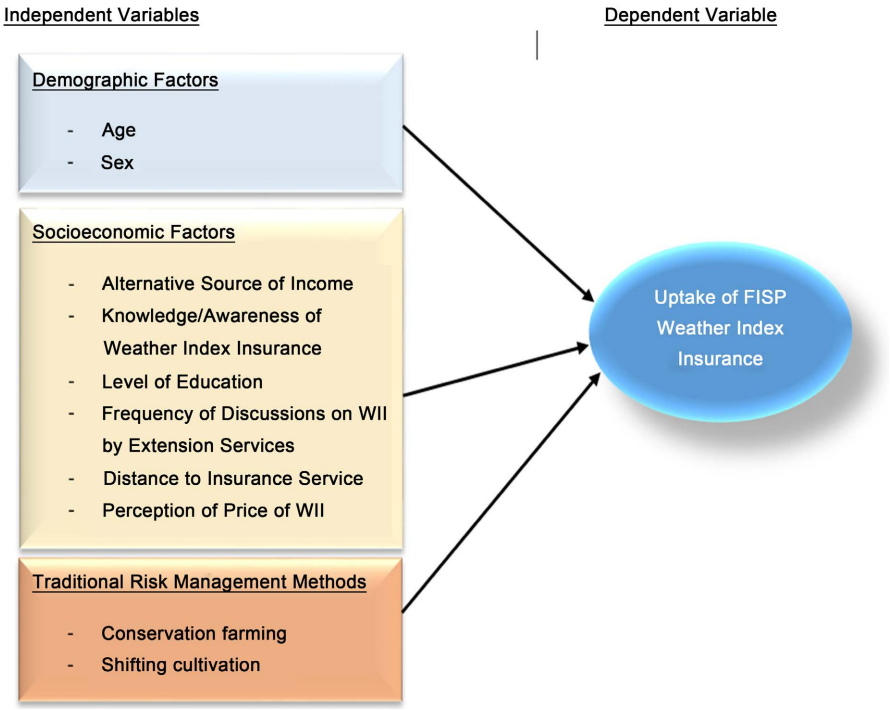

Figure 1. Dependant and independent variables. Source: Author's construction based on literature review.

on the uptake of agriculture index insurance. Much of the literature on the effect of awareness of WII on uptake reveal that farmers who received enlightenment about WII through extensions services were more likely to take up the service.

Another factor advanced against uptake of WII is the nature of product design. According to a study by Castellani & Vigano (2015), farmers appear to be sensitive to the ability of the product to meet their diversified insurance needs. The researchers in fact maintained that offering each farmer a combination of weather derivatives is better than offering an index insurance, somehow standardized. Lack of customization and of flexibility may hamper the adaptability of products to farmers. Generally, although the potential benefits of WII are great, implementation has been a challenge due to a lack of suitable and customized products that meet the aspirations of respective would be end users (Hazell, 1992).

Demographic factors have also been found to have an influence on uptake of WII. For instance, a study conducted in Coimbatore District, Mumbai, India concluded that age among other variables significantly determine demand for insurance (Ngoma & Chowa, 2021). Akinola (2014) in Nigeria discovers that older farmers who were more experienced in farming and were exposed to occurrence of risk and uncertainty in crop cultivation in the past are influenced to go for adoption of crop insurance to avoid income loss. Karthick & Mani (2013) and Bharati et al. (2014) in India as well as Njue et al. (2018) in Kenya and Abdulmalik et al. (2013) in Nigeria who concluded in their studies that age and experience of the farmers are paramount in adoption of agricultural innovations such as crop insurance.

Another factor of uptake is level of education of a household. Apart from determining a farmer's decision to participate in general, education increases one's ability to receive, decode, and understand information relevant to making innovative decisions Karthick & Mani (2013). Tsikirayi et al. (2013) in Zimbabwe established that an educated household head was more likely to uptake WII. Further, another study by Njue et al. (2018) in Kenya made similar conclusions. Jin et al. (2016) in rural China concluded that in the absence of training and sufficient knowledge of agriculture insurance, uptake would continue to remain low.

The perception which smallholders hold about the price of insurance also affects uptake. Ngoma & Chowa (2021), Tsikirayi et al. (2013), Sihem (2019) and Kishore et al. (2018) have asserted that price has an effect on the uptake of WII.

In addition, studies have asserted that a farmer's contact with extension education is connected to the farmers' awareness and knowledge about insurance and its benefits. Masara & Dube (2017), Akinola (2014), Falola et al. (2007), Wairimu et al. (2016) and Karthick & Mani (2013) all conclude in their studies that extension services assist farmers to understand the importance of insurance and thus are likely to take it up.

An alternative source of income has also been found to be a material factor of

uptake. Studies by Mahammed & Ortmann (2005) in Eritrea, Ellis (2017) concluded that households with alternative income sources had a tendency not to take up agriculture insurance.

Distance to the Service Providers is another variable that affects uptake of insurance. Studies have established that accessibility of services has a bearing on uptake of agriculture insurance. Tsikirayi et al. (2013) and Wairimu et al. (2016) in their respective studies done in Zimbabwe and Kenya learned that the remoteness of farms from service providers posed a challenge to uptake of agriculture index insurance.

Empirical literature reviewed highlighted that farmers who engage into spreading of risk by diversifying crops and practicing conservation farming as a mitigation measure to the risk of drought and floods, or indeed other risks have no impetus to purchase an insurance policy unless they have experienced loss in the past farming season. Thus, a farmer who has managed risk by diversification and has had a positive experience in the past has no motivation to take up any crop insurance (Akinola, 2014; Masara & Dube, 2017).

2.4. Research Gap

There is sufficient research that has been carried out in Asia, Europe and some Sub-Saharan African countries on factors influencing uptake of insurance, however, very little research on this topic has been carried out in Zambia. Although Weather Index has existed at pilot stage since 2014, facilitated by aggregators of Zambian government through the Ministry of Agriculture, there have not been many studies on uptake of WII in Zambia, and very limited literature is available for Kasama district. This study therefore targets to close the knowledge gap and devise a model to address the low uptake at household level.

3. Methodology

3.1. Research Design

Mubita (2020) opines that a research design can be said to be a plan containing details of steps and actions to be taken in the successful completion of a study. The study employed mixed method strategy as it eased design of data collection instruments, improved accuracy and helped limit researcher's bias Denscombe (2010).

3.2. Study Area and Population

The study was conducted in Kasama district of Northern province of Zambia, located 852 km from Lusaka the capital city of Zambia with an area of 10,788 km sq (1,078,800 ha). The District lies on longitude 30 degrees and 32 degrees east and latitude degrees 9 and 11 degrees south and at an average altitude of 1300 m (https://www.nor.gov.zm/?page_id=1614). The study picked on this district as it is rural, actively involved in smallholder farming activities and the farmers have been affected by the production farm risks (Ngoleka, 2013; Jain, 2007).

Saumure & Given (2008) define a population as every individual who fits the criteria that the researcher has laid out for research participants. The study population was comprised of smallholder farmers in Kasama district. According to the 2010 Census of Population and Housing, Kasama district has a farmer population of 91,525 of which over 80% are smallholders (https://www.nor.gov.zm/?page_id=1614).

3.3. Sampling Procedures

Participants in this study were purposively selected. Purposive sampling refers to a method of selecting participants because they have particular features or characteristics that will enable detailed exploration of the phenomena being studied (Frost, 2011). As Cohen, Manion, & Morrison (2018) note, in many cases, "purposive sampling is used in order to access 'knowledgeable people', that is, those who have in-depth knowledge about particular issues, maybe by virtue of their professional role, power, access to networks, expertise or experience." This sampling method was used in order to recruit smallholder farmers who were in a rural setting and experienced farm production challenges that require the use of Agriculture Weather Index Insurance.

3.4. Sample Size

The sample size of this study was 384. The sample size of respondents was computed by applying Moazzams's formula:

$$n = N * X/(X + N - 1)$$

$$X = z^2 pq/d^2$$

$n = N * X/(X + N - 1)$, where,

$N = 91{,}525$

$X = Z\alpha/22 - *p*(1-p)/MOE2$, or

$$X = z^2 pq/d^2$$

n: the desired sample size

z: the standard normal deviation usually set at 1.96 (which corresponds to the 95% confidence level)

p: the proportion in the target population to have a specific characteristic. If no estimate available set at 50% (or 0.50)

q: $1 - p$

d: absolute precision or accuracy, normally set at 0.05.

The sample size in this study was.

$$X = (1.96)^2 (0.5)(0.5)/(0.05)^2 = 384$$

$$n = 91{,}525(384)/(384 + 91{,}525 - 1) = 35{,}145{,}600/91{,}908 = 382$$

Therefore, the study targeted to interview 384 respondents. 200 questionnaires

and 5 responses from key informants were received, representing 53.66% response rate.

Furthermore, the study validated adequacy of the responses received through thoughts advanced by Morgan (2008) who contended that it makes sense to try to estimate anything with a small sample in that at 95% confidence level (internal), a sample size of 200 gives between 44% to 56% accurate estimates for variables that have to be expressed as simple percentages. Table 3 demonstrates Morgan's views on how Sample Size affects accuracy in the case of estimating a simple percentage.

In addition to Morgan's views, Cohen, Manion, & Morrison (2018) hold the view that a sample size of thirty can be a good minimum if researchers plan to use some form of statistical analysis on their data, although relatively small size is weak and a considerably higher number would be better. They further added that in ethnographic or qualitative research, such as this, it is more likely that the sample size will be small because of constraints such as cost, time and administrative requirements. Based on the scholarly views above, it can therefore be concluded that the responses from of 200 respondents sufficed.

3.5. Data Collection and Instruments

The researcher endeavoured to select the instrument that helped collect quality and detailed information for the research to attain data saturation (Fusch & Ness, 2015). Data saturation is the ability for a study to be replicated should the sample size be increased.

Primary Data

Primary data were collected using semi-structured questionnaires.

Secondary Data

Secondary data were accessed from articles, books, journals, online sources, and theses.

Table 3. An Illustration of how Sample Size affects accuracy in the case of estimating a simple percentage.

Sample Size	95% Confidence Level
10	19% to 81%
25	30% to 70%
50	36% to 70%
100	40% to 60%
250	44% to 56%
500	46% to 54%
1000	47% to 56%

Source: Morgan (2008), Sampling, The SAGE Encyclopaedia of Qualitative Methods, Vol 1 & 2 Sage Publications, London.

As a material proportion of the data was quantitative, preparation mainly involved checking for accuracy, consistency and uniformity at the questionnaire level, as well as categorization and coding (Denscombe, 2010; Cohen, Manion, & Morrison, 2018).

Coded data was loaded in the Statistical Package for Social Scientists (SPSS version 22) and Stata version 15 software for analysis.

3.6. Model Specification

The Probit Regression model was employed in this study to establish the relationship or influence of the independent variables on the uptake of WII. Probit analysis is ideal in dichotomous choice research problems (Fonta et al., 2018), because it improves the precision of the uptake estimates by curing the problem of heteroscedasticity of the error terms by way of restricting predictions to lie between the 0 and 1 range.

The model is specified as follows:

$$\Pr\left(Upt_i = 1\right) = \phi\left(\beta_0 + \beta_1 \text{KnwWII}_i + \beta_2 \text{Age}_i + \beta_3 \text{Edu}_i + \beta_4 \text{Price}_i + \beta_5 \text{ExtServices}_i + \beta_6 \text{AltRmgt}_i + \beta_7 \text{FarmInc}_i + \varepsilon_i\right)$$

where β_0 - β_8 are parameters to be estimated on independent variables and ε_i is an error term. Table 4 below defines the specified variables.

Table 4. Showing the specified variables.

Variable	Variable	Definition	Expected Sign
Dependent Variable:			
Uptake_WII	Uptake of WII	Yes = 1 No = 0	Dependent
Independent Variables:			
Age_Farmer	Age of Household head	Continuous	+/−
Sex	Sex of respondent	1 = male 2 = female	+/−
EduLevel	Education level of household head	Dummy 1 = has formal education 2 = no formal education	+/−
AltIncome	Having alternative income	Continuous	+/−
WIIisAffordable	Perception of Price of WII	Continuous	−
Knowledge	Awareness of WII	Dummy 1 = have 0 = Do not have	+
AvailabilityWII_Limited	Distance to providers of insurance	Dummy 1 = easily accessible 2 = not easily accessible	−
WIICoverage_Freq	Frequency of extension services discussions on WII	1 = regular 2 = otherwise	+

Justification for the Use of Probit Model

Scholars such as Gujarati (2007), Hahn & Soyer (2005) and Salisu (2016) have asserted that to model a dummy qualitative dependent variable which takes the binary outcome of either 1 or 0, that is (yes or no), and is a non-linear estimation the Probit and Logit Models can be utilized.

A number of studies on choice, particularly on whether to take up weather index insurance or not undertaken both on the African continent and elsewhere were reviewed. Sibiko & Qaim (2017) used the Probit model to analyse determinants of Weather Index Insurance Uptake. Some of the regressors included to his model were farm size, sex, age, education of the household head and the experience of weather shocks. In addition, institution factors such as access to credit, agriculture extension studies and transport were included. Kishore et al. (2018), Karthick & Mani (2013) applied the Probit model to study adoption of crop insurance in India, whereas Falola et al. (2007) used the same model to investigate willingness to take agricultural insurance by cocoa farmers in Nigeria.

4. Results and Discussion

4.1. Descriptive Statistics

Table 5 below shows descriptive statistics for demographic and other variables of uptake of weather index insurance. The table shows that 51% of respondents were male, whereas 49% were female.

4.1.1. Distribution of Respondents by Sex

The pie chart, Figure 2 below summarises the distribution of respondents by gender. The majority of the respondents, 51% were male and 49% was female.

4.1.2. Distribution of Respondents by Level of Education

Figure 3 shows that 70% of the respondents had formal education, whereas 30% had no had exposure to education.

4.1.3. Distribution of Respondents by Alternative Source of Income

Figure 4 shows the distribution of respondents by alternative source of income. Majority of the respondents, 47% had no alternative source of income, whereas 53% indicated to have had alternative source of income.

4.1.4. Distribution of Respondents by Knowledge of Weather Index Insurance

The respondents were asked whether they knew weather index insurance. Figure 5 shows that 84% of the respondents were aware of Weather Index Insurance while 16% reported that they were not aware.

4.2. Factors Influencing Uptake of Weather Index Insurance (WII) in Kasama

The tests carried out on field data, as indicated Table 6, show that age of the head of household, which is relates to farming experience, awareness or knowledge

Table 5. Descriptive statistics on factors of uptake of weather index insurance.

Variable	Total Sample		Uptakers		Non-Uptakers			
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	X2 and t-statistic	P-Value (5% CL)
Sex 1 = Male, 2 = Female	0.51	0.50	0.52	0.5	0.42	0.51	0.7096	0.4
Age	41.3	10.51	40.67	10.53	47.52	8.28	2.7447	0.0066*
Education Level 1 = Formal Education 0 = Do not have	0.70	0.46	0.69	0.46	0.79	0.42	0.7861	0.40
Knowledge of WII 1 = Have 0 = Do not have	0.84	0.37	0.88	0.32	0.42	0.51	26.21	0.000*
Alternative Income 1 = Has alternatice income 0 = otherwise	0.43	0.50	0.39	0.49	0.78	0.42	11.04	0.0008*
Distance to Service Providers of WII 1 = within 50 km 0 = Over 50 km	0.11	0.31	0.10	0.28	0.21	0.42	1.51	0.131
Affordability of WII 1 = Affordable 0 = otherwise	0.37	0.48	0.37	0.48	0.42	0.51	0.22	0.64
Traditoinal Risk Management methods 1 = Diversification' 0 = other	0.79	0.41	0.77	0.43	0.92	0.28	1.60	0.21
Extension Services Frequeny 1 = WII discussed once a month or more 0 = WII never discussed	0.51	0.50	0.52	0.5	0.33	0.49	2.35	0.13

Source: Computation of Field data in STATA (2021).

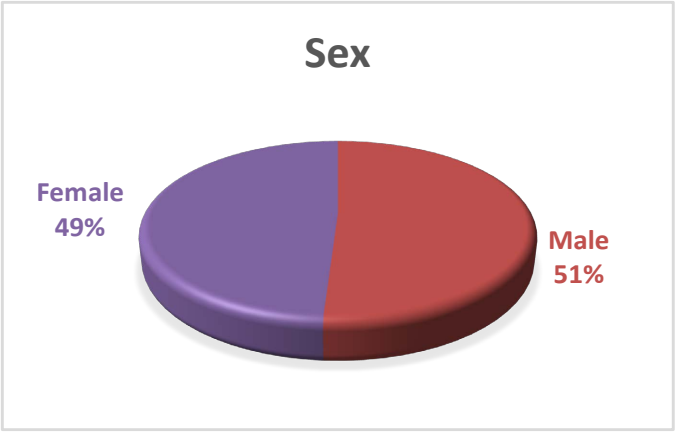

Figure 2. Distribution of respondents by gender.

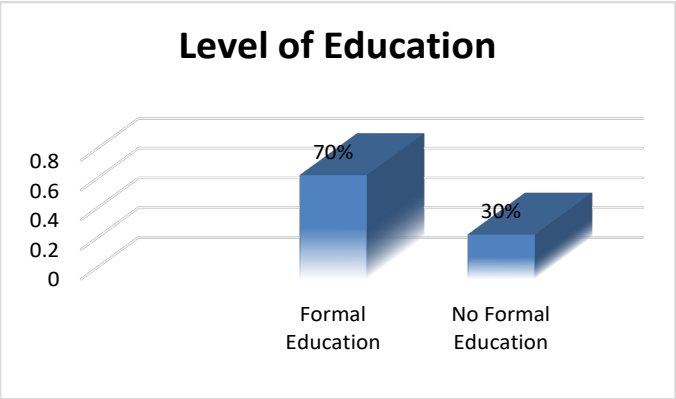

Figure 3. Distribution of respondents by level of education.

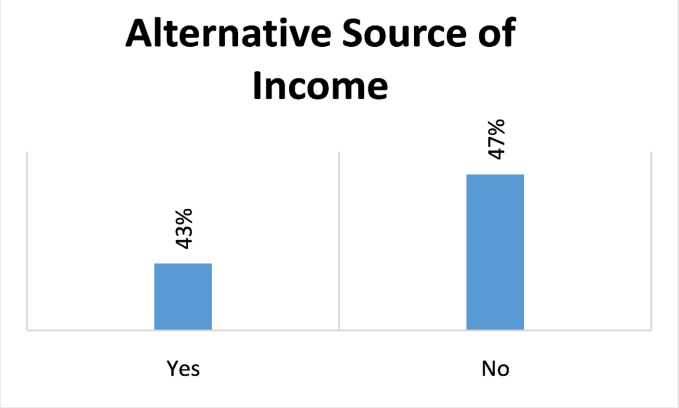

Figure 4. Distribution of respondents by alternative source of income.

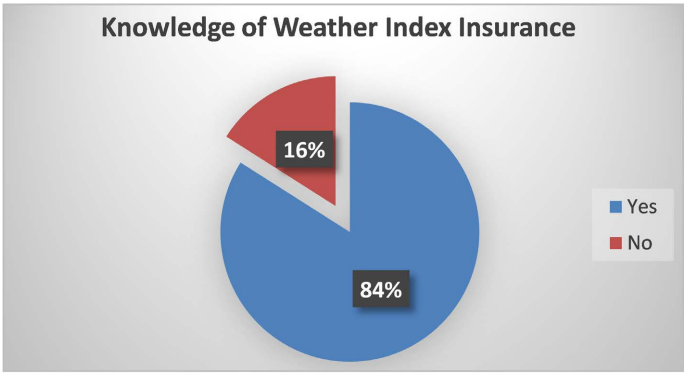

Figure 5. Distribution of respondents by knowledge of weather index insurance.

Table 6. Probit regression margin effects for uptake of weather index insurance.

Variable	Dy/dx	Std Error	P-value
Age	−0.0025	0.0014	0.0065**
Alternative Income Source	−0.0912	0.0397	0.021*
Knowledge of WII	0.2932	0.114	0.008*

Continued

Frequency of Extension Service Discussion of WII	0.0141	0.0185	0.455
Perception of Price of WII	−0.0127	0.0201	0.527
Education Level of Household Head	−0.022	0.0156	0.0140

*means statistical significance at 5% level, **means statistical significance at 10% level. Source: Computation of Field data in STATA (2021).

of the insurance product, as well as alternative income were found to be statistically significant factors influencing uptake. Age and alternative income had negative coefficients, imply that increasing the coefficients or units of these variables leads to reduced uptake of WII. A positive coefficient was noted on awareness of WII, implying that awareness increases the likelihood of uptake. This finding agrees with the conclusions by Bharati et al. (2014), Karthick & Mani (2013) and Falola et al. (2007) that age and alternative income have an influence on uptake of weather index insurance.

On the other hand, although the coefficient of frequency of discussions on WII was positive, the factor was not statistically significant at influencing uptake. This finding contradicts conclusions by Masara & Dube (2017), Akinola (2014) and Karthick & Mani (2013) who found that a farmer's contact with extension education is connected to the farmers' awareness and knowledge about insurance and its benefits, which then influence uptake. Other studies being contradicted, which also concluded that Frequency of Extension Services discussions of WII had an influence on uptake include Wairimu et al. (2016), Kishore et al. (2018), Njue et al. (2018) and Abdulmalik et al. (2013).

In addition, perception on price of the WII service and educational level had negative coefficients but were insignificant factors statistically. This position can be explained by the nature of packaging of WII in which the product is bundled with farming inputs. Mandatory offering of WII by combining it with other products tends to increase uptake regardless of the price (Nshakira-Rukundo et al., 2021). The same conclusion was arrived at by Sibiko, Veettil, & Qaim (2018). However, this position contradicts conclusions made by Tsikirayi et al. (2013), Kishore et al. (2018) and Sihem (2019), who demonstrated that the price of insurance services had a negative influence on uptake of the service.

The study further observed that gender was also not significant at influencing uptake. This finding is line with the conclusions of Njue et al. (2018) who in their study about uptake of crop insurance among smallholder farmers, insights from maize producers in Kenya, found that gender does not have any influence on uptake of crop insurance. Wairimu et al. (2016) and Akinola (2014) also found that gender did not influence uptake of WII. **Table 7** illustrations this finding based on sample date.

In addition, the observation of this study that education level had no influence on uptake of WII is one which contradicts several studies such as Xu & Zia (2012),

Table 7. Test of association between gender and uptake of WII.

Have you used WII Before?	Gender		
	Male	**Female**	**Total**
Yes	8	11	**19**
No	92	84	**176**
Total	**100**	**95**	**195**

Person Chi^2(1) = 0.7096, Pr = 0.400; Source: Computation of Field data in STATA (2021).

Tsikirayi et al. (2013), Njue et al. (2018) and Jin et al. (2016) who concluded that the level of education influences uptake of WII services. In addition, Akinola (2014) and Abdulmalik et al. (2013) also concluded in their respective studies that level of education influenced uptake of WII.

As for traditional risk management methods, this study found that the factor was not significant at influencing weather index insurance. This finding contradicts Masara & Dube (2017), Akinola (2014) and Karthick & Mani (2013) who found negative statistically significant association between use of traditional risk management methods and uptake of WII.

Lastly, the distance to the providers from a farm of a smallholder was also found to be not significant at influencing uptake of WII. It is further noted that this finding contradicts conclusions by Tsikirayi et al. (2013) and Wairimu et al. (2016) who found an association between the distance to WII service providers and uptake.

4.3. Analysis of Factors Influencing Uptake of WII

The study also met objective two, which involved an analysis of factors influencing uptake of WII in Kasama District of Northern Zambia. The Probit model analysis employed helped to analyse how the ascertained factors influence uptake of WII. The model results showed that at 5% level of significance, a unit increase in the awareness or knowledge of weather index insurance increases the likelihood of uptake by 29.32%. That is, the coefficient resultant from the Probit model was +0.2932. This is as expected from the theoretical review, particularly Choice theory, because awareness increases the consumer's (farmer) cognitive understanding of the benefits derivable from an insurance policy. Moreover, this finding resonates with the understanding shared by the industry experts who follow the view that the number one challenge for the sector in Zambia has been the lack of awareness on insurance, its benefits and how it works (Twaambo, 2018).

Furthermore, several studies have established that awareness of WII is positively related to Uptake Sibiko & Qaim (2017) and Njue et al. (2018) made the same conclusion that farmers who were more aware tended to go for insurance services. Other studies by Tsikirayi et al. (2013) and Karthick & Mani (2013) have also noted that lack of knowledge about insurance negatively affects uptake

whereas improved awareness improves its uptake. The same position was arrived at by Nshakira-Rukundo et al. (2021).

As for age of a farmer, the study was able to establish that at 10% level of significance, age has a negative influence on uptake of weather index insurance. It was observed that age had a coefficient of −0.025, which implies that a unit increase in age for a farmer is more likely to reduce the uptake of WII by 0.25%.

Furthermore, the study evaluated that at 5% level of significant, an alternative source of income is statistically significant and negatively influences uptake of WII. The model predicted that a unit increase in alternative sources of income reduces the likelihood of uptake of WII by 9.12% for a smallholder farmer in Kasama district.

That awareness or knowledge of WII services is likely to improve uptake of WII is a finding which many other scholars from the literature reviewed have arrived at. Nshakira-Rukundo et al. (2021) asserted that mere exposure to insurance does not matter unless where a farmer can understand the underlying insurance concepts and mechanisms to be able to make sound decisions. Other studies whose findings resonate with this finding includes that of Tsikirayi et al. (2013) and Karthick & Mani (2013) who both found in their respective studies that crop insurance purchase decisions are influenced by awareness of benefits from purchase of insurance. Other findings with the same conclusion include Sibiko & Qaim (2017), Wairimu, Obare, & Odendo (2016) and Haruna (2015).

Age on the other hand speaks to the farmer's experience in the farming business. This study evaluated that the older the head of a household, the higher the likelihood of reduced uptake of WII as such a farmer would be more experienced to manage farm risk with alternative methods. This echoes the findings of Njue et al. (2018), Masara & Dube (2017), and Mahammed & Ortmann (2005) who in their respective different studies concluded that age had an influence on uptake of Agriculture insurance. However, this outcome contradicts the conclusions by Akinola (2014) who asserted that older farmers who were more experienced in farming and were exposed to occurrence of risk and uncertainty in crop cultivation in the past were influenced to go for adoption of crop insurance to avoid income loss.

On alternative income, the understanding from literature is that a farmer who has alternative sources of income is reluctant to take up insurance as their income source is diversified. This outcome also correlates with findings of Mahammed & Ortmann (2005) who concluded that households with alternative income sources have a tendency not to take up agriculture weather insurance because high income due to having an alternative source provides a risk diversification strategy that discourages the need to take up insurance policies. Other studies which arrived at the same conclusions include Ellis (2017) and Mahammed & Ortmann (2005).

Following these conclusions, and based on the tests in **Table 5** which were

carried out in SPSS and STATA on the assumption that the error terms of the independent variables were normally distributed at 5% and 10% levels of significance, the following hypotheses were tested:

H_0: The factors had no influence on uptake of Weather Index Insurance (WII) in Kasama District of Zambia.

H_1: The factors had influence on uptake of Weather Index Insurance (WII) in Kasama District of Zambia.

With the results in Table 5, the proposed research model for uptake of WII in Kasama district is:

$$Y = \Pr(\text{Uptake} = 1) = 3.9 - 0.0025 * *\text{Age} - 0.0912 * \text{Alternative\_Income} + 0.2932 * \text{Knowledge}(\text{Awareness})$$

Robustness Check for Estimated Model Results

To check the model for robustness, the Breusch Pagan Test for Heteroscedasticity was employed. The presence of heteroscedasticity in the data leads to biased estimators that are unreliable for inference (Gujarati, 2007). **Figure 6** below shows the regression and Breusch Pagan Test for the variables that have been included in the model.

As can be seen from the Breusch Pagan Test results, the chi2(6) = 123.86, with Prob > chi^2 = 0.000, which strongly rejects the null hypothesis for the presence of heteroscedasticity. It was therefore concluded that the estimators were unbiased and the model is reliable for explaining factors of uptake of weather index insurance in Kasama district.

Source	SS	df	MS
Model	4.40267068	6	.733778447
Residual	12.6564691	179	.070706531
Total	17.0591398	185	.092211566

Number of obs = 186
F(6, 179) = 10.38
Prob > F = 0.0000
R-squared = 0.2581
Adj R-squared = 0.2332
Root MSE = .26591

HaveyouUsedWIIbefore	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AgeatLastBirthday	.0049501	.0019722	2.51	0.013	.0010583	.0088419
FarmersEducationLevel	.0396142	.0300424	1.32	0.189	-.0196686	.098897
DoyouKnowWII	.329672	.0542569	6.08	0.000	.2226066	.4367374
DoyouhaveAlternativeSourceof	-.1373227	.0421085	-3.26	0.001	-.2204157	-.0542297
WIIisAffordable	.0110219	.0290091	0.38	0.704	-.0462219	.0682658
WhatistheDistancetoWIIProvi	-.0201167	.0337457	-0.60	0.552	-.0867072	.0464738
_cons	.6841274	.1814048	3.77	0.000	.3261604	1.042094

```
. hettest AgeatLastBirthday FarmersEducationLevel DoyouKnowWII DoyouhaveAlternativeSourceof WIIisAffordable WhatistheDist
> ancetoWIIProvi

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: AgeatLastBirthday FarmersEducationLevel DoyouKnowWII DoyouhaveAlternativeSourceof WIIisAffordable
                    WhatistheDistancetoWIIProvi

         chi2(6)      =   123.86
         Prob > chi2  =   0.0000
```

Figure 6. Breusch pagan test results.

4.4. Ways to Improve Uptake of WII

The study achieved objective number three, based on the observations made by executing the requirements of the first and second objective. That is, as awareness positively influences uptake, the study establishes that increasing awareness leads to increased uptake of WII. Further, since age reduces uptake of WII reduces, the study established that introducing WII lessons to relatively younger farmers and embedding insurance in the school curriculum would improve its awareness, understanding and uptake. Moreover, as age which entails experience with and exposure to the merits and demerits of WII, product design which fits the expectations of the end user will be one avenue to improve acceptance and uptake of the insurance product.

5. Conclusion

The study aimed to evaluate factors influencing the uptake of agriculture index insurance by smallholder farmers in Kasama district of Zambia. The specific objectives were to ascertain factors influencing uptake of WII among smallholder farmers in Kasama district of Zambia, to analyse factors affecting Uptake of WII and to establish ways to improve uptake of WII among Smallholders.

Factors hypothesized to influence uptake of WII in Kasama district of Zambia included age, gender, alternative source of income, awareness/knowledge of WII, frequency of discussing WII during extension services, farmer perception of price of insurance, education level, distance to the providers of WII from the farm and use of traditional risk management methods.

From the sample data and taking a leaf from literature review, the study established that age of a household head, awareness of WII and alternative source of income were statistically significant factors influencing uptake of WII. The model results showed a unit increase in age was likely to reduce uptake by 0.25% at 95% confidence level. Further, it was concluded based on the Probit results that a unit increase in the knowledge or awareness of WII among smallholder farmers is likely to increase uptake by 29.32%. As for Alternative Source of Income, the study concluded that a unit increase in the alternative endowment would reduce uptake by 9.12%.

On the other hand, the Frequency of Extension Service Discussion of WII was positively correlated with Uptake of WII but the statistical test showed that the factors were not significant at influencing uptake. In addition, perception on the price of WII, and educational level although negatively correlated were not statistically significant at influencing uptake of WII. Distance from the smallholder farms to the providers for Weather Index Insurance services and the use of traditional methods in managing production risks among smallholder farmers were also not significant factors influencing uptake of WII, and were not included in the Probit Model.

Thus, according to the results of this study, age, knowledge of WII and alternative source of income were found to be statistically significant factors influen-

cing uptake of WII. In addition, whereas age and alternative income had negative and significant effect on Uptake, knowledge of WII had a positive and significant effect. The rest of the factors were insignificant statistically.

6. Recommendations

As awareness of WII was found to be a statistically significant factor influencing uptake of the service, the study recommended that stakeholders who include the government, the farming groups and well as insurers must work to promote awareness about the Weather Index Insurance. In addition, age being a proxy for a farmer's farming experience was also found to be a factor influencing uptake. On this basis, the study recommended that insurance lessons be introduced at an early stage in schools and cooperative meetings for all individuals to get exposure to the concept of insurance whilst still young.

Areas of Future Research

The study recommended that similar studies be conducted in other farming districts of Zambia were smallholder farming is prominent. This step would help identify common challenges and solutions that would be a step in the direction of improving uptake of WII. It was further recommended that future studies extend the research to likelihood of farmers taking up WII if the service was not offered bundled with other products such as inputs or credit.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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