Weather-index based crop insurance as a social adaptation to climate change and variability in the Upper West Region of Ghana

Developing a participatory approach

Working Paper No. 189

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security

CGIAR CCAFS

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Photos: by Samuel G.K. Adiku (University of Ghana).

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Abstract

Climate change and variability are major challenges to rain-fed crop production in Africa. This paper presents a report on a pilot project to test a concept for operationalizing weather-index crop insurance as a social adaptation to the climate change and variability problem in the Upper West Region of Ghana. An analysis of long-term weather variables showed rising temperature of 1.7 ^{o}C over a period of 53 years as well as major shifts in rainfall patterns. Farmers face a new reality that cannot be addressed with their indigenous knowledge alone.

The weather-index based crop insurance concept discussed herein was developed by combined effort of University of Ghana, the German International Cooperation (GIZ) and the Ghana National Insurance Commission (NIC) since 2010. This development was carried out via their filial, the Ghana Agricultural Insurance Pool (GAIP). The proposed concept sought to link various agricultural stakeholders such weather technical persons, farmers, agricultural extension officer, input dealers and other aggregators, and financial institutions as well as the insurance industry and focused on a participatory farmer led approach. The piloting of the concept was supported by the Climate Change and Food Security (CCAFs) project and was tested in the years 2012 and 2013 using a theatrical drama sketch in two districts in the Upper West Region of Ghana: Jirapa and Lawra. It was observed that training of farmers in the basic principles of weather (data collection, interpretation, etc.) facilitated the discussions on drought insurance, adding to the body of evidence supporting participatory design tools.

The aim of this paper is to record this process and to put the results into recent context, through discussing them through the lens of insurance operations and research in Ghana. Ensuing discussions showed that although all stakeholders considered the participatory design tools to be meritorious, a number of logistical challenges were identified that need to be addressed for effective scaling. The study also highlighted the high spatial variability of rainfall in the Upper West region of Ghana, showing the necessity of satellite-derived rainfall products. Finally, the framework suggested in this report highlights the complexity and the institutional structures required to implement an effective insurance. In effect, our simple study has exposed the complexities and intricacies that must be overcome in establishing a sustainable insurance scheme in Ghana.

Keywords

Index insurance; Ghana; Lawra; Climate change, adaptation, insurance delivery concept.

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This work falls within two CCAFS funded projects:

- "Assessing the feasibility of a weather indexed based crop insurance as an adaptation to climate change", 2010-2012
- "Capacitating Smallholder Farmers with Climate Advisories and Insurance Development" (CASCAID), 2015-2018, https://ccafs.cgiar.org/building-climate-risk-management-capacity-west-africa

Contents

Introduction

Variations in the weather have always been important for farmers to address. Since the Industrial Age, natural variations in the weather and climate have been increased by the impact of anthropogenic climate change. There is strong evidence to suggest that global temperatures are increasing due to this, along with associated impacts on global, regional and local weather systems. Current observations suggest that global temperatures are now at least 1 °C above pre-Industrial levels (NOAA, 2016) and that future temperatures are likely to face meaningful increases. There are also many more complex projections for rainfall, with many regions experiencing more severe weather events.

Farmers must manage these risks to survive. A commonly used strategy is to work to become even more productive in remaining 'good' years, allowing them to offset their losses in the bad. One way to achieve that productivity is to invest in new inputs or technology, but the risk of doing that can often leave farmers even more vulnerable to the weather. For example, farmers might increase their yields in a normal year by taking out a loan to purchase high-quality seeds and fertilizer. But if a severe drought strikes, there is the chance they will lose everything and go into debt. Furthermore, banks often perceive farming as a 'high-risk' venture, and thus are not readily willing to provide a loan in the first place. This means that, unfortunately, threats like drought—the very reason for adopting these climate-smart practices—also represent a huge risk that make farmers reluctant to invest.

Agricultural insurance is one method to transfer this climate risk when it cannot be mitigated. Traditionally this has taken the form of indemnity insurance, where compensation is awarded based on directly measured damages. These policies are often difficult to implement in many situations due to the complex logistics of visiting every farm and the moral hazard of farmers neglecting their crops to gain compensation. In recent years, indemnity insurance has been complemented by a focus on index-based products, which award compensation based on some proxy for damage (USAID, 2014). There are two common forms of index insurance, discussed further in Appendix A. Weather based index insurance typically focuses on protection against a single named peril such as low rainfall at a specified point in the season, or high winds. In this case, compensation is awarded based on an external measurement of this peril (e.g. the rainfall recorded at a nearby gauge, or from a satellite pixel). Area yield insurance is comparable to multi-peril insurance in that it covers everything that might cause low yields. In this case, instead of compensation being awarded for a specific customer, it is awarded based on the average yield (or livestock mortality) over the region of interest. This overcomes many of the issues of moral hazard as the performance of an individual farmer is much less likely to influence a potential pay-out. Both indemnity and index insurance products have roles to play within agricultural risk management, with both types of policy available in many countries.

It has been often stated that agricultural insurance may be too complex for smallholder farmers to understand, too expensive to purchase, or that it is too difficult to implement (Biswanger, 2012). Agricultural insurance must also fit into farmers' existing risk management strategies alongside the many other challenges they face, such as low credit worthiness, low production output, partial integration into commercial activities. Despite these concerns, over the last few decades many African countries have made efforts to introduce index-based agricultural insurance to smallholder farmers. Agricultural insurance has already reached nearly 1,000,000 farmers in Africa, through governments, Non-Governmental Organisations (NGOs) and commercial programmes, many of which are unsubsidized (Greatrex et al, 2015).

Recent evidence is starting to suggest that participatory design tools and tailored information are useful in overcoming these barriers to insurance adoption by farmers, allowing insurance to be implemented within existing risk management frameworks. This paper provides additional evidence to suggest that this is the case, alongside an examination of index based insurance within Ghana.

We also find that irrespective of these efforts, an equally pressing issue is a general lack of a workable framework that links not only the financial institutions and farmers to insurance but also the other stakeholders in agricultural production such as agricultural extension officers, aggregators, input suppliers, marketers, regulations, reinsurers, policy makers and climate and weather technical officers, among others. Worldwide, the most successful agricultural insurance programmes have made strides to address this, for examining the incentives and enabling environment for different stakeholders to engage (GSMA, 2014). It is our conception that such a comprehensive approach will be required in Ghana to overcome the numerous challenges to the creation of sustainable agricultural insurance programmes.

This paper first discusses the meteorology and climate of Upper West Ghana in order to assess how agricultural insurance might fit. It then discusses a pilot programme conducted in Lawra district of the Upper West Region of Ghana in 2012/2013, where different participatory tools were assessed and farmers helped to design the general framework of an agricultural insurance programme. This was one of the earliest examples of such research. Finally, we discuss the recent history of agricultural insurance in Ghana and how these participatory methods have been carried through into operational insurance.

Climate vulnerability in the Upper West Region of Ghana

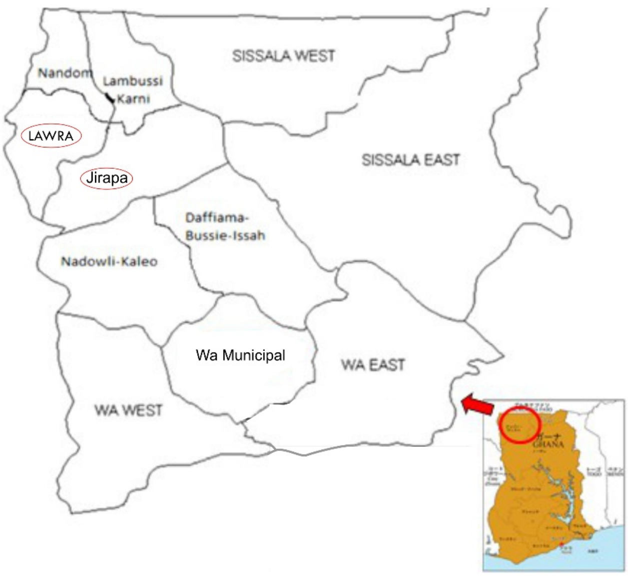

Figure 1. The Upper West Region of Ghana, indicating the study locations[1]

There have been several shifts in the recorded climate of the Upper West region of Ghana, in the Interior Savannah agro-ecological zone (Figure 1). For this zone, the analysis of long-term climate records for Wa (the capital of the region) as a representative location reveals a steady rise of air temperature by 1.7^{o}C over the past 53 years (1953 to 2005) or 0.028 ^{o}C/yr. If this trend continues, the average temperature would increase from the current value of 27 ^{o}C to

[1] Source:http://www.jica.go.jp/project/english/ghana/006/background/index.html

almost 30 °C by the year 2050. It is also evident that the rate of rise of the minimum (Tmin) was higher than the average (Tav) and maximum (Tmax) temperatures. This implies a narrowing of the diurnal temperature range which has implications for agricultural productivity. Apart, the number of days with Tmin >25 °C, Tav > 30 °C and Tmax > 35°C have been steadily increasing. Further analysis showed that the potential evaporation, ETo, (vapour demand by the air, estimated by the Thornthwaite method), which is dependent on temperature (Figure 2) showed a steady increase over the years. For the first 27 years (1953-1979), the average evapotranspiration rate was 1519 mm/yr but this increased significantly ($p < 0.01$) to 1818 mm/yr during the next 26 years (1980-2005) almost by a factor of 22%.

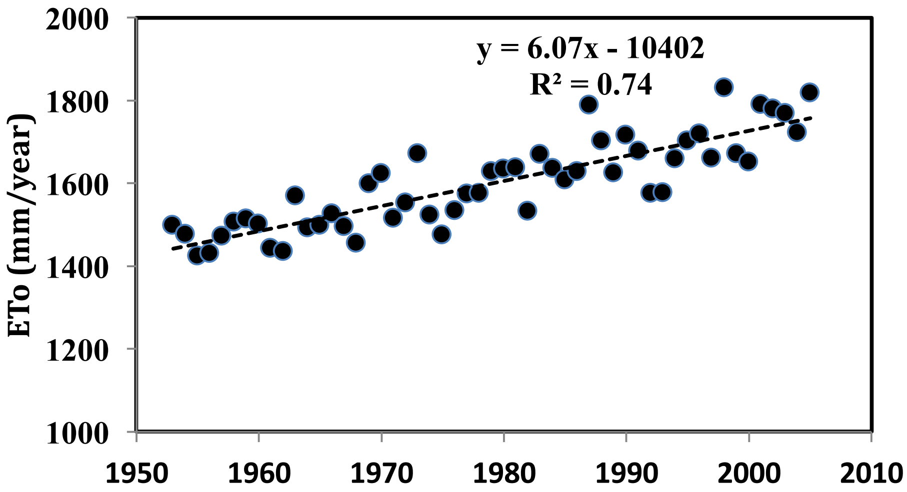

Figure 2. Time-series of potential evapotranspiration at Wa.

Despite the increases in temperature and potential evapotranspiration, there was no observable change in the total annual rainfall over the years (Figure a). The average rainfall for the first 27 years (1953 -1979) was 820 mm while that of the last 26 years (1980-2005) was 790 mm. The difference was not significant. However, it was evident that the number of rainy days declined over time, resulting in a gradual increase in the average rainfall intensities (Fig. 3b). Conceivably, the same annual rainfall occurs in fewer events in the more recent periods. The fewer rainfall events with higher intensities could be attributed to temperature increase, alongside other synoptic shifts in the regional climatology. Basic climatology shows that for every 1°C rise in air temperature, the environmental moisture demand (Saturated Vapour Pressure, SVP) will rise by 7%, because hot air can hold more water vapour than cold air. This will affect rainfall in the manner in which rainfall is distributed within the season. In simple terms, the time duration required to saturate a hotter air parcel is longer (i.e. longer dry spell) and when this finally does happen and the air parcel cools by rising, greater quantities of water will be deposited as rain (heavier storms).

In effect, farmers in the Upper West Region of Ghana are increasingly confronted with major shifts in rainfall distribution patterns, not only from year to year, but also within the season. For example, the smaller rainfall events have declined during the last 30 years from 1983 to 2011, compared with the previous 30 years from 1953 to 1982 (Fig. 3c) suggesting that not only drought but also flooding is now a major menace.

Perhaps, the major change in rainfall pattern at Wa relates to the decline in the very early rains in March, April and May (Fig. 4). On the contrary, rainfall for the months of June and July remained unaltered but August rain increased significantly. September rainfall also remained unaltered while that of October declined over time. With the month of June becoming the first stable rainfall month and that October rainfall (end of season) declining, it is conceivable that much of the annual rainfall is now concentrated within a few months and the length of the growing season has reduced.

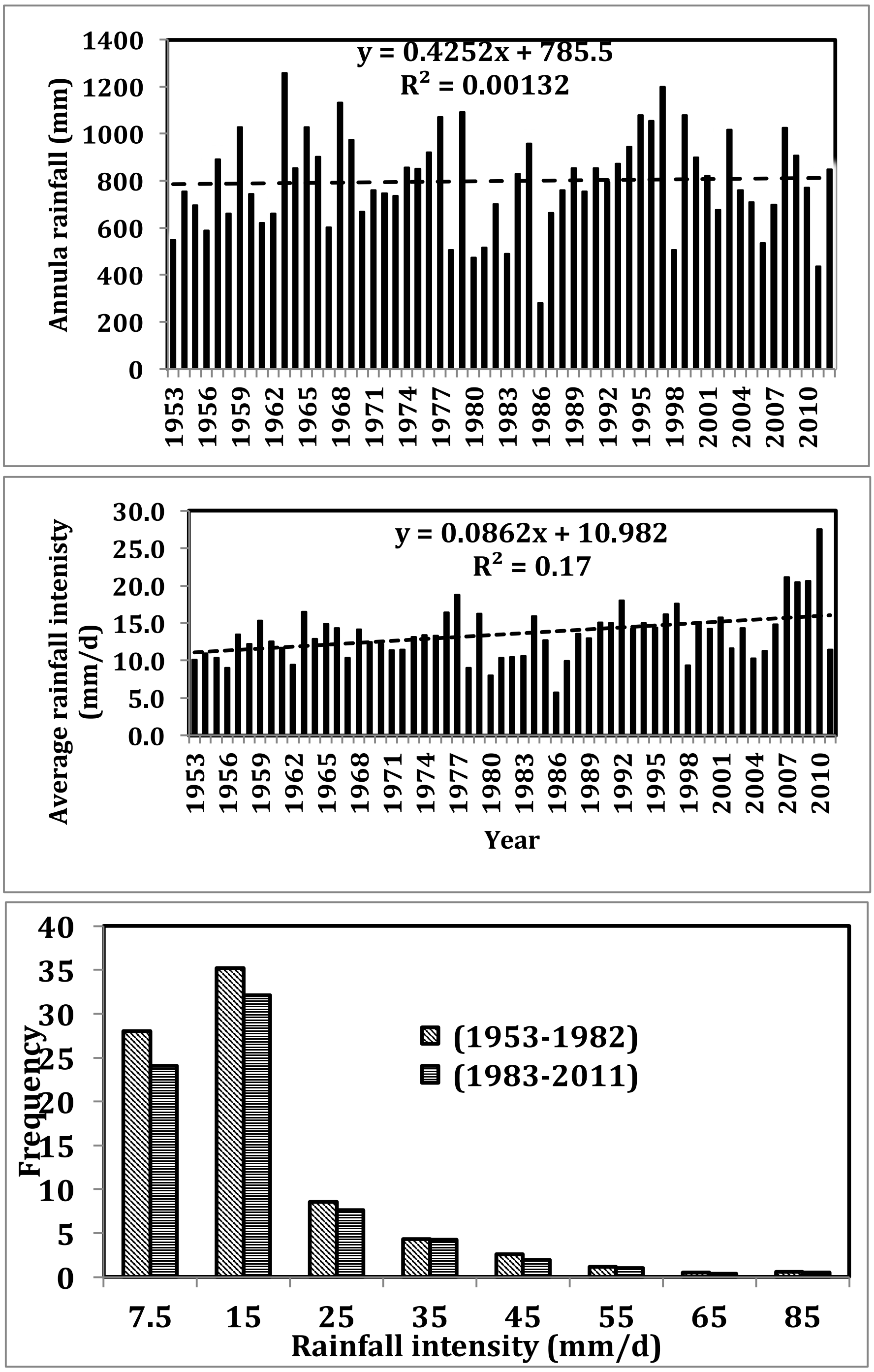

Figure 3. Time-series of total annual rainfall (a), average intensity per event (b) and shifts in daily rainfall distribution (c) at Wa.

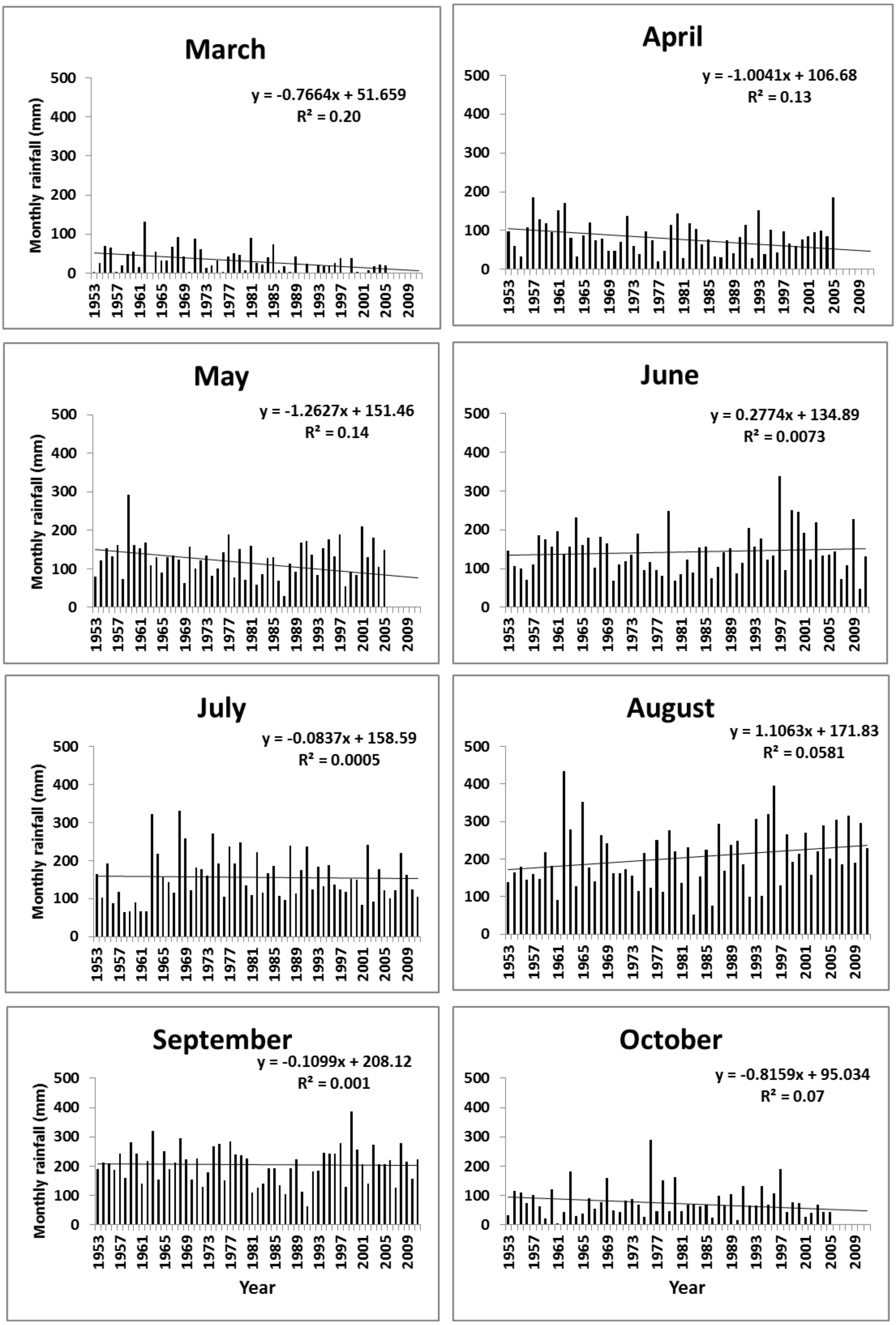

Figure 4. Time-series of monthly rainfall totals at Wa.

The combination of increasing temperatures and changing rainfall distribution implies that farmers face new realities that their indigenous farming knowledge alone may be incapable of coping with. The average ratio of the rainfall to potential evapo-transpiration for the years 1953 to 1979 was 0.54 and this was significantly (p = 0.05) different from that (0.47) for the 19080 to 2005 (Fig. 5a). This declining ratio implies increased aridity, even if the total rainfall remains unchanged. Given the low irrigation development in Upper West Region, rainfall remains the major source of agricultural water and rainfed crops are likely to be adversely affected by water stress. In general, hot and wet (H/W) as well as hot and dry (H/D) climates have increased considerably in the last decades (Fig. 5b).

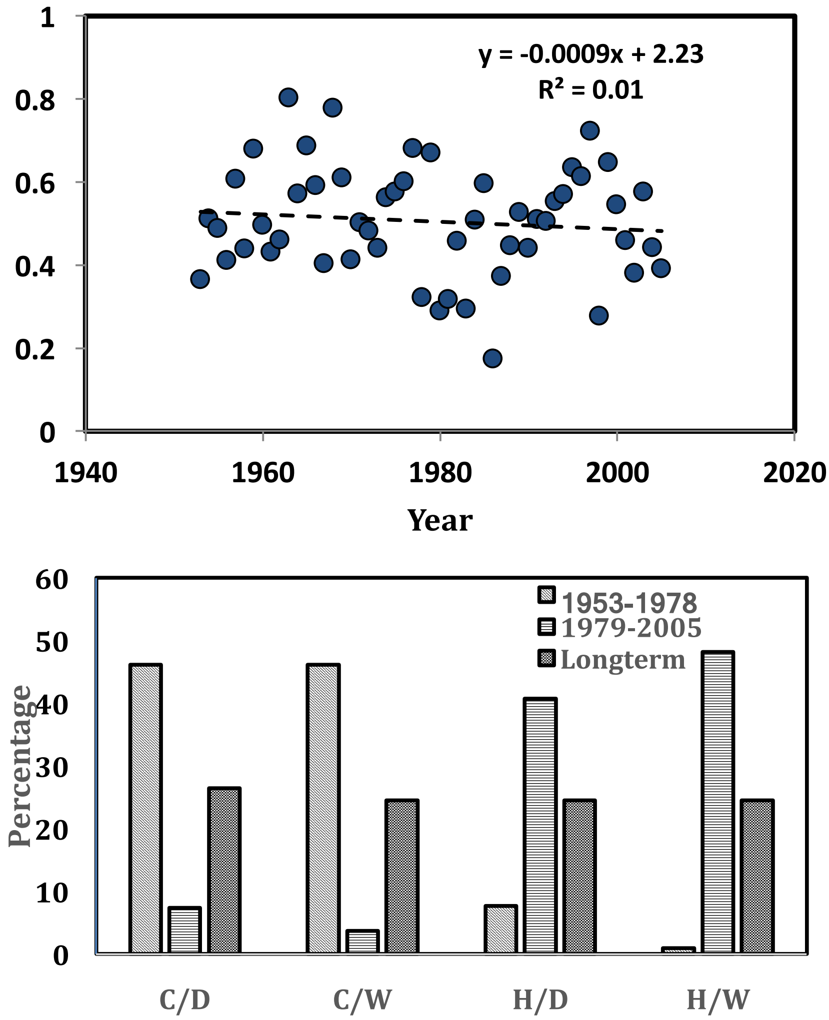

Figure 5. Variation of the ratio of rainfall/evapotranspiration with time (a) and frequencies of cool and dry (C/D), cool and wet (C/W), hot and dry (H/D) and hot and wet (H/W) for different periods of times at Wa.

One factor often ignored in drought analysis in a given area is the soil water storage. The latter determines what is termed "agricultural drought". Even in the event of meteorological drought (reduced rainfall), soils with good water storage could still sustain crop growth. Soils of the Upper West Region of Ghana are dominantly very gravelly, coarse-textured shallow (less than 50 cm) and store less than 60 mm water. This contrasts with a "good" soil with depths of at least 120 cm and water storage capacity of about 250 mm/m. While soils could be rendered drought resistant by good management such as residue retention, increased soil organic matter, among others, the current soil management practices in the region is poor, with residue burning or removal for other purposes. Thus, even though rainfall totals appear to be stable, the combination of increasing aridity due to temperature increases, changes within-year rainfall distribution and poor soil management predispose the Upper West Region to severe climate change impact that will require a holistic approach for resolution. Evidently, farmers who still rely on March to May rainfall to commence farm operations face an increased risk as poor crop establishment. Those who plant too late face a risk of floods.

Climate risk management

The above analysis suggests that climate change and increased variability are challenges that farmers in the Upper West Region of Ghana must overcome if they are to ensure sustainable crop production. The complex nature of the problem requires a holistic approach, building on expertise in meteorology, socio-economics and agronomy. What options are available to mitigate the impact of climate change and variability on rainfed crop production? One common approach is to support farmers with better information on the weather and climate to support agricultural decision making. This could be for example, more timely, easily accessible and higher skill seasonal forecast information, (Hansen, 2005; Adiku et al., 2007). New participatory approaches such as the Participatory Integrated Climate Services for Agriculture (PICSA) campaign have recently been implemented to allow both historical climate information and forecasts to be included within farmer decision making (Dorward et al., 2015; Torgbor et al, 2016). However, such programmes are new in Ghana and are yet to reach the majority of farmers. Short term weather forecasts are now available from both the Ghana Meteorological Agency (GMET) and from private companies. For example, farmers can now send a Short Messaging System (SMS) message to receive a daily weather forecast from their mobile phone company (Brännvall, 2016). Nevertheless, forecasts and climate information will only ever be able to fill one part of the climate risk management portfolio.

A complementary approach is to support agricultural extension in their efforts to improve soil and water management with practices such as such as mulching to reduce evaporation, ridging to minimize flood effects, and dugouts for water harvesting for supplementary irrigation, among others. These efforts have not yet been widely adopted and practiced across Upper West Region of Ghana. Agricultural insurance has been promoted as complementary to these risk management activities. In particular it has been suggested that it can enable the uptake of other productive options through reducing the risk of climate-based failure. For those new to agricultural insurance a brief primer is given in Appendix 1. The next section discusses some of the frameworks and participatory tools designed to support agricultural insurance in Ghana.

Laying the foundations for the introduction of crop insurance in Lawra and Jirapa

There are many roles for agricultural insurance in the development landscape. One role is to support the uptake of productive options that a farmer might wish to engage in, through mitigating the risk of an adverse event. For example, ACRE Africa offers a "re-planting guarantee" for individual bags of seed if there is a dry start to the season (GSMA, 2015). Many programmes bundle agricultural insurance with loans (World Food Programme, 2016; Hamasaka 2016) or with holistic packages of climate smart agricultural techniques (World Food Programme, 2016). The framework for agricultural insurance has also been useful as a method for targeting aid as part of social safety nets (World Bank, 2015). It has also been used to protect existing assets, particularly livestock (World Bank, 2015, Chantarat et al. 2013). Agricultural insurance has been applied at a micro level (where the product is sold directly to farmers), at a meso-level (where it is sold to aggregators such as banks or seed companies either on behalf or farmers or to cover a portfolio), or at a macro level (where it is typically sold governments in order to stabilise climate related fluctuations in GDP).

There is a growing body of research to suggest that micro-level insurance programmes can result in significant uptake if linked to farmer education and capacity building (Aidoo et al

2014; Norton et al, 2015; BalmaIssaka et al., 2016). This paper provides early evidence of this effect, reporting on activities conducted between 2012 and 2013 as part of the CCAFS funded project entitled "Assessing the feasibility of a weather indexed based crop insurance as an adaptation to climate change." We also discuss the logistical frameworks that would allow these approaches to be used in a commercial or operational insurance programme.

This study also built upon the experiences and achievements of the German International Cooperation (GIZ) supported crop insurance project that began in the three northern regions of Ghana (Northern, Upper East and Upper West) from 2011. This was an early precursor of the current operational Ghana Agricultural Insurance Pool that now provides all agricultural insurance to farmers in Ghana. This paper reports a CCAFS-supported pilot study to assess the challenges faced in introducing the weather-index based crop insurance programmes in Ghana's Upper West Region. The study was conducted in two Districts: Lawra and Jirapa (Figure 1). The study had several components:

- Discussions on farmer perceptions of climate change.
- Education on the different types of crop insurance.
- Training of Farmers and Extension Officers on the fundamentals of climatology, i.e. rainfall variables and their measurement as a prelude to understanding weather-index based crop insurance.
- Development of an insurance concept for financial institutions.
- Support for the implementation of selected crop insurance schemes for 2013 growing season.

A total of 6 visits were made to the Districts during the 2012 and 2013 growing seasons. Interactions were with farmers via questionnaires as well as group discussions.

Pilot location

According to the Ghana Statistical Survey data, the Upper West Region (Figure 1) which lies within 9.8 - 11°N and 1.6 – 3°W is home to some 702,110 inhabitants. It is situated in the Interior Savannah Zone of Ghana and has a total land area of 18,476 km^2, carrying a vegetation of grassland interspersed with wood and shrubs. Ghana Soil Survey Manuals also indicate that the soils, which are classified as Ferric Acrisols are typically coarse-textured (sand > 70%) and shallow (< 50 cm). Gravelly outcrops are common in some locations. About 72 % of the population is engaged in agriculture. The major crops cultivated include maize, millet, sorghum, groundnuts and cowpeas. The growing season in the Upper West Region of Ghana begins from May and extends to the end of September. The growing season extends over almost 7 months with a total rainfall of 800 mm to 1000 mm. However, the within-season rainfall distribution can be problematic and pose challenges to decision making. Season onset can be as early as April but the rainfall stabilizes by late May. Yet, dry spells of varying duration often occur in June after the stabilization of the rains from late May. The result is a wide window of planting time, as farmers are making "best guesses" of the optimal sowing date, based on their past experiences. Farm sizes are often small (0.5 to 2 ha) and crop yields are often low (maize: < 1000 kg/ha) (CCAFS, 2015) compared with potential maize yield of more than 4500 kg/ha.

Administratively, the Region has 8 Districts with Wa (the regional capital city) having 3 Sub-Districts. Each Sub-District contains a Ministry of Food and Agriculture (MoFA) Unit. The Extension Officers from the Units advise farmers on good crop husbandry practices. The Districts are not equally endowed with resources. Out of the 8, good weather stations can only be found in Wa and Lawra. Other Districts have mainly rainfall stations, many of which have been dysfunctional for many years. Some of the Districts have banks, other agriculture-related Non-Governmental Organizations (NGOs) and input dealers.

The Pilot Project

With the help of Extension Officers, a total of twenty farmers (ten from Jirapa and ten from Lawra) were selected for the training based on the following criteria:

1. The farmer holds a minimum of 1.0 ha with at least 0.5 hectare cultivated regularly to maize,
2. The farmer shows evidence of the ability to keep records,
3. The farmer is recommended by the District Agricultural Office as trustworthy, and
4. The farmer has no unpaid debts.

The concept of agricultural insurance was explained in detail to the farmers, showing the clear differences between index-based insurance and other conventional types of insurance. The strengths and disadvantages of the insurance types were discussed with the farmers during group discussions at the District Agricultural Office (Fig. 6).

Figure 6. Training of farmers on insurance principles at Jirapa

Training on Weather Variables (Rainfall) Measurement and Analysis

One assumption made in this study was that the customer needed to understand their local meteorological conditions and how to measure them, if they were to fully understand weather index based insurance. As a consequence, farmers were trained in the basics of rainfall measurement and interpretation. Famers at Lawra visited an automatic-recording weather station located at the District Agricultural Office (Fig. 7) where the functions of various types of equipment were explained.

Figure 7. Visit to the Lawra Automatic Recording Weather Station at Lawra and Explaining the mode of functioning of the Equipment to Farmers and extension Officers

This was followed by a more intensive training on the use of rain gauges for rainfall measurement (Fig. 8). For practical experience, each farmer was presented with a simplified rain-gauge, with colour ranges corresponding to different rainfall amounts. Rainfall below 5 mm/day was indicated as red, between 5 and 25 mm/day as green and above 25 mm/day as blue. The farmers were trained to record rainfall on charts according to the colour codes (Fig. 8).

Figure 8. Training on rainfall recording at Lawra and Jirapa.

Farmers were handed rain gauges which they installed on their farms in August 2012 and collected daily rainfall data until December 2012. In January 2013, all the participating farmers were invited to a review meeting to discuss their data and experiences based on their rainfall records (Fig. 9).

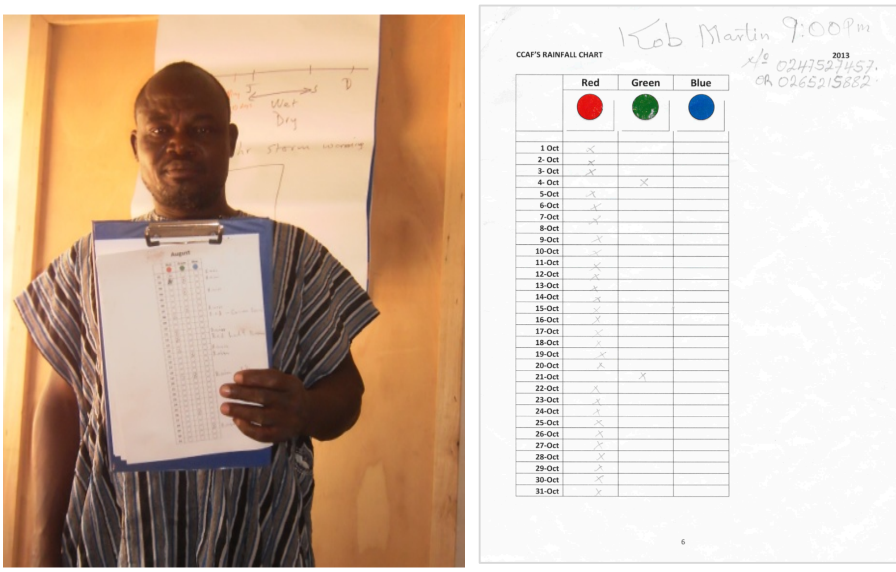

Figure 9. Left A farmer from Jirapa (left) presenting his rainfall records for discussion. Right, a sample page from the rainfall record belonging to Farmer Kob Martin, Lawra

In a bid to further enhance the meteorological comprehension of farmers, some rainfall characteristics were analysed and discussed. The first was the number of days with "normal" rainfall (between 5 and 25 mm, as captured by green colour) which was quite low at most locations. In August, there were only 5 days for Jirapa and 4 for Lawra (Figure). This increased to 7 at both locations in September and declined sharply from October to December. It was inferred that farmers who planted late would have their crops maturing into dry periods unless they select the appropriate varieties.

Second, the length of dry spells increased as the season progressed in 2012. The end of rainfall was quite abrupt in September such that the dry spell length increased sharply from about 7 in September to more than 20 in October. Statistical analysis of the rainfall data showed a high probability of dry day followed by day (*P*(D/D)) ranging from 0.77 in August to 0.99 in December at Jirapa. At the Lawra site, the *P*(D/D) was from 0.75 (in August) to 0.99 in December. At both sites, the probability decreased slightly in September (0.67 and 0.73 at Jirapa and Lawra, respectively). The probability of a wet day following a wet day was generally low at both sites, ranging from 0 to a maximum of 0.25.

Third, rainfall was quite variable from farm to farm. Data from 8 farms within the Jirapa District showed that the coefficient of variation (CV) for "normal" rains ranged from 21% in August to more than 71% from October and beyond. Similarly at Lawra, the CV for "normal" rains was at least 50%. Although this study was only based on data from one season, it suggested that a single district-wide index based on one weather station is probably not sufficient to reflect the spatial variation experienced across the district. This therefore adds to the body of evidence suggesting that satellite rainfall or a high density of rain-gauges would be needed to implement weather based index insurance across the region.

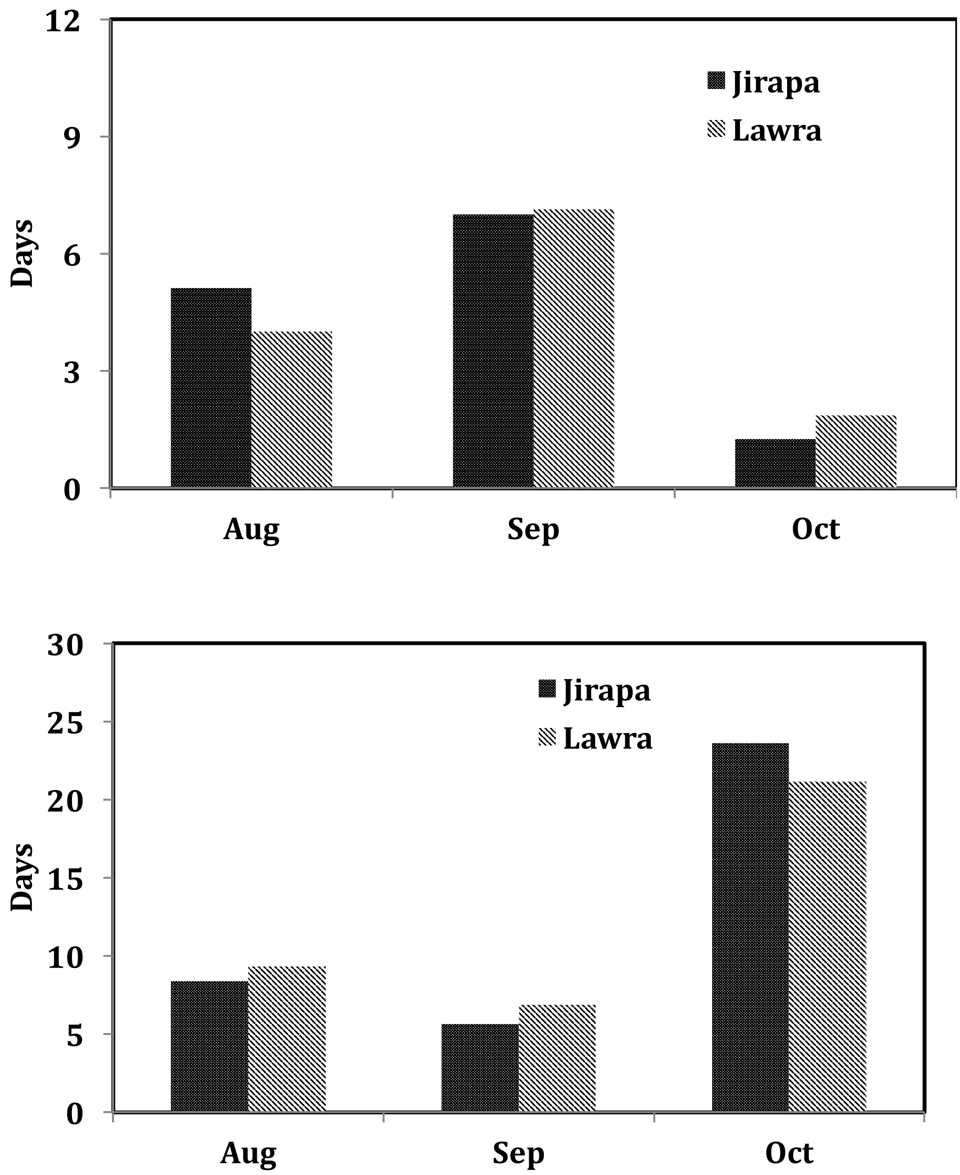

Figure 10. Average number of "normal" rainy days (above) and dry spell length (below) at Jirapa and Lawra in the months August to October, 2012.

Fourth, though somewhat isolated, one farm within the Jirapa District experienced 5 heavy rainfall storms within a period of 7 days from late August to early September, leading to transient flooding of the maize farm. A previous interview indicated that from the farmer's recollection, there was no flooding of the farm during the past 10 years. However, documentation was not available to cross-check the farmer's claims though our initial inspection of the field revealed some evidence of prior flooding.

The merit of this study is that from now onwards, the farmers have seen the need to document rainfall events and other occurrences on their farms. We considered the ability to understand these fundamentals by farmers as important for their appreciation and adoption of weather-index based insurance.

Developing a framework for micro scale crop insurance

The major hypothesis for this study was that if farmers were insured against climate-induced crop failures, they could become credit worthy, and capable of re-investing in the next season, because the insurance would pay for the loan repayment in the event of poor rainfall. This brings to the fore the role of financial institutions (banks, creditors, etc.) in supporting agricultural activities. Traditionally, farmers that are considered to be credit worthy and backed by recommendation from the Ministry of Food and Agriculture (MoFA) may access credit and loans from banks. These are typically used to finance agricultural activities such as payment for tractor services, or the purchase of inputs. The current loan transaction procedure is often direct between farmer and money lending institutions, and is schematically shown in Fig. 11. Farmers provide their own collateral as a surety against failure to repay loan and interest. The inability of farmers to repay loans could result in court summons and fines and/or loss of their collateral. There is also opinion amongst banks that high risks of crop failure due to unreliable rainfall can lead to high default rates of loan repayment (Addae-Korankye, 2014), although it should be noted that there are also many other sources of loan default (Awunyo-Vitor, 2012).

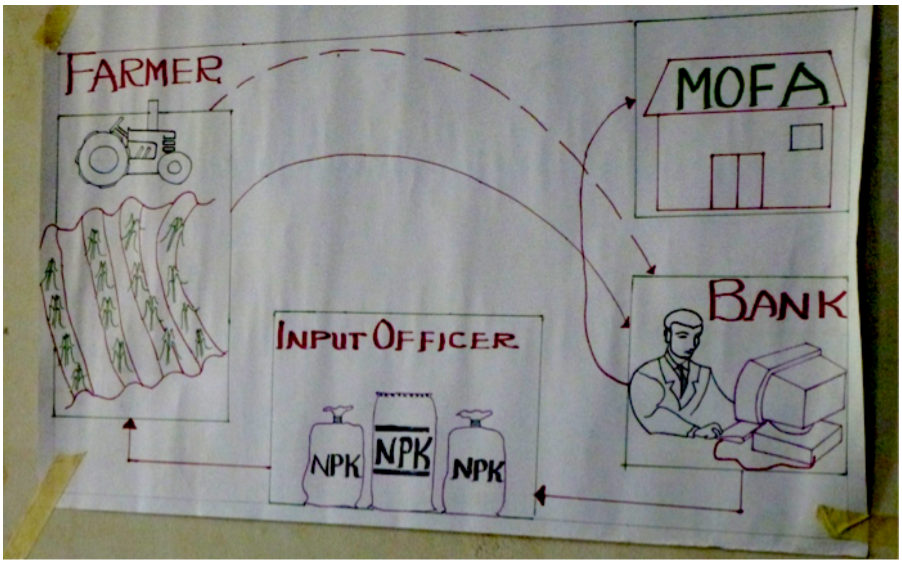

Figure 11. Current loan transaction procedure for farmer credit access

The question of interest is what additional modifications must be introduced to the loan transaction procedure in Fig. 11 to facilitate the involvement of the banks and other financial institutions in the delivery of a climate-sensitive credit and loans to farmers. To address this issue, we recognize that there is a chain of events that lead to crop production and this also involves several actors, such as farmers, extension officers, agricultural financiers, banks, input suppliers, among others. A successful climate-sensitive insurance scheme must link all these actors to the insurance industry if it is to be bundled with credit.

Further, it is worthy of note that farms are varied, and there may be the need to tailor the insurance products to meet various categories. For example, for small-scale farmers holding between 1 and 3 ha who constitute about 70 % of farmers in many tropical regions, often face liquidity problems in paying insurance premiums. Hence, some additional subsidy or third party support might be required to enhance their adoption rate. In recent research in Ghana (Greatrex, et al, 2016), another option was postulated that would allow aggregators to pay premiums in cash, to be repaid by farmers in-Kind (e.g. using grain). In other insurance programmes around the world, this obstacle was overcome by linking with larger "Food for Work" safety net programmes, so that farmers could pay the insurance premium through labour (World Food Programme, 2016). However, this would rely on the existence of such programmes in Ghana.

For the medium (3 to 6 ha) scale farmers who constitute about 20 % of smallholders, premiums must be relatively cheap to attract their interest and must be easily payable, for example via mobile banking. In other locations around the world, these farmers have proven to be the ideal customers for micro-insurance bundled with inputs such as seed in the form of "a replanting guarantee". In this case, there is also an incentive for a seed company to pay for the premiums as they are gaining valuable information about their customers' practice and location through the mobile sign up.

The relatively few large-scale commercial farmers (< 10%) in Northern Ghana then become eligible for other types of products such as the area-yield or named peril or indemnity insurance. As discussed above, some large-scale farmers could essentially act as meso level aggregators to provide insurance to their outgrowers.

Here, we present and discuss a concept and framework for bank-supported small-scale farmer micro-insurance, which was designed in collaboration between the CCAFS project team and the Ghana Agricultural Insurance Programme (GAIP). The aim of the framework was to ensure that farmers are more protected against climate shocks, allowing greater support by banks and other agricultural financiers. The framework was then tested with a small group of trial farmers in Lawra and Jirapa. The same farmers who participated in the meteorological and insurance principles training formed the target group for this pilot.

A modified loan transaction procedure postulated to place agricultural insurance within the agricultural financing context is shown in Fig. 12). Two layers of control were introduced, namely: (i) a Technical Advisory Team (TAT) or Technical Management Unit (TMU) and (ii) an Agricultural Insurance Office Plate 6). The TAT would have expertise in the relevant aspects of agro-hydrology and agro-climatology, agronomy, and crop insurance and will have the responsibility of organizing all farmer and Extension Officer training. The TAT will also assist in installing rain gauges on farmers' fields, or in recording GPS locations if a satellite insurance product was used.

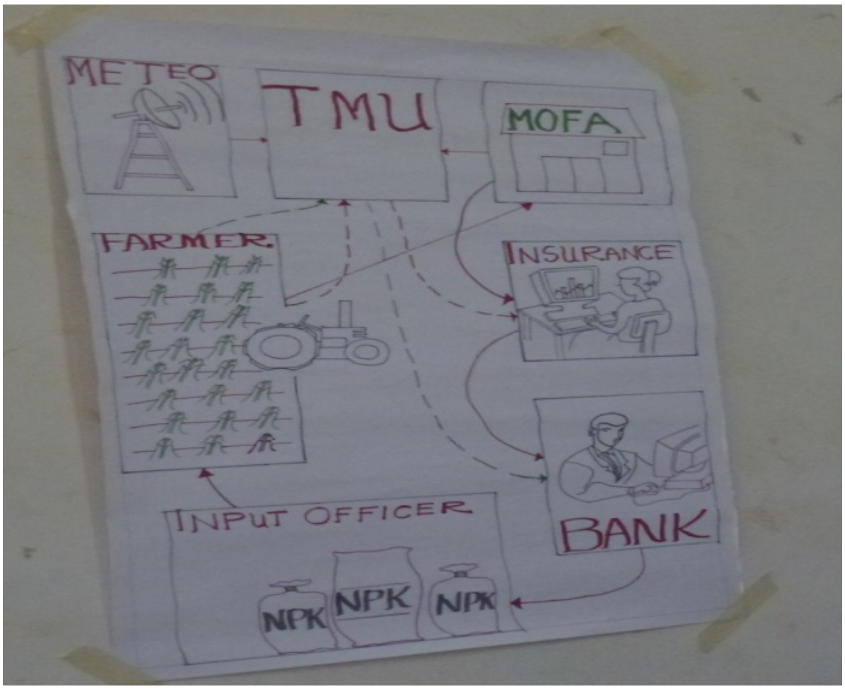

Figure 12. Proposed scheme for micro-scale agricultural insurance and access to credit.

It was suggested that the TAT could be a public office, located at the District Agricultural Office and will be supported by Government funding. The second level of control was to establish a Crop Insurance Office Unit, which can be privately operated. This office will sell insurance premiums and make pay-outs to farmers.

Farmers interested in crop insurance must have acquired the basis training in insurance principles and meteorology and certified by the TAT. They may then purchase insurance from private agents or from the GAIP and be issued with a purchase certificate. The insurance companies would guarantee the loan the farmer contracts from the bank or input creditors. Farmers would record rainfall throughout the season using their charts. At the end of the season, a review meeting between insured farmers and the TAT will discuss the official seasonal rainfall data from the Ghana Meteorological Agency GMET). Farmer's rainfall records would serve to exhibit the extent of spatial variability of the rainfall and provide a basis for adjusting the GMET data, if necessary (e.g. by relying on additional satellite data to capture rainfall variability). The TAT would then provide the required meteorological data to the insurance agencies for pay-out determination. Pay-outs would be made directly to the banks, if the farmer was unable to repay loans due to failed crops. No direct payments would be made to farmers.

Participatory training of farmers

The proposed concept of small-scale farmer-oriented crop insurance described above was formulated into a theatre sketch by the Research Team and the roles were played out by the farmers and agricultural officers. The roles of the three major institution components, namely, TAT, insurance company and bank, were played out by the extension officers. The sequence of actions was as follows (Fig. 13):

1. Farmers first enrolled in a field school and receive training in insurance and rainfall data collection and interpretation, organized by the TAT;
2. Trained farmers, upon recommendation by the TAT contracted and purchased crop insurance from a sales agency or company;
3. Farmers used purchased insurance as collateral to access credit from a bank.

Figure 13. Participatory role-play. A farmer being advised by Insurance Officer (left) and thereafter introduced to a bank official after she has purchased insurance (right).

In the drama sketch, the agricultural credit was offered to the farmer as a bundled product with up to 70 % of the as loan paid in kind (e.g. payment for fertilizer, and tractor services, disease/pest control, soil management e.g. ridge and furrow construction, soil conservation, etc.) and the rest as cash for farmer's day-to-day farming expenses such as planting, weeding, harvesting, haulage, storage, etc. The in-kind credit was in the form of pay vouchers.

As a monitoring measure, assigned Extension Officers of the District Ministry of Agriculture documented the planting dates of the maize farmers who accessed bank credit using mobile phone SMS, followed by at least two farm visits during the growing period. They also inspected the rainfall record cards during each visit and also confirmed actual acreages cropped during the season.

At the end of the season, farmers who purchased insurance and accessed bank loans were invited to meet with the TAT, as indicated in the concept. The TAT advised the insurance agencies who determined pay-outs using appropriate weather-index insurance models. The entire theatre sketch was captured on video.

Discussions ensuing from the drama sketch showed that the concept was of merit and appealed to all the stakeholders that participated in the workshop. A discussion was then held about how this concept could be applied in an operational context. Several challenges were highlighted by the group:

- The inclusion of the TAT (or TMU), and Insurance Office and insurance purchase as pre-requisites for accessing agricultural loan would increase the bureaucracy in agricultural financing, unless a one-stop shop is established with both the TAT and Insurance Officers housed within the same District Agricultural Office. The role of Agricultural Extension Officers must be clearly defined. Farmers have over the years developed trust in Extension Officers and require their support in engaging in a new scheme such as Crop Insurance.

- The sustainability of the insurance scheme will depend on the minimization of risks such as moral hazards because of the consideration of farmers' rainfall records in adjusting the GMET weather data. If farmers conspire to skew their records for their benefit, the insurance agencies would be adversely affected. Farmer records have also been proven useful in other index insurance programmes without becoming formally part of the index or data for assessment. For example, in the R4 Initiative, farmers keep their own records throughout insured seasons. Although this data isn't used in determining payouts, it allows farmers to be more literate in the feedback and complaints process and is a useful independent piece of evidence for determining basis risk events (Stanimirova et al, 2016).
- It would be useful to have a continuous open scheme that trains 'non-qualified" farmers to become eligible and thereby increase the pool size. For example, farmers holding below 0.5 ha maize farms could be encouraged to pool up resources to meet eligibility criteria.

Implementing crop insurance in Lawra and Jirapa Districts

In the pilot, training in insurance principles covered themes of weather-index as well as Area Yield Index Insurance (AYII). Thus, apart from the theatrical sketch in 2012, farmers were sensitized to participate in an actual insurance scheme during the 2013 growing season. The weather-index insurance product and AYII were offered by GAIP to farmers in Lawra and Jirapa, respectively. Premiums were set at GHS 10.00/ha ((2 GHS = 1 US$ at the time). Total crop failure attributed to weather would attract a pay-out of GHS 100/ha. As a promotion drive, the CCAFs project contributed GHS5.00 to each 1 ha insurance purchase. About 100 farmers (equivalent of 200 ha) insured their maize crop for the season. No pay-outs were made to farmers at the end of the 2013 season because the trigger was below the threshold for both insurance types.

History and status of Ghanaian agricultural insurance

The study discussed in this paper formed a key part of the development of agricultural insurance in Ghana. This section aims to bring the reader up to date on parallel and new initiatives in order to put the study into full context.

Operational insurance in Ghana

The development of GAIP

The Ghana Agricultural Insurance Programme (GAIP), a public private partnership between Ghana's National Insurance Commission (NIC) and the Ghana Insurance Association, currently provides all agricultural insurance in Ghana.

The origins of GAIP date back to late 2009 with the launch of the Innovative Insurance Products for the Adaptation to Climate Change programme (IIPACC). This was formed as a collaboration between the NIC and the German Society for International Cooperation (GIZ), funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The core aim of IIPACC was to assist the public and private sectors in Ghana to develop and implement sustainable agricultural crop and livestock insurance. In 2010, they completed a technical and institutional feasibility study, leading to the formal creation of GAIP in 2011 (IICPACC, 2010).

The initial target group of IIPACC was the "meso-level" intermediary group of service providers such as banks and financial institutions, to support them in securing their agricultural credit portfolios against default due to low rainfall. Several research efforts have reviewed the scheme (Aidoo et al 2014; Balmalssaka et al.,2016). They identified several challenges to the willingness by farmers to participate in the schemes such as education level, age, land tenure, access to credit, experience with other types of insurance schemes (e.g. motor insurance). The probability of willingness to participate in crop insurance increased with the return period of damage (how often failures occur) and declines if there are other off-farm income sources. The general consensus from the reviews was that some form of micro-finance or government support was required to make crop insurance schemes successful.

Current status

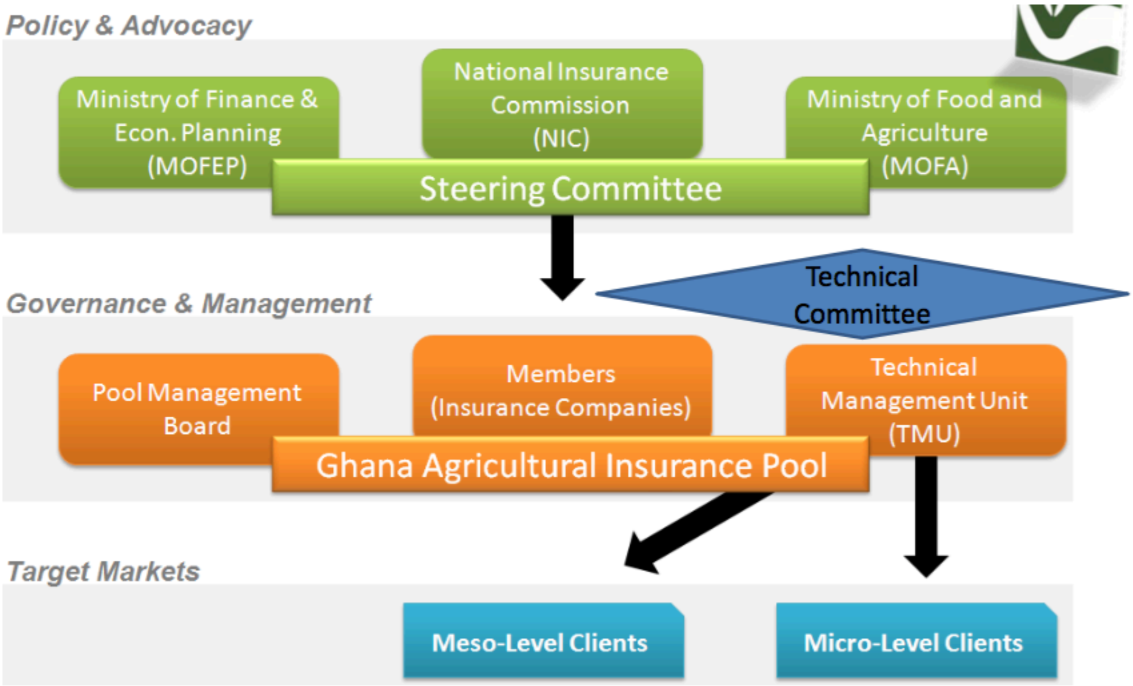

Figure 14. Organizational structure of GAIP.

The IIPACC programme ended in 2013, with GAIP now fully supported and controlled by Ghanaian partners (its organizational structure is shown in Fig. 14). GAIP focuses on a range of products for both micro and meso level clients:

- Drought insurance has been available for maize and groundnut since its initiation in 2011. This was designed using focus groups with farmers on risks and bad years, structured questionnaires on crop growing practices and greenhouse experiments. The current product provides coverage across the growing season, including a dry day based germination cover, a dry day based growing season cover and a total rainfall cover during flowering.
- In 2012 and 2013, area yield insurance was offered in the Lawra, Jirapa and Wa districts in the Upper West Region of Ghana. This was the product used in this study. Crop yield cuts for the district for that year were compared with the long-term average to determine pay-outs to those farmers that purchased crop insurance prior to the season. As an incentive to motivate farmers to participate in the scheme, the AYII product was subsidized by 50% for participating farmers to purchase. Since this study, AYII has not been available in Ghana due to the logistical difficulties of setting up robust crop cutting

measurements outside a research environment. Nevertheless, it is highly requested by customers.

- From 2013, Multi-peril insurance was added to the portfolio for commercial farmers.
- From 2015, poultry insurance has been offered to commercial farmers.
- In 2016, the Government of Ghana announced further support for crop insurance through Ghana Agricultural Sector Investment Programme, run through the Bank of Ghana and co-funded by the Government of Ghana and the International Fund for Agricultural Development (IFAD) (Futokpor, 2016).

GAIP also offers both micro and meso insurance through a variety of partners. None of its current products are subsidised. Part of their insurance portfolio is marketed directly to farmers through local sales agents (micro insurance); some is marketed through third parties such as NGOs, commercial farmers, rural banks or input companies; and some is used at a meso level to protect the portfolios of the third parties e.g. the farmers are getting "invisible cover" through greater access to services. In some cases, the insurance is compulsory part of a bundle and in some, it is a voluntary purchase option. As of 2016, it is reaching over 5000 farmers a year. Indeed, the Government of Ghana announced in May 2016 a policy to introduce crop insurance to farmers by supporting financial institutions to secure their credit and loan paid to farmers.

Research on Ghanaian Insurance

There has also been a significant amount of research on agricultural insurance in Ghana.

Yale/IPA (2009-2011)

In 2009 (and in parallel to the IIPACC process), Yale University and the US based organisation Innovations for Poverty Action (IPA) began a three-year research campaign to understand the impact of insurance in Ghana, based on a large randomised controlled trial. Farmers were randomly allocated to receive cash grants, grants of insurance, opportunities to purchase insurance at varying prices, or some combination.

This paragraph is a summary of their result as described in Karlan et al (2012). In 2009, IPA offered free insurance to 230 farmers who elected to participate, at approximately 5 acres per farmer. The insurance was designed in conjunction with the farmers and was based on the number of dry days in a fixed window. The contract triggered and a payout was made to 171 farmers within 2 weeks of the end of the window. The average payout was $350, conditional on receiving a payout. In 2010 and 2011, IPA introduced a series of differential premium rates to understand farmers' willingness to pay, with premiums between 1% and 14% (an actuarially fair rate was approximately 10%). They found high willingness to pay the small amount, that approximately half the farmers would pay an actuarially fair amount and a reasonable number of farmers (20-40%) would pay equal to a market rate. The index for 2010 was the same dry day based index as for 2009. This paid out for a proportion of farmers within several weeks of triggering. In 2011, the programme transitioned onto the official GAIP index and did not trigger. The research project found that farmers had good comprehension of the insurance product and found money for their purchase through informal loans, produce sales, gifts or small ruminant sales. They also found that insured farmers were more likely to invest in fertilizer and to cultivate more acres of land.

DIRTS - Disseminating Innovative Resources and Technologies to Smallholders (2013-2017)

The research discussed above heralded the launch of a new experiment, which is running between 2013 and 2017 (DIRTS, 2013). The aim of this randomised trial is to examine the difference extension advice or access to better inputs (or a combination) makes on farmers. It is working with 3,240 households in 162 farming communities and has also provided valuable feedback to the insurance design process. For example, feedback from this programme led to the development of an early and a late contract for different farming styles (IPA, 2016).

CASCAID - Capacitating African Smallholders with Climate Advisories and Insurance Development (2015-2018) - University of Ghana, GAIP and Columbia University IRI

This is a CCAFS funded Flagship 2 Programme, developed in conjunction with GAIP and building upon the results discussed in this paper. Its operational goal is to provide general support to the agricultural insurance industry in Ghana, for example support on capacity building, index design or building connections with the international insurance industry. CASCAID also has two more general research goals. The first is to explore how agricultural insurance is perceived and used across different socio-economic and cultural groups. This is particularly focusing on how more qualitative sociological approaches could be efficiently used in the index design process. The second focus is on how different agrometeorological tools might be best used in index design, from satellite rainfall, to greenhouse experiments and crop simulation models.

Current research outputs include:

- A semi-structured qualitative toolkit to understand the impact of insurance on women and communities;
- Greenhouse experiments to support the design of a drought index for rice;
- An investigation into the maize growing practices of 200 farmers and their perceptions of "bad" years, which has been used to run a large APSIM derived crop simulation ensemble;
- An examination of basis risk of the Ghanaian indices;
- A workshop involving the Ghanaian insurance industry on the use of satellite rainfall in index design (Black et al, 2016);
- A series of workshops for commercial farmers in Ghana on agricultural insurance and how they might protect their outgrowers. The results of these workshops have also fed into the research goal of understanding the varying languages people use to talk about insurance.

OSU-ACET Index Insurance Program (2013-2016)

The University of Ghana, Ohio State University and the African Centre for Economic Transformation are currently finishing a randomised controlled trial on insurance across northern Ghana (Miranda and Sam, 2016). This is aiming to examine the impact of insurance, credit and irrigation on smallholder decision making. The research is being spearheaded through the PhD project of Mr. Francis Kemze.

PhD and Masters projects

There are also several other PhD and Masters dissertation projects examining agricultural insurance in Ghana. Mr John Bosco Sumani is working with Antioch University to explore sociologically how insurance is interacting with farmer's existing risk management strategies and livelihoods. Mr. Isaac Nyamekye recently completed a CCAFS funded MSc. thesis which developed two non-separable household mathematical programming and simulation models to examine the relationship between crop-diversification and index-based (area-yield) insurance for a representative agricultural household (Nyamekye, 2016).

Lessons Learnt

This paper examined the issue of crop insurance within the context of rural farmers in the Upper West Region of Ghana. The analysis of the historical climate of Upper West Ghana showed increasing temperature trends coupled with changes in rainfall distribution patterns that present a new reality that farmers must cope with. Indeed, farming in this region is under a major threat from climate change and variability. Farmers were basically aware of the climate change but continue to rely mainly on their indigenous knowledge with some forms of trial and error adjustments. In particular, the shift of the season onset from March to May has lengthened the planting window which ranges from late April to July. Farmers who planted early risk of poor crop establishment whereas those who planted late risk flooding of their fields.

In a bid to introduce the concept of drought insurance, a limited number of farmers educate farmers were educated on the basic principles of weather data collection and interpretation, and the relationship to drought and agricultural insurance. The rainfall data collected by the farmers in the 2012 growing season showed high spatial variability, indicating that the reliance on a single weather station data for insurance pay-out trigger may not be justified.

A small-scale farmer-oriented weather index insurance concept was developed and tested within a theatrical drama sketch. The concept brings farmers directly in contact with insurance providers, agro-meteorologists and agronomists, and considers these interactions as essential pre-requisites for access to climate-sensitive agricultural credit from financial institutions such as banks. Discussions showed that though stakeholders considered the concept to have merit, several challenges were identified that needed to be addressed for an effective implementation. This paper also summarises how the insurance industry in Ghana has since developed and discusses the role of participatory materials within agricultural insurance for smallholders.

With hindsight, this pilot contributed to the evolution and design of operational insurance in Ghana in several ways:

- A participatory index design approach was seen to be very effective in engaging farmers, both in this study and in the parallel research effort conducted by Innovations for Poverty Action. However, such an effort is very labor and resource intensive. Though a method that logistically incorporates such efforts into operational insurance marketing and design has not yet been found, our study could provide a guide especially, given that the Government of Ghana now intends to formally support insurance (Futokpor, 2016)..

- Some of the participatory materials designed here have been used by GAIP. For example, the theatrical play was adapted into radio shows, which went out alongside a question and answer session about crop insurance in Ghana.
- The necessity to include satellite rainfall estimates as additional data source for pay-out determination benefited from our data analysis that showed large spatial variability of rainfall. The sparse density of GMET rain gauges lowers the confidence of farmers in weather-index crop insurance. Furthermore, the 20 km validity range of rain gauges was not always correct. Therefore, the 10 x 10 km satellite resolution provides more confidence and reduces some of the basis risk.
- The framework suggested in this report highlights the complexity and the institutional structures required to implement an effective insurance. . This is a challenge that cannot be addressed by any single actor. Observations indicated that even the popular Area Yield product (AYII) could still not be scaled out because of conflicts of interests. The same agricultural staff who are promoting the insurance product are also the very ones that determine yields on client's fields. In the same vein, many of the challenges facing GAIP in its scale up are not due to the lack of appropriate insurance products but to the need to set-up all of the institutional relationships needed for insurance to be useful and scalable, for example with banks, mobile phone companies, reinsurers, policy makers, meteorologists, farmer groups, NGOs and agricultural extension (amongst others). In effect, our simple study has exposed the complexities and intricacies that must be overcome in establishing a sustainable insurance scheme in Ghana.

In summary, this study provides some of the earliest evidence to support participatory farmer based insurance design. We hope that its documentation provides a key part in understanding the development of crop insurance in Ghana.

Appendix 1: An agricultural insurance primer

As described above, insurance is one way to reduce and transfer the risk of a climate shock. If the safety of insurance coverage can increase a bank's willingness to make loans available or help farmers feel comfortable making additional investments, then farmers can take advantage of productive opportunities that bring them higher income in most years, knowing that their investment is protected. In other words, insurance can build resilience not only by providing a safety net to help farmers survive and protect their assets, but it can also unlock opportunities to increase productivity in the normal years. There are two forms of insurance that are commonly used for agriculture:

Traditional Indemnity-based Crop Insurance

Indemnity insurance provides compensation based on measured damages, either for a single peril (such as fire), or for multiple perils that might impact a farm. The sum insured is selected from a range of insured yields and insured values. Indemnity is based on the measured *% physical damage* multiplied by a selected sum insured purchased by the farmer and is usually subject to a deductible (excess). The farmer bears an excess in the form of a coinsurance, qualifying franchise or deductible.

Losses are adjusted in field, individually, at the time of loss. It is a simple and easily understood policy (for farmers and insurers, alike), the loss is adjusted at time of loss and payment of the claim is immediate to the farmer once the damage has been assessed. Indemnity insurance is reliant on the expertise and availability of experienced loss adjusters, therefore it is unsuitable for smallholder farmers, due to the number that would need to be visited. It also suffers from a form of "basis risk" (where compensation does not match the insured peril), because it is often difficult to tell the difference between mismanagement and loss from an external factor. There is also a high likelihood of moral hazard, where a farmer is incentivised to allow their crop to die to claim on the insurance.

As its name suggests, single peril insurance will only cover a farmer against damages from one, named, risk. This makes it suitable for perils such as hail, fire or wind, which have a distinctive damage footprint. It is less suitable for perils such as drought, which are difficult to distinguish from mismanagement. Multi-peril insurance covers farmers from a larger range of risks, including pests and disease. The insured yield is based on an agreed % of the individual farmer's own actual production history (e.g.10-year average yield) and the sum insured is a product of the insured yield and the agreed value, which is usually based on a % of the sale price of the crop. Losses are adjusted immediately before harvest on the farmer's field and individually to establish the "Actual Yield". The basis for the indemnity is the loss incurred which is calculated as the amount of yield shortfall below the insured yield multiplied by the agreed value per unit of yield.

As of 2016, customised agricultural indemnity insurance is available in Ghana through the Ghanaian Agricultural Insurance Pool. It is offered to farmers and aggregators who farm at least 50 Acres and covers both crops and poultry.

Index-Based Insurance

Index insurance was designed to extend the range of insurance to a larger range of farmers. It is designed to work in homogenous "single threat" situations where there is an overriding and externally measurable peril. An example of such a peril might be low rainfall at the start of the season, or flooding. Instead of compensation being determined by measured on-farm damage, it is instead linked to an external index that is closely correlated with those losses. If the index reaches a predetermined threshold, a payout is triggered.

An advantage of index insurance is that it does not require on-farm visits, allowing it to be extended to smallholder farmers. It also minimises moral hazard because compensation is not dependent on individual farm performance, so a farmer is incentivised to obtain a good yield. Index insurance is commonly bundled with other agricultural risk management strategies such as access to credit and is rarely used as a single climate risk management strategy. There are two main types of index insurance currently in use in Ghana:

Weather-index-based Insurance

Weather index-based insurance was the first introduced by GAIP in 2011, specifically drought index insurance (DII). As the name implies the offer covers for low rainfall only. The index is linked to several critical phases of crop growth. For example, a farmer might receive compensation if there were dry spells during emergence and establishment, or low rainfall during flowering. The index is calibrated for individual crops. The index is linked to precipitation either measured at a weather station or estimated from a satellite source, although the weather station based index is only available to farms within 20 km of each gauge. An advantage of weather based index insurance is that compensation could be provided during the season, for example in the case of a replanting guarantee in the event of early season drought. As of 2016, DII is available across Northern Ghana through the Ghanaian Agricultural Insurance Pool. Several thousand farmers have purchased policies, typically through aggregators such as commercial farmers, banks or NGOs.

Area-Yield Index Insurance

In this case, the average yield of a large geographical area (such as a community, district or a municipality) is used as a threshold to trigger indemnity payments, allowing protection against multiple risks. This again protects against moral hazard, as there would be no way for an individual farmer to influence the larger landscape. Area Yield Index Insurance (AYII) is based on sampled crop cuttings across each region of interest, therefore it is most successful with a mature yield reporting framework in place. A shortfall of AYII in many places is that it requires historical yield data to establish premium rates, a dataset that is often unavailable.

References

Addae-Korankye, A. (2014). Causes and Control of Loan Default/Delinquency in Microfinance Institutions in Ghana. American International Journal of Contemporary Research, 4(12), 36-45.

Adiku, SGK., Mawunya, FD ., Jones, JW. And Yangyuoru, M. (2007). Can ENSO help in Agricultural Decision Making in Ghana? In: MVK Sivakumar and J. Hansen (eds.). *Climate Prediction and Agriculture Advances and Challenges.* Pp. 205-212. Pub.: Springer, Berlin.

Aidoo, R., Mensah, J.O., Wie, P. and Dadson, A-v. (2014). Prospects of crop insurance as a risk management tool among arable crop farmers in Ghana. Asian Economic and Financial Review.4, 341-354.

Awunyo-Vitor, D. (2012). Determinants of loan repayment default among farmers in Ghana. Journal of Development and Agricultural Economics, 4(13), 339-345.

BalmaIssaka, Y., Wumbei, B.L., Buckner, J., and Nartey, R.J. (2016). Willingness to participate in the market for crop drought index insurance among farmers in Ghana. African Journal of Agricultural Research, 11:1257-1265.

Bielza M., Conte C., Dittman C., Gallego F., Stroblmair (2008): 'Agricultural Insurance Schemes', JRC Scientific and Technical Report EUR 23392 EN, JRC45927. (http://mars.ec.europa.edu/mars/Bulletins-Publications/Agricultural- Insurance-Schemes-I-JRC-Scientific-and-Technical-Report).

Biswanger, H.P. (2012). Is there too much hype about index-based agricultural Insurance? Journal of Development Studies, 48:187-200.

Black, Emily, Helen Greatrex, Ross Maidment, and Matthew Young. "Incorporating satellite data into weather index-based insurance." *Bulletin of the American Meteorological Society* 2016 (2016).

Brännvall, R., 2016, Enabling user-inclusive innovation in African agriculture, Youth E-Agriculture Entrepreneurship, Issue 83 , 7 October 2016, accessed on 11/10/2016 at http://ictupdate.cta.int/2016/10/08/enabling-user-inclusive-innovation-in-african-agriculture/

CCAFS 2015. CCAFS Baseline Survey Indicators for Lawra-Jirapa/Jirapa, Ghana. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org.

Chantarat, Sommarat, Andrew G. Mude, Christopher B. Barrett, and Michael R. Carter (2013). "Designing Index-Based Livestock Insurance for Managing Asset Risk in Northern Kenya" Journal of Risk and Insurance, Volume 80, Issue 1, pages 205–237

Disseminating Innovative Resources and Technologies to Smallholder Farmers in Ghana, 2013, Project Website: http://www.poverty-action.org/study/disseminating-innovative-resources-and-technologies-smallholder-farmers-ghana, accessed on 11/10/2016

Dorward P, Clarkson G, Stern R. 2015. Participatory Integrated Climate Services for Agriculture (PICSA): Field Manual. Walker Institute, University of Reading

Futokpor, A., 2016 Government to introduce crop insurance scheme, Ghana News Agency, written on 31 May 2016, accessed on 10/11/2016 at http://www.ghananewsagency.org/economics/government-to-introduce-crop-insurance-scheme-104332

Ghana News Agency (2016). Ghana Government to introduce crop insurance scheme. http://www.ghananewsagency.org/economics/government-to-introduce-crop-insurance-scheme-104332 (Accessed date: September 18, 2016)

Greatrex H, Hansen J, Garvin S, Diro R, Blakeley S, Le Guen M, Rao K, Osgood D. 2015. Scaling up index insurance for smallholder farmers: Recent evidence and insights. CCAFS Report No. 14. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Greatrex, H, Tettey, A, Yeboah, A, 2016, Commercial Farmer Training report, CCAFS Capacitating African Smallholders with Agricultural Advisories and Insurance Development

GSMA, 2015, "Micro-Insurance in Mobile Agriculture – Case study & takeaways for the mobile industry", accessed on 10/11/2016 at http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/05/ACRE-Africa-Final-Report.pdf

Gurenko, E. and Oliver, M. (2004). Enabling productive best asset poor farmers to succeed: a risk financial framework. World Bank Policy Research Paper 3278.

Hamasaka, 2016, 60,000 farming households access weather insurance cover, Musika press release, accessed on 11/10/2016 at http://www.musika.org.zm/press-releases/76-60-000-farming-households-access-weather-insurance-cover

Hansen, J.W. (2005). Integrating seasonal climate prediction and agricultural models for insights into agricultural practice. Phil. Trans. Soc. B. 360, 2037-2047.

Hazell, P., Carlos, P and Alberto, V. (1986). Crop Insurance for Agricultural Development: Issues and Experiences. Johns Hopkins University Press, Baltimore, USA.

IIPACC (2010). Crop Insurance Feasibility Study 2010. Prepared by C Stutley, August 2010, accessed on 11/10/2016 at http://seguros.riesgoycambioclimatico.org/DocInteres/eng/Ghana-Crop-Insurance.pdf

IPA (2016), Disseminating Innovative Resources and Technologies to Smallholders (DIRTS), Newsletter | January – June 2016, accessed on 11/10/2016 at http://www.poverty-action.org/sites/default/files/DIRTS%20quarterly%20update_Y3Q2.pdf

Karlan, D., Osei, R., Osei-Akoto, I., & Udry, C. (2014). Agricultural Decisions after Relaxing Credit and Risk Constraints*. Quarterly Journal of Economics,129(2).

Miranda, M. and Sam, A., OSU-ACET Index Insurance Program, Project Website, accessed on 11/10/2016 at http://ipa.osu.edu/worldwide-projects/africa/osu-acet-index-insurance-program

NOAA National Centers for Environmental Information, State of the Climate: Global Analysis for May 2016, published online June 2016, retrieved on November 8, 2016 from http://www.ncdc.noaa.gov/sotc/global/201605.

Norton, M., Osgood, D., Madajewicz, M., Holthaus, E., Peterson, N., Diro, R., ... & Gebremichael, M. (2014). Evidence of demand for index insurance: experimental games and commercial transactions in Ethiopia. Journal of Development Studies, 50(5), 630-648.

Nyamekye, I., 2016, Area Yield Crop Insurance and Diversification in Ghana: An Agricultural Household Programming Model, MSc Thesis, Department of Resource Economics and Environmental Sociology, University of Alberta

Skees, J. Hazell, P. and Miranda, M (1999). New approaches to crop insurance in developing countries. Environmental and Production Technology Div. International Food Policy Research Institute Paper.

R. Stanimirova, H. Greatrex, R. Diro, G. McCarney, J. Sharoff, B. Mann, A. Louis D'Agostino, M. Rogers-Martinez, S. Blakeley, C. Small, P. Ceccato, T. Dinku, D.E. Osgood (2013), "Using Satellites to Make Index Insurance Scalable", Final IRI Report to the ILO Micro-Insurance Innovation Facility

Torgbor, F., Clarkson. G. and Asare, K., 2016 Better decision support for improved livelihoods among farmers in northern Ghana, Jun 23, 2016, CCAFS Blog accessed on 10th November 2016 at https://ccafs.cgiar.org/blog/better-decision-support-improved-livelihoods-among-farmers-northern-ghana

World Bank, 2015, New Insurance Model Protects Mongolian Herders from Losses 03/04/2015, accessed on 11/10/2016, at http://www.worldbank.org/en/news/feature/2015/03/04/new-insurance-model-protects-mongolian-herders-from-losses

World Food Programme, 2016, R4 Rural Resilience Initiative: Quarterly Report | April - June 2016, accessed on 11/10/2016 at https://www.wfp.org/content/r4-rural-resilience-initiative-quarterly-report-april-june-2016

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