The indirect impact of crop insurance on household food security in the Guinea Savannah region of West Africa

Powell Mponela[1@] and Fred Kizito[1]

[1] *Alliance for Bioversity and CIAT, C/O IITA, CSIR Campus, Accra, Ghana*

Abstract

Under high climatic, disease and market uncertainty, smallholder farmers make heuristic decisions on whether to manage risk and invest in profitable alternatives or, as a risk-averse mechanism, continue with the traditional low-risk low-return practices. The goal of this paper is to investigate the role of information, social capital, and resource endowments on farmers' decision to invest in insurance bundled with fertilizer and modern improved seeds and its impacts on food security indicators including surplus produce, marketing share, and produce storage. Results show that insurance induces a 113% increase in the proportion of maize sold and an increased probability to keep food reserves for the lean period by 42%. Impacts of insurance on marketing and storage are contingent on cropping system, agro-advisory and resource endowments with differentiated effects. These findings reveal that bundling crop insurance with high-cost productivity improving inorganic fertilizers and modern improved varieties bred for drought tolerance is a viable option for farmers to make risky productivity-enhancing investments and improve livelihoods that contribute economic development and food security.

Keywords: *Crop insurance, agro-advisory, bundling, risk, food security*

Introduction

West Africa is one of the regions with heightened efforts to address vulnerability to climate change but, with a relatively weak adaptive capacity and covariate shocks such as COVID, the existing crop management measures are insufficient to offset the negative effects on crop yields, quality and marketability (IPCC, 2014, 2022). Most smallholder farmers, defined as those with small plots, low input, low productivity, and lower market access are the most vulnerable (Chamberlin, 2007). With fewer tools to deal with risk, most tend to be risk averse, they forgo profitable but risky high-value marketable crops and shift to low-risk low-return crops yielding just enough for subsistence (Benneh, 1973; Wiggins, 2000). However, farming systems have transitioned and most productivity gains of the 1980s and 90s which were achieved through extensive cultivation of natural landscapes have reached the expansion limits and, with limited technological change, margins of return to labour have significantly diminished (Djurfeldt & Djurfeldt, 2013). With emerging climate change threats and market opportunities, there has been a growing need for adaptable strategies. Across Africa, there are micro-level successes reportedly in communities that have transitioned from subsistence towards market oriented (Houssou et al., 2016).

In the Guinea Savannah, maize is the most important staple food crop and fourth commercial crop but faces productivity constraints due to variable rainfall patterns (Houssou et al., 2016). With the prevailing land condition, existing agronomic practices and institutional settings, the crop exhibits high vulnerability to climate change with projected losses of up to 21% by 2050. Studies show that in the last 45 years, 25 years were characterised by rainfall deficit with the most recent decade being the driest (Abbam et al., 2018). In 2020, drought affected maize yield with a 13% reduction (Obour et al., 2022; Oppong-Ansah, 2021). Although the climate impacts on crop production in terms of decreases in crop yields and water availability are projected to be moderate under additional warming of less than 2°C (IPCC, 2014), covariate shocks that affect wider populations such as delayed inputs due to COVID disrupt resource endowments and livelihoods. For the farming communities, the risk of crop failure is considered the binding constraint (Mukherjee et al., 2017). Drought is a covariate risk that affects many people at one time making it challenging and costly to manage in smallholder farmers require adequate financial instruments (IFAD, 2010)

Studies have shown potential for community resilience to climate shocks through innovative business and farming solutions that increase awareness and empower smallholder farmers whilst de-risking the farming enterprise (Asravor, 2018). Climate information and climate-smart agro-advisory have been widely promoted as readiness strategies for farmers to cope with climate change risks. Much as these strategies guide farmers to avert shocks, faced with unforeseen hazards such as terminal drought or lodging due to heavy rains, farmers require innovative approaches to cushion vulnerability. Input subsidies and price stabilisation have been used to reduce risk exposure but do not translate to improved adaptive capacities (Fan & Rue, 2020).

Crop insurance is promoted cited as one of the strategies for improving food security among smallholder family farms across the globe (AII, 2016; Ankrah et al., 2021; FAO, 2016; Forichi, 2022). However, the insurance coverage is still in its infancy stage with only 1.9% of African farmers being insured and mostly covered as index-based agricultural micro-insurance or social schemes in which insurance is delivered as products tied to crop loans (Robles, 2021). Unlike the indemnity-based parametric crop insurance that enrols/(indemnifies) individuals based on actuarial risk assessment, in most smallholder settings, index-based insurance is offered by state and non-state agencies as social protection programmes for the most vulnerable societies. In Ghana, it was reported that 40-50% of farmers were awarded grants and took up insurance (Karlan et al., 2011), but overall demand for index programs remained low despite the large premium subsidies (Robles, 2021). Despite low adoption, there is evidence from randomised control trials that index insurance policies, for which the farmer is the policy holder and claimant on pay-outs, spur technology adoption (Mishra et al., 2022). The low uptake is attributed to inadequate knowledge and experience, premiums and inaccessibility (Aidoo et al., 2014; Ankrah et al., 2021; Issaka et al., 2016). For instance, a randomised control field experiment in Malawi found that, with limited knowledge, more farmers opted for uninsured input credit than the insured loan (Giné & Yang, 2009).

As the commercial viability of smallholders is gaining the interest of the private sector, bundling crop insurance with high-cost productivity improving inorganic fertilizers and modern improved varieties bred for drought tolerance is seen as a viable option for farmers to take productivity-enhancing risks (Mukherjee et al., 2017). In most parts of Africa, produce aggregators prefinance farmers with inputs credit and embed index-based (weather and area yield) insurance based on long-term yield averages. Although index-based insurance is preferred to overcome administrative costs and technical feasibility and is more suited for public insurance programs, there are concerns about setting the basis risk with a significant deviation between the calculated index vs actual productivity loss incurred. The basis risk error arises from either product design, landscape heterogeneity or high variability farming techniques that increase the error (The Lab, 2019). Notwithstanding the basis risk, this study explores ways in which insurance impacts farmers livelihoods. We build on the hypothesis that although insurance alone cannot provide food security, it plays a big part in raising awareness of the importance of risk mitigation and encouraging investments in increasing the agricultural efficiency thereby contributing to food security (Forichi, 2022).

We use a collaborative pilot case where the CGIARs (providing scientific advice), WorldCover (a private crop insurance firm), and DEGAS Ltd (a produce aggregator) investigate options for improving the development, delivery, and verification of bundled insurance packages (Alliance for Bioversity and CIAT, 2021). Through bundled services that incorporate index-based crop insurance, agro-advisories, and input credit, these piloted solutions targeted to reduce the production risk of maize by 60% and increase crop yields by 30% thereby significantly improving smallholder food and income security in the vulnerable region of Northern Ghana. One of the novel approach to reduce basis risk has been that the World cover provided a peer-to-peer mobile microinsurance platform on the emerging blockchain technologies that improved verification and pay-out (The Lab, 2019). Bundling of insurance with inputs and agro-advisory further reduced risk in terms of the improved genetic potential of their seed, boost in soil fertility coupled with good agroclimatic advice and agronomic practice. This study, therefore, uses the bundled insurance use case of Northern Ghana to evaluate factors that support/hinder farmers to take up crop insurance and assess the impact of crop insurance on household food security.

Methodology

1.1 Study site and context

The study was conducted in Northern regions where 16.5% of the farmers took crop insurance of which 67% was for maize, 15% for rice, 15% for beans and 14% for other crops. The smallholders in the region cultivate about 1 hectare of land, consume most of their produce and sell a small percentage. During the past 45 years, they faced a rainfall deficit in 25 years of which 7 were classified as a drought, the recent being 2002 (Abbam et al., 2018). Data was collected between

October 2020 and February 2021 from 4 regions: Savannah, Northern, Upper East and Upper West.

The Ghana Agricultural Insurance Pool (GAIP), a group of 15 insurance providers has since 2011 piloted area yield index insurance with smallholder farmers covering staples maize, sorghum, millet and groundnuts with the objective to ensure that farmers are not thrown into extreme food insecurity when hit by droughts and floods. Farmers have directly benefited through pay-outs of up to 80% of the loss and the recent reports show that over the 10 years since 2011, 30,000 of an estimated farmer population of 11.3 million have been registered with GAIP (GhanaWeb, 2022).

1.2 Empirical strategy

The purpose of insurance is to indemnify risk-averse individuals when hazards such as drought-induced crop failure that leads to loss of livelihoods. For climate-induced crop failure, setting the insurance objective is challenging due to insufficient knowledge of differences in exposure to perils and hazards among farmers, probabilities of loss estimated based on the relative frequency of fewer recorded occurrences in the past, and high levels of uncertainty (Ahsan et al., 1982). With limited information on risk aversion and indemnification, the farmer’s choice of insurance is not to maximise the utility, rather it is bounded rational (Křečková & Brožová, 2017; Waldman et al., 2020). As such, farmers tend to be risk-averse as a mechanism to preserve capital. With information being asymmetrically availed through bundled agro-advisory approaches and as the need for insurance cover is heightened by changing climate, farmers are expected to choose to invest in risky business over less risky business if, based on past experiences and available information on alternatives, they perceive higher future returns amidst uncertainty.

In a smallholder farming setting, risk and poverty are inextricably linked, hence to take or not take up the bundled package, farmers have to realise financial resources and de-risk (Hill & Torero, 2009). The demand for bundled packages is suppressed if the farmer has other resources and de-risking strategies. Considering exposure to a range of production risks, with limited knowledge, more farmers are assumed to opt for uninsured credit than an insured loan (Giné & Yang, 2009). Given a farmer who grows maize mixed with other crops for subsistence and sells the surplus, s/he tends to be risk-averse. Entrenched with multiple constraints including information asymmetries that bound rationality, the utility of debt/insurance contract is suboptimal (Giné & Yang, 2009). With higher levels of inefficiency and factor substitutability such as low use of improved inputs, the impact of bundled policy is potentially endogenous.

The underlying feature of impact assessment is that *causes precede the effect in time*, and in this cross-sectional survey study, we estimate prevalence rather than incidence. Even if desirable, longitudinal studies are challenging due to changing behaviours and contexts, discontinuity in project participation, they encounter ethical concerns with randomisation and lack of information on unobserved factors such as intentions and expectations. Moreover, faced with climate uncertainty, farmers often make heuristic decision rules rather than goal-oriented ones. In our case, time is implicitly embedded in the background knowledge to establish the presumed causal and temporal ordering of variables (Cox, 1992). Causal relations are latent, not directly observed.

Given these notions, we use the Insurance in Agriculture Framework (IAF) by Ahsan et al (1982) to empirically hypothesise that insurance is an exogenous economic resource aimed at indemnification of risk-averse individuals who are adversely affected by natural probabilistic events such as droughts. Secondly, given that inorganic fertilizer is offered as a bundled technology aimed at improving soil fertility, we control for endogeneity and assume that the probability for a farmer to adopt the fertilizer was assumed to be related to the expected utility derived from its realised and future potential outcomes.

We assume that, given I^* as the difference between utility if the farmer, i, purchases insurance or adopts fertilizer (U_{Pi1}) and the utility from not purchasing or adopting (U_{Pi0}), the decision to purchase or adopt (P) is made when $I_i = U_{Pi1} - U_{Pi0} > 0$, contingent on available information and resources. Since the utility is unobservable, it can be expressed as the function of observable attributes in the latent variable estimated using the probit model (Wooldridge, 2010) as:

$$F_i^* = P_i + \beta x1_i + \varepsilon_{i1} \text{ with } F_i = \begin{cases} 1 & \text{if } F_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (1)$$

where β is a vector of parameters to be estimated; $x1$ is a vector of household and farm attributes that are key in framing farmers' capacity to purchase insurance or adopting fertilizer including education level among household members as a proxy for technical understanding, age of head as a proxy for decision making, labour and farm size as resource endowments, and income from non-crop activities indicating competing/complementing livelihood strategies (Beyene & Kassie, 2015; Manda et al., 2021; Nahayo et al., 2017; Pattanayak et al., 2003); and ε is the random error term.

Bundled *insurance* influences livelihood strategies through *fertilizer* and directly through complimentary agro-advisory that reinforce good agricultural practices and can be expressed as determinants of resilience outcomes, Y_s, in a probit model (2) for maize surplus and reserved stocks and the linear regression model (5) for the proportion of the surplus sold as:

$$Y_i^* = \alpha x3_i + \delta F_i + P_i + \varepsilon_{i3} \text{ with } Y_i = \begin{cases} 1 & \text{if } Y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

$$Y_i = \alpha x3_i + \delta F_i + P_i + \varepsilon_{i3} \quad (3)$$

x3 are other productivity controlling agronomic practices including cropping system, training in good agricultural practices, available household labour and land, and complementary enterprises.

This model fit requires that there be no confounding variables correlated with x_s, *F* and *P*; x_s, *F* and *P* be measured without error, and there be no reverse causation (x_s, *P* and F_s affect Y, but Y must not affect x_s, *P* and F_s), and x_s, *P* and F_s not correlated with ε (Wooldridge, 2010). However, in bundled insurance services under study, technology acquisition and adoption are non-random. Furthermore, due to technological advances in the agricultural system since the 1950s, *P* and F_s are potentially primed by previous resilience outcomes, i.e. having an inherent reverse causality. Moreover, there are considerable measurement errors in the farmer reports during surveys that would lead to attenuation bias. Furthermore, there exist heterogeneous treatment effects as F_s are adapted to land parcels with different fertility and response, compounded by differences in management practices. Therefore, the error terms of equations 1-3 may be correlated which may lead to biased estimates.

These are key challenges to ascertaining the validity of causal inference made with observational program impact evaluation (Cox, 1992). Bias arising from observables are controlled by including farmer, plot, and institutional variables. Unmeasured confounders such as ability and motivation that bundled (insurance + input credit + agro-advisory) product fosters are difficult to control but may influence the decision of the households to purchase insurance/adoption of inorganic fertilizer and become part of the error term thereby leading to biased estimates.

Propensity score matching (PSM) and instrumental variables (IV) are the main approaches used in program evaluation (Wooldridge, 2010). The PSM approach is used when it is practical to collect data on every confounding variable to ensure a balance of observed variables between treatment and control groups. However, the PSM approach only controls for observed and not unobserved heterogeneity. In our study, the decision to purchase bundled insurance and to adopt fertilizer was not random as such farmers may have self-selected into the adoption category based on their resource endowments thereby leading to endogeneity problems. To properly account for self-selection, reverse causality and omitted variable bias, we use the quasi-experimental method - instrumental variables (IV) – which is most suited (Angrist & Krueger, 2001; McArthur & McCord, 2017; Pizer, 2016; Wooldridge, 2010).

To control for the endogeneity of bundled insurance and fertilizer adoption, we used *market-distance* as an IV. The variable measures the distance between the global positioning system (GPS) location of households to the nearest market and administrative site spread across the study area. We assume that it gives the farmers in proximity an insurance purchase advantage but does not influence resilience outcomes directly (Pan et al., 2018). The instrument further addresses the omitted variable bias problem as *market-distance* is assumed to be uncorrelated with the farmer's resource endowments and farm productivity and captures cross-sectional random variations (Cawley et al., 2018). Several studies have used distance as a valid IV (Abdoulaye et al., 2018; Jaleta et al., 2016; Zeng et al., 2017), but unlike these studies, we used GPS to accurately measure the distance which in turn increases the credibility of the IV (Kubitza & Krishna, 2020).

We use the GPS estimated latitude that captures rainfall variations across the Guinea Savanna ecological zone from sub-humid northern regions to semi-arid upper regions to instrument the decision to adopt inorganic fertilizer (Kubitza & Krishna, 2020).

To address the potential endogenous engagement in insurance and endogenous covariates, we use the extended regression model (Statacorp, 2021). The ERM is estimated in 3 stages (Cox & Wermuth, 2001): the first and second stages focus on exogenous variables to estimate probabilities for engagement and adoption, while the third stage uses the endogenous variables as predictors of the farm-level resilience outcomes.

Treatment (insurance) $P_i^* = \beta_0 + \beta_1 x1_i + \beta_2 z_i + \beta_2 IV_i + \beta_3 \pi_i + \varepsilon_i$ (4)

$$\text{Endogenous (fertilizer)} \quad F_{ij}^{*} = \beta_{0j} + \beta_1 x2_{ij} + \beta_2 z_i + \beta_2 IV_i + \beta_3 \pi_{ij} + \varepsilon_{ij} \quad (5)$$

$$\text{Outcome} \quad \log(Y_{im}) = \beta_{0m} + \beta_1 x3_{im} + \beta_2 z_i + \beta_2 P_i + \beta_3 F_i + \varepsilon_{im} \quad (6)$$

where *IV* is the *market-distance* instrumental variable, π is the latitude, which is used to account for random factors across spatial scales. To address reverse causality, we use the instrument *z* (livestock sales and extension) in treatment, endogenous and outcome variables. We assume that the livestock is sold as a complementary enterprise hence affecting the ability to purchase insurance and inorganic fertilizers and indirectly influencing crop productivity. The prevailing GAP access is assumed to influence knowledge of novel technologies such as insurance and fertilizers but also directly influence crop productivity.

Given that treatment, *P* is binary, we estimate the average treatment effect on the treated (ATT) that measure the impact of insurance for the households who participated as:

$$ATT = E\left(y_{pi} \middle| P, F, x, z\right) - E(y_{0i} | P, F, x, z) \quad (7)$$

where y_p is the expected resilience state realised by farmers who purchased to p^{th} and y_0 is the expected resilience state if the farmer had chosen not to participate, which is estimated for non-participants as a counterfactual reference.

Results

The empirical results (Table 1) show that farmers who took insurance sold a significantly larger share of their cereal produce and had enough reserves to cover the preseason food-deficit periods than the uninsured counterparts. Insurance was associated with a 113% increase in the proportion of maize sold and an increased probability to reserve food by 42%. Post estimation test indicates that the error terms for participation in insurance and the outcome models are correlated, revealing potential endogeneity problems that the model addressed.

Results further show that co-variate to insurance, resilience outcomes are influenced by the cropping system, agriadvisory and resource endowments. Farmers practising a mixed cropping system are less likely to produce surplus maize for the market than those practising mono-cropping. Farmers who received training in good agricultural practices (GAP) were at an advantage to produce surplus and sell. Among agro-advisory channels, we observe that those in contact with extension agents have a higher likelihood to sell a greater share of produce and had reserves that covered the food deficit period. Those that received agricultural information through radio programming had a higher probability to sell the surplus maize and sold relatively a greater share but were less likely to reserve for the lean period.

On resource endowments, the study shows that larger farming families (with more available labour or potentially more dependants considering the population pyramid) are more likely to sell their produce and in large quantities compared to small families. We also found that farmers with alternative income sources are less likely to sell maize, and if they do, they sell significant smaller proportions. The study further reveals that farmers who sell livestock are more likely to also produce surplus maize and sell it.

Table 1: Impact of insurance and endogenous co-variates on maize surplus and food reserve

		Resilience outcomes		
	VARIABLES	Surplus maize sold	Maize sold (%)	Storage cover lean period
Treatment	Insurance	0.54	2.13**	1.42**
		(0.41)	(0.66)	(0.59)
Endogenous	Fertilizer	-0.79	0.68	0.86
		(0.61)	(0.19)	(0.75)
Cropping system	Mixed vs mono	-0.26*	1.02	0.21
		(0.13)	(0.07)	(0.13)
Agricultural advisory	GAP trained	0.25*	1.05	0.19
		(0.14)	(0.09)	(0.15)
	Extension contact	0.13	1.17*	0.55***
		(0.15)	(0.10)	(0.17)
	Radio program	0.28*	1.17*	-0.30*
		(0.15)	(0.10)	(0.16)
	Mobile messaging	-0.18	0.83*	
		(0.25)	(0.10)	
Resource endowments	Land size	-0.87***	0.65***	-0.16
		(0.16)	(0.06)	(0.20)
	Household size	0.08***	1.06***	-0.02
		(0.01)	(0.01)	(0.01)
	Nonfarm activity	-0.43***	0.84**	
		(0.14)	(0.06)	
	Tropical livestock units	0.02	1.01	-0.01
		(0.01)	(0.01)	(0.02)
	Sold livestock	0.48***	1.14	
		(0.14)	(0.10)	
Error correlations	corr(e.insureyn,e.mzsoldyn)	-0.51**	0.50***	-0.69*
		(0.21)	(0.08)	(0.36)
	corr(e.fertyn,e.mzsoldyn)	0.36	1.36	-0.29
		(0.38)	(0.30)	(0.48)
	corr(e.fertyn,e.insureyn)	0.04	0.97	0.04
		(0.14)	(0.12)	(0.14)
	Constant	-0.18	3.88***	-1.35**

	(0.57)	(0.94)	(0.62)
Observations	508	499	508

The results from treatment and endogenous ERM sub-models (Table A1) show that insurance participation and fertilizer adoption are primed by agro-advisory, resource endowments, social capital (including gender) and demographics. Training in good agricultural practices supported farmers in buying the insurance and applying fertilizer while farmers who reported having contact with extension agents were less likely to purchase bundled insurance. Farmers with access to mobile disseminated agro-advisory also seem to have a slight advantage of being insured and applying fertilizer compared to those without access.

Interestingly, the results further show that farmers with smallholding tend to apply fertilizer but are less likely to buy insurance. As a proxy for land tenure, ease of acquiring land through lineage and social networks supports farmers to adopt fertilizer. Income from livestock sales supports the purchase of insurance and fertilizer. Larger households tend to have a lower propensity to purchase insurance but are associated with an increased likelihood to apply fertilizer.

Among social and demographics, group membership as social capital is associated with a reduced propensity for farmers to purchase insurance. It is also revealed that female household heads are less likely to purchase both insurance and fertilizers Noteworthy, the propensity to purchase insurance is lower for both youth and single-headed households compared to older and married households, respectively. The single-headed households also tend to have a lower likelihood to adopt fertilizer.

Discussion

In this study, we contribute empirical evidence on the potential impacts of insurance on households' capacity to sell and reserve food as indicators of resilience to drought. The resilience of farmers in West Africa is critical as The Intergovernmental Panel on Climate Change (IPCC) sixth assessment projects increased the vulnerability of smallholder farmers in the region in the face of water-related perils of extreme droughts and precipitation deficits due, apart from climate change, to a significant influence of socioeconomic drivers with a greater impact on the poor (IPCC, 2022). Insurance is promoted as a proactive strategy with the potential to build the adaptive capacity of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters (Aidoo et al., 2014).

Improving farmers' adaptive capacity is essential to maintain key livelihood functions such as food security, economic growth and wellbeing (Serfilippi & Ramnath, 2018). With 45% of Ghana's population in rural areas, the development of the agricultural sector still represents a key factor for food security and economic growth. To support the growing population, productivity must increase by 60% by 2050, but climate change and market volatility threaten growth and sustainability. In addition to productivity effects, perils such as drought induce downstream risks ranging from disruptions in trade agreements, and commercial balance of power that favour retailers, to product quality-related sanitary measures that disadvantage farmers. With a greater share of produce utilised for home consumption and surplus sold, insurance presents direct and indirect effects.

Direct benefits of insurance on supporting climate resilience have been observed in Malawi where, following devastating floods of the 2020-2021 season that led to 93% yield reduction, 65000 farmers received insurance pay-outs that were a springboard towards food security and risk mitigation (WFP, 2021). In addition to direct pay-out benefit our study shows that insurance further induces farmers to produce and sell larger portions and reserve enough food for the lean period thereby contributing to food security and economic development. Our study contrasts findings by Karlan et al (2011) and Mishra et al (2022) who found that index based insurance had negative impact on production but it demonstrates that insurance induce market and food-sufficiency behaviours.

The livelihoods and sustainability of smallholder family farms are affected by high risks and uncertainties arising, in addition to climate change, from lack of technologies and supporting infrastructure, and inherent low adaptive capacities of the farms and the farmers. When hit by catastrophic events, their livelihoods are precarious, and the social support in terms of food rations they receive is inadequate and erratic. Considering the perpetual low-productivity low-resilience cycle, adaptive measures such as government subsidies, NGO grants and soft loans are implemented, which leads to a passive dependency syndrome (Aidoo et al., 2014). Bundling crop insurance with high-cost productivity-improving inorganic fertilizers and modern improved varieties bred for drought tolerance is a viable option for farmers to take productivity-enhancing risks (Mukherjee et al., 2017). The agro-advisory supports farmers to implement good agronomic practices that maximise output per resource input and minimize the vulnerability of the farming enterprise. This study reveals that agricultural extension has a positive impact on food reservation which entails the food sufficiency focus of the extension system. However, despite its rich history, extension outreach is limited (Sarku et al., 2022). Studies have found that social networks influenced the heuristic short-run adoption of irrigation (climate adaptation strategy) in the Netherlands (van Duinen et al., 2016).

In this study, we have found that radio programs promote market orientation with significant implications on off-season food availability. A related study in western Ghana found that despite popularity, irregular messaging and fixed-time radio programming affect women's access to agro-advisory due to their lack of free time, affecting their principal contribution to food security bargaining. This calls for triangulation and networking of information sources to reduce the information usability gap: the difference in the provider's view of the usefulness of information versus the user's view of how applicable the information is for decision-making in their context (Sarku et al., 2022). Farmer clubs have been found effective platforms for knowledge sharing and feedback consolidation among farmers, Interlinkages in actionable knowledge provision and emphasizes the role of local farmer-to-farmer networks (Nyamekye et al., 2020)...

A greater effort and progress have been made in the provision of weather forecast information. Earlier, weather information was channelled mainly through radio by the Ghana Meteorological Agency but with advancement in information technology and agro-business, the mobile phone has become a key instrument if the provision of targeted information to farmers which support them to make climate mitigation decisions (Sarku et al., 2022). Although mobile ownership is around 80%, the greater number of farmers are yet to benefit from mobile phone Short Message Services (SMS) and Interactive Voice Response (IVR) as these services are provided through commercially oriented farmer club memberships (Nyamekye et al., 2020). The mobile platforms provide tailored information on seasonal forecasts and varieties of crops to cultivate. Since the mobile service is private sector-led, it lowers the propensity for farmers to reserve their production for the lean period as farmers produce for the market.

Although still used by a few, studies show that farmers' willingness to pay for crop insurance range from 60% (Issaka et al., 2016) to 76% (Aidoo et al., 2014). To unlock the potential of insurance, propositions includes establishing regulatory framework in both insurance and agricultural sectors (MoFA, 2007; Republic of Ghana, 2006), improving access to credit, formal education, non-crop insurance programs, and addressing cultural beliefs (Issaka et al., 2016). Ensuring secure land tenure and providing social safety guards in form of premium subsidy have also been found as key enabling factors (Aidoo et al., 2014).

Conclusion

The study reveals that farmers on the insurance program had a higher likelihood to sell a greater share of their produce and reserved grains for the lean period. Insurance spurred farmer's to be commercially oriented by two folds as well as to be food self-sufficiency by 50 percentage points thereby contributing to smallholder's economic development and food security. Although insurance's main role is to indemnify individuals from calamities beyond their managerial control, the bundled information and agronomic practices improves productivity. The effect of insurance is inherently endogenous, which we control using instrumental variables in the ERM. These results form a significant contribution to insurance policy and strategy formulation as disasters have worsened in the last three decades leading to food insecurity and disruption of livelihoods.

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Appendix

Table A1: Determinants of participation in insurance scheme and adoption of inorganic fertilizer estimated in ERMs for maize sold, selling percentage, and the reserve.

		Insurance			Fertilizer		
	VARIABLES	Sold	Sold%	Reserve	Sold	Sold%	Reserve
Agro-advisory	GAP trained	0.23	0.24	0.46***		0.48***	0.38**
		(0.17)	(0.19)	(0.18)		(0.16)	(0.16)
	Extension contact	-0.73***	-0.54**	-0.92***	0.07	-0.05	0.07
		(0.20)	(0.26)	(0.20)	(0.20)	(0.20)	(0.17)
	Radio program	-0.16	-0.21	-0.11	-0.13	-0.21	-0.27
		(0.20)	(0.19)	(0.19)	(0.19)	(0.20)	(0.17)
	Mobile messaging	0.42*	0.39	0.43*	0.86**	0.83**	0.70*
		(0.25)	(0.24)	(0.22)	(0.39)	(0.38)	(0.42)
Land size & tenure	Smallholder	0.21	0.31*	0.07	-0.46**	-0.39*	-0.36*
		(0.21)	(0.18)	(0.20)	(0.21)	(0.21)	(0.19)
	Ease in acquisition	0.25	0.08	0.13	0.24	0.24**	0.15
		(0.18)	(0.10)	(0.10)	(0.16)	(0.10)	(0.10)
ownership	Joint vs male		0.31	0.68***		0.12	-0.15
			(0.29)	(0.24)		(0.22)	(0.22)
	Female vs male		-0.44	-0.49		0.11	0.00
			(0.59)	(0.59)		(0.30)	(0.31)
Labour, nonfarm and livestock	Household size	-0.03*	-0.05***	-0.04**	0.04*	0.04*	0.03
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	Off-farm income	0.15	0.12	0.08	0.12	0.12	0.13
		(0.17)	(0.16)	(0.16)	(0.16)	(0.16)	(0.15)
	Tropical livestock units	0.02	0.02	0.02	0.02	0.03	0.03
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	Sold livestock	0.23	0.23	0.28*	0.26*	0.25	0.31
		(0.17)	(0.17)	(0.16)	(0.15)	(0.16)	(0.19)
Social capital	Group membership	-0.62***	-0.66***	-0.46**	0.13	0.12	0.13
		(0.20)	(0.19)	(0.22)	(0.19)	(0.18)	(0.21)
	Gender of head	0.61**	0.81***	0.47*	0.75***	0.75***	0.75***
		(0.25)	(0.22)	(0.25)	(0.25)	(0.25)	(0.25)
	Youth vs age>32	-0.42*	-0.28	-0.44*	-0.11	0.06	-0.06
		(0.22)	(0.21)	(0.25)	(0.21)	(0.21)	(0.20)
	Single vs married	-0.49*	-0.55**	-0.65**	-0.76**	-0.94***	-0.68**
		(0.29)	(0.24)	(0.29)	(0.32)	(0.31)	(0.33)
	Formal education	0.20	0.05	0.12	0.18	0.17	0.12
		(0.18)	(0.16)	(0.20)	(0.22)	(0.20)	(0.20)
Spatial covariates	Latitude	-0.51***	-0.38**	-0.45**	0.48***	0.53***	0.51***
		(0.17)	(0.18)	(0.21)	(0.14)	(0.15)	(0.15)
	Market distance	1.7e-5*	2.5e-5***	2.7e-5***	-2.2e-5**	-2.2e-5**	-2.3e-5**
		(9.4e-6)	(9.1e-6)	(1.0e-5)	(1.1e-5)	(1.1e-5)	(1.1e-5)
	Constant	3.74**	2.40	2.90	-3.73***	-4.57***	-4.27***
		(1.79)	(1.72)	(2.03)	(1.41)	(1.52)	(1.55)
	Observations	508	499	508	508	499	508