

Evidence-Based Insurance Development for Nigeria’s Farmers:

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Federal Ministry of Agriculture and Rural Development (FMARD) priorities for agricultural insurance

1.1 The policy context of agricultural insurance in Nigeria

Agricultural insurance was introduced to Nigeria in 1987 through the Nigerian Agricultural Insurance Scheme (NAIS). Objectives of NAIS are to: (a) provide financial remediation to farmers after natural hazards, (b) stimulate financial institutions to offer rural credit, (c) promote agricultural production by encouraging investments, and (d) minimize the need for the government to provide assistance after a disaster (World Bank, 2011). The Nigerian Agricultural Insurance Corporation (NAIC) was established in 1993 as a public-sector corporation to administer NAIS and its associated subsidies, foster agricultural credit, and generally promote increased agricultural production to reduce the need for ad-hoc agricultural disaster assistance from the government (Epetimehin 2011).

With the government support, the NAIC can offer premiums that are half directly subsidized by the government for many types of agriculture insurance including crop, livestock, poultry and aquaculture (World Bank, 2011). Farmers seeking loans for agricultural activities are mandated to purchase this agricultural insurance to protect the loans. Currently, the NAIC is the sole insurance company in Nigeria under the NAIS to receive government support, and in the event of catastrophic losses incurred by NAIC, the government will financially remediate damages greater than 200% of the premium cost (World Bank, 2011).

The NAIC has presence throughout the country and has offices in 36 states of the Federation. Despite its wide presence, NAIC covers less than 1% of farmers in Nigeria, even after 23 years of existence (World Bank, 2011). Although insurance is available to small, medium, and large-scale farmers – as groups and individuals (Aina and Omonona, 2012), the market is dominated by larger farmers producing commercial crops.

1.2 Scaling up insurance in 2015-2017

Dialog between FMARD and CCAFS began during Climate Week in New York, September 2014. The Honorable Minister, Dr. Akinwumi Adesina, presented on plans to expand insurance to 15 million smallholder farmers by 2017, at CGIAR Development Dialogs at Columbia University. Dr. Debisi Araba also discussed these plans informally at an IRI-sponsored panel on Building Innovative Index Insurance Markets. Subsequent discussions between Dr. Araba, and Drs. Bruce Campbell, Jim Hansen, Jon Hellin and Kevin Coffey led to plans for a knowledge-sharing workshop in London, and this his briefing paper.

Plans to expand agricultural insurance in Nigeria are linked to several new initiatives under the Agricultural Transformation Agenda (ATA). The ATA, launched by the Federal Ministry of Agriculture and Rural Development (FMARD) in 2011, seeks to reorient Nigeria's agriculture from development to a business, with a goal of adding 20 million metric tons (MT) of food to the domestic food supply and creating 3.5 million jobs by 2015. A commitment, announced late 2014, to expand insurance to 15 million smallholder farmers by 2017, is one of the pillars of the National Agricultural Resilience Framework (Adegoke et al., 2014).

1.2.1 *Planting with Peace Program*

The Growth Enhancement Support Scheme (GES), launched in 2012, seeks to improve production by providing subsidized production inputs to small-scale farmers. The GES enables farmers to receive a 50% subsidy on a maximum of two bags of fertilizer that are purchased directly from agro-dealers, hence bypassing the government and middlemen. Farmers receive their redeemable subsidies via a mobile phone platform called the “e-Wallet”, or by vouchers for those who are unable to access the mobile phone platform. The goal is to reach 20 million farmers in the next four.

As part of the GES, the Nigerian Agricultural Insurance Corporation (NAIC), an Agency under the FMARD, also has plans to develop and deploy crop insurance cover via the e-wallet to all farmers that are entitled to subsidized input under the GES scheme. There will be payments of financial compensation to insured farmers in the event of crop losses due to flood, drought, fire, pests and diseases. Cost of insurance will be included in the price of each bag of fertilizer sold under the GES scheme. The maximum claims payout will be N 20,000 for each bag of fertilizer received by the farmer for the cultivation of one acre of crop farmland. NAIC will charge a flat premium of N 500 on the sum insured (value at risk) of N 20,000.

The insurance scheme will reduce the need for the Federal Government to provide compensation to farmers in the event of agricultural disasters. NAIC will be responsible for compensating farmers for agricultural losses. The plan is to have all crop farmers covered in the initial phase and then extend to all smallholder farmers either individual or farmer groups, including aquaculture and other livestock farmers. The targeted minimum number of farmers is 10 million.

1.2.2 *Crop index insurance*

Index insurance differs from traditional indemnity insurance (such as the aforementioned insurance under the GES scheme, where payouts are explicitly based on measured loss for a specific client). Instead, in index insurance, farmers purchase coverage based on an index that is correlated with crop losses. Indices include the amount of rain during a certain window of time (weather based indices) or average yield losses over a larger region (area yield indices). Payouts are then triggered when this index falls above or below a pre-specified threshold.

Index insurance is a tool that enables smallholder farmers to better manage climate risk, and encourages growth in the agricultural sector. Index insurance might allow a farmer to access credit, which they can then use to invest in new agricultural technologies or inputs such as drought-tolerant seed. Farmer can then use their increased profits to pay for the insurance premium, knowing that the insurance would allow them to repay their loan in the event of a climate shock. Worldwide examples of index insurance are provided in Section 2.

FMARD also wishes to develop, implement and launch weather index insurance (parametric insurance) in selected parts of the country susceptible droughts and floods. Strong consideration is being given to subsidizing the premium in order to reduce the amount that farmers would have to pay. FMARD is interested in knowing more about the donor funds available in the international market that will help NAIC in the design and implementation of weather index insurance (as well as the aforementioned insurance for fertilizer). The Planting with Peace Program may include index-based insurance in locations where this is feasible.

FMARD has also expressed some interest in a binary parametric insurance product that is offered at an aggregators' level. A binary product is a case of weather index based product in which the strike merges with the exit. For example, some rainfall index based insurance schemes payout once the level of rainfall falls below a certain level (strike), which leads to decrease in yield for a particular crop. The payout increases for every missing cm of rainfall until a point, below which the crop is assumed to be entirely lost and hence the farmer gets the maximum payout (exit). In case of a binary product, the farmer gets a payout only when the exit level is reached i.e. for a drought related product, a lump sum will be paid once there is a declared drought.

2 Lessons from farmer insurance initiatives worldwide

In this section, we provide brief details on four index insurance schemes worldwide and identify the lessons learnt that are of relevance to FMARD's plans for Nigeria. The four case studies are:

- In India, national index insurance programs cover over 30 million farmers through a mandatory link with agricultural credit and government support.
- In East Africa, ACRE (Kenya, Rwanda) has recently scaled to reach 200,000 farmers, bundling index insurance with agricultural credit and farm inputs.
- In Ethiopia and Senegal, the R4 Rural Resilience Initiative has scaled unsubsidized index insurance to over 20,000 smallholder farmers using insurance as an integral piece of a comprehensive risk management portfolio.
- The Index-Based Livestock Insurance project in Kenya and Ethiopia demonstrates innovative approaches to insuring poor nomadic pastoralists.

This following material section draws heavily on Greatrex et al. (2015).

2.1 India's national index-based insurance schemes

Weather-based and area-yield index insurance have a long heritage in India. India has the world's largest weather index insurance market, reaching tens of millions of farmers each year. India has several index insurance programs: the National Agricultural Insurance Scheme (NAIS), which has now partly been replaced by the modified National Agricultural Insurance Scheme (mNAIS), and the Weather Based Crop Insurance Scheme (WBCIS). The scaling-up of these programs can be attributed to requiring insurance as a prerequisite for agricultural credit, and the premium subsidies. Premium subsidies vary, but often the farmer pays between 25% and 40% of the premium and the government provides a subsidy to cover the remainder.

- **National Agricultural Insurance Scheme (NAIS)** - The index is an area yield product at sub-district scale. Payouts are triggered if regional yield measurements fall below a pre-specified threshold. The state-sponsored Agriculture Insurance Company of India (AIC) covers the claim up to the premium, local and national governments contribute equally to cover the remainder.
- **Modified NAIS (mNAIS)** - modifications from NAIS to mNAIS included: changing the governments financial liability into up-front subsidy on premiums, reducing the

insurance unit size to village level to lower basis risk, elimination of calamity years in calculating threshold yield, coverage for prevented sowing & post-harvest risks, plus additional coverage for failed planting based on weather indices.

- **Weather Based Crop Insurance Scheme (WBCIS)** - Around 40 crops are insured under the category for climatic risks including drought, high temperature, and high winds. The project now covers over 13 million farmers. WBCIS is based on weather data linked to one of the network's 5000 reference weather stations. Private sector insurance companies compete with the AIC to offer the subsidized products.

2.2 East Africa and Agriculture and Climate Risk Enterprise (ACRE)

ACRE (Agriculture and Climate Risk Enterprise) is the largest index insurance program in the developing world in which the farmers pay a market premium, and the largest agricultural insurance program in Sub-Saharan Africa. ACRE is projected to reach 3 million farmers across 10 countries by 2018. There are three pillars to ACRE's approach: i) farmers are offered a wide range of products, ii) ACRE's role as an intermediary between insurance companies, reinsurers and distribution channels/aggregators (e.g. microfinance institutions, agribusiness and agricultural input suppliers) and iii) the link to the mobile money market, e.g. the M-Pesa scheme, hence, facilitating enrollment and payment of claims.

ACRE's products include insurance linked to agricultural credit from Micro-Finance Institutions (MFIs). This credit was designed for farmers who wished to grow maize using improved inputs. ACRE also offers contract seed grower insurance for large-scale producers (> 20 acres and insuring an average of \$650 per acre). The seed company pays the premiums at the start of the season. This is repaid by the farmers at harvest when delivering their seeds to the company. More recently, insurance is linked to replanting guarantee by a seed company. The insurance premium is incorporated into the price of a bag of maize seed. Each bag contains a scratch card with a code that is texted to ACRE at planting time to start coverage against drought. Each farm is monitored using satellite imagery for 21 days. If the index is triggered, farmers are automatically paid via M-Pesa for a new bag of seed to allow replanting.

Indexes used for ACRE's products are based on several data sources. These include 130 solar powered automated weather stations, satellite rainfall measurements, and government area yield statistics. Indexes have been developed for maize, beans, wheat, sorghum, millet, soybeans, sunflowers, coffee, and potatoes. ACRE has leveraged the expertise of this partner network to implement new and innovative solutions farmers' problems. ACRE is an example of where innovative technology solutions lead to scale in smallholder agricultural insurance.

2.3 Ethiopia and Senegal and the R4 Rural Resilience Initiative

The R4 Rural Resilience Initiative (R4) is a strategic partnership between the UN World Food Programme (WFP) and Oxfam America. Its aim is to improve the resilience and food security of vulnerable rural households in the face of increasing climate risks. R4 refers to the four integrated risk management strategies implemented by the program. Index insurance is one of the components. The program has scaled 200 Ethiopian farmers in the 2009 pilot in Tigray, to over 24,000 in Ethiopia and 2,000 in Senegal in 2014. The R4 initiative is deliberately targeted at poor smallholder farmers who were previously considered to be uninsurable due to a combination of poverty, lack of education, data limitations and

remoteness. To overcome the liquidity constraint of poor farmers, they have the option of paying premiums either in cash or through insurance-for-work (IFW) programs.

One challenge facing the R4 Initiative is data availability. Because ground based weather stations are extremely sparse in the R4 project area, several data-sources were used in index design and validation. As with any weather-based index, reducing and appropriately communicating basis risk is also a challenge. The program has a farmer-led index design process that integrates local farmers' and experts' knowledge and expertise. The project has directly engaged organizations at all stages of the insurance process, including farmer groups, governments, banks, microfinance institutions, local insurers, research institutions and reinsurers.

2.4 Kenya and Ethiopia and Index-Based Livestock Insurance (IBLI)

The arid and semi-arid lands (ASALs) of northern Kenya and southern Ethiopia suffer from regular droughts. These can have a severe impact on pastoralists. The International Livestock Research Institute (ILRI), in partnership with Cornell University and the University of California – Davis, created Index-Based Livestock Insurance (IBLI) to stabilize asset accumulation, enhance economic growth, and keep livestock keepers out of poverty traps by insuring them against the loss of their livestock due to drought.

The IBLI team used a statistical relationship between livestock mortality data (collected since the year 2000) and the remotely sensed Normalized Difference Vegetation Index (NDVI). As the livestock in East African pastoral production systems depend almost entirely on forage for their nutrition, NDVI functions as an indicator of the vegetation available in the area for the livestock to consume and is linked to mortality. IBLI has features including creative education methods for pastoralists, culturally specific products and a division-level mortality index. IBLI provides substantial immediate development benefits in the event of a payout, as participating households are less likely to sell livestock

IBLI is active in an area of Kenya without good mobile phone reception, severely limiting its ability to connect with mobile services such as M-Pesa. The project has decided to develop an open-source ICT-based platform that will be used for both sales and information dissemination. It will use mobile phone technology to collect premiums and provide indemnity payments, to send messages to the insured clients and the sales agents on the status of the index, and to send product-related information such as upcoming sales or payouts.

2.5 Lessons learnt from the case studies

The viability of index-based insurance for poor smallholder farmers (including pastoralists) in the developing world is a topic of ongoing debate. Although agricultural insurance has a long heritage with significant ongoing investment, it has only started to become more widely applied across the developing world in recent years, driven in part by innovations in index-based insurance. A few common features of the case studies that have contributed to recent progress and which are likely to be of relevance to the situation in Nigeria include:

- Explicitly targeting obstacles to improving farmer income
- Bundling of insurance with key farm inputs such as improved seed

- Giving farmers a voice in the design of products
- Investing in local capacity, and science-based index development;
- Bringing together partnerships of diverse actors such as farmers, input suppliers, insurance companies, re-insurers and government.

The rapid progress observed in recent years suggests that index insurance has the potential to benefit smallholder farmers at a meaningful scale, and suggests the need to reassess arguments that lack of demand and practical implementation challenges prevent index-based insurance from being a useful tool to reduce rural poverty. The case studies have also shown that index insurance is not going to be appropriate in every circumstance and that there are still several challenges still to overcome, including data management, basis risk, logistical and client communication.

In terms of this workshop, one area that warrants further investigation is the extent to which crop (index) insurance can enhance farmers' investment in productivity enhancing agricultural technologies and practices in Nigeria. These technologies include several climate smart agricultural practices that CCAFS has prioritized such as drought-adapted crop varieties. The aforementioned case studies have demonstrated that improving access to credit and adoption of improved production technology are explicit objectives of the India (WBCIS and NAIS), ACRE and the R4 programs. These index insurance programs do have a positive effect on adoption of more profitable production technologies. In the case of Nigeria, Government has explicitly highlighted increased farmer use of seed and fertilizer as priorities and it is worth exploring how FMARD's planned insurance initiatives can be designed even greater farmer uptake of climate smart technologies. In Annex 1, we provide details on one such relevant climate smart technology, drought tolerant maize that is suitable to conditions in Nigeria.

3 Options for addressing needs and overcoming constraints

Achieving the ambitious goal of providing effective insurance coverage to most of Nigeria's smallholder farmers by 2017 will require overcoming many challenges. Several challenges have come up in discussions between FMARD and CCAFS, and in an index insurance prefeasibility study by the World Bank (2011). In this section, we discuss a few areas where CCAFS sees potential solutions to anticipated challenges.

3.1 Connecting insurance with credit, technology and inputs

Insurance initiatives targeting smallholder farmers have been most successful when they have intentionally and effectively either unlocked opportunities for increasing income (for example by improving access to credit or improved production technologies), or protected productive assets (for example, livestock herds). These initiatives have generally treated insurance as one component of a comprehensive approach to managing risk, and have intentionally connected insurance with, e.g., credit, production inputs, market opportunities, management advisories, or social protection programs. The National Agricultural Resilience Framework (Adegoke et al. 2014) notes the work of Micro-Ensure in Malawi, in 2005-2006, as a potential model. The project in Malawi (Hellmuth et al, 2009) initially targeted groundnut producers who had limited access to improving their inputs since drought-

resistant varieties of groundnuts were expensive. Rainfall index insurance was bundled with loans for a package of groundnut, and subsequently maize and tobacco, production inputs. Nearly all eligible farmers purchased insurance as part of a bundle, at an actuarially fair price. Improving access to credit and adoption of improved production technology are explicit objectives of the India (WBCIS and NAIS), ACRE (formerly Kilimo Salama) and the R4/HARITA programs. Available evidence suggests that they do in fact have a positive effect on adoption of more profitable production technologies (Greatrex et al., 2015). On the other hand, several studies that used randomized control trials to control the influence of factors that are synergistic with insurance, such as access to credit, have shown low demand among smallholder farmers for insurance in isolation.

ACRE, which insures more African farmers than any other program, offers a range of products that bundle insurance with credit, inputs and/or training (ACRE 2014). An example with similarities to Planting with Peace, is a package that bundles insurance with a replanting guarantee by a seed company, linking ACRE, UAP Insurance and SafariCom. The insurance premium is incorporated into the price of a bag of seed. Each bag contained a scratch card with a code that could be texted to ACRE during the planting period to start drought coverage. If a satellite rainfall index is triggered within the next 21 days, farmers are automatically paid via the M-Pesa (a mobile phone based banking system) for a new bag of seed so that they can replant.

CCAFS is particularly interested in the role insurance plays in improving accessibility of climate-smart production technologies, especially drought-tolerant maize seed (Annex 1). In East Africa, CCAFS is launching a new 4-year project, lead by CIMMYT, to use index-based insurance to overcome barriers smallholder farmers face in accessing improved seed.

3.2 Farmer participation in insurance design

Our recent review of case studies of index insurance for smallholder farmers argued that the evolving capacity of local service providers to engage farmers and provide relevant services may be the key determinant of how these initiatives scale up (Greatrex et al., 2015). Farmers participate in social change not as passive subjects, but rather as social actors. The effectiveness of communication with farmers is a key factor that influences trust and farmer uptake of all technologies and practices, including crop insurance schemes. This is especially the case when it comes to index insurance. Initiatives that are successfully scaling up insurance for smallholder farmers have invested considerable effort in building the capacity of farmers to understand insurance products, and in giving them a voice in their design (Greatrex et al., 2015). Studies of India's index insurance program – the largest in the world – highlight increasing farmers' input into design as a top priority to further improve services. The ACRE program in East Africa gives farmers a choice among a range of products, all developed with considerable input from farmers.

Nigeria's ambitious plans to rapidly scale up agricultural insurance will require efficient, scalable mechanisms to engage farming communities, and build their capacity to understand and hence effectively demand appropriate insurance products. Whether the focus is conventional indemnity insurance or index insurance, farmers need to trust that the people they are paying to take on their risk will be around to provide payouts, and need to understand and trust the structure of the contract. Partnering with organizations that already interact with farming communities, and that have already built trust, proved to be

effective in most of the case studies reviewed in Greatrex et al. (2015). In these cases, building the capacity of farmers required building the capacity of local institutions to effectively engage farmers. There is a plethora of literature and experience on how effectively to work with farmers in a participatory way (e.g., Pretty et al., 1995). There are well-documented participatory approaches and guidance materials to streamline the processes of building awareness of farmers and obtaining their input into the design of (index) insurance. For example, the International Research Institute for Climate and Society (IRI) has developed guidance and training materials to streamline the process of engaging groups of farmers in participatory in educational games and interactive exercises, based on their experience in the early development of several successful index insurance projects.

The interaction with farmers need not all be face-to-face. For example, in the case of ACRE, the insurance products is marketed to farmers over the radio (and at group training sessions). Radio announcements are used, since this is how most farmers already get information. The announcements discuss the benefits of ACRE's work, and advise which input suppliers to visit to acquire the product. Building on the considerable experience of Farm Radio International, a forthcoming CCAFS report (Woodley et al. 2015) provides guidance for developing interactive models of rural radio programming to efficiently build farmers' awareness of insurance, and obtain their input into the design of index-based agricultural insurance.

Offering the products to aggregators like millers, processors, input providers, seed companies, might offer an alternative to scaling up agricultural insurance, since they are better educated and at a better position to stand against contractual non-performance on part of the insurers.

3.3 Overcoming challenges to crop index insurance

FMARD sees index-based insurance as a significant part of its commitment to scaling up insurance to Nigeria's smallholder farmers, despite the challenges and conclusions of the pre-feasibility study. FMARD, in turn, has also identified some of the challenges to implementing crop index insurance:

- *The high start-up costs associated with the conceptualization, development and implementation of the index insurance schemes.* This is largely due to the data requirements for designing and properly pricing an index insurance product. Long-term data on various weather parameters are required for proper modeling and pricing. Furthermore, regular reporting of weather outcomes is required at a high resolution for efficient and timely calculation of indices and speedy payouts.
- *Challenges in the area of procurement of the appropriate reinsurance cover at minimal cost and less stringent terms and conditions from overseas reinsurers for weather index insurance.*
- *Access to high quality weather data and infrastructure, especially weather stations that will provide credible and unbiased weather data that will minimize basis risk.*
- *The ability of small-scale farmers and other users to understand the operational dynamics of index insurance contracts in view of its technicalities and complexities.*

- NAIC has been offering to farmers, a loss of input cost crop insurance policies that provides a comprehensive insurance cover against a wide range of natural, climatic and biological perils including fire, drought, flood, windstorm, pests and diseases. The weather index insurance contracts technically remains a mono peril policy, which may negatively impact on its acceptability by the farmers because of its restrictive scope of cover and high cost.

A World Bank (2011) pre-feasibility study of crop weather index insurance in Nigeria, requested by NAIC, identified a similar set of challenges, and concluded that they would adversely affect the feasibility of scaling up weather index insurance. First, weather indexes cannot capture the most important insurable crop production risks (disease > flood > fire > drought). The report suggested that drought, which accounts for only 9% of the value of claims in NAIC's crop insurance portfolio, is the only of these perils that is suitable to insure with a weather index product. It notes difficulties of using excess rainfall as an index for flood-related crop losses. Second, the study report suggests that crop and weather data records are not adequate to support index-based insurance: *"the weather station network density in Nigeria is currently insufficient for the implementation of any commercial and scaled up weather index insurance program."* Historic production statistics are apparently available only at a state or higher level of aggregation. Third, for drought-prone regions the study noted poor correlations between indexes developed with available station-scale rainfall data, and state-level crop yield statistics. It also suggests that weather index insurance is not suited for intercropping.

Although we do not see straightforward index-based solutions for crop disease or fire risk, promising solutions do exist for other challenges. These provide opportunities for FMARD and CCAFS to work together and we hope that they can be discussed during the workshop.

3.3.1 Addressing the data challenge for weather index insurance

Because the relationship between crop yields and weather observations weakens, and therefore basis risk increases, with increasing distance, early pilots only offered index insurance to farmers within a given distance from a long-term weather station. Sparse and generally declining weather observation networks were seen as a major obstacle to scaling up weather index insurance. Weather insurance schemes elsewhere (e.g. ACRE in Kenya, WBCIS India) are prompting investment in new automatic weather stations to fill gaps in real-time observations. Interest in strengthening weather observing infrastructure to enable scaling up weather index insurance, has been prominent in recent communications from FMARD, including the Ministerial Forward of the National Resilience Framework. Expanded weather station networks play an important role in improving the accuracy and reduce basis risk of indexes. But it will take decades for new networks to provide enough historic data to quantify risk sufficiently to inform the design of robust contracts.

Satellite-based estimates of rainfall and other weather data offer a potential alternative to sparse ground-based observations. Satellite rainfall estimates, which now go back over 30 years, offer complete coverage in time and space. However, most satellite products are constrained by some combination of coarse spatial and temporal resolution, short period of record, inhomogeneity when sensors or methods were changed, and poor or unknown accuracy due to lack of calibration with ground observations.

An effort by the IRI in partnership with CCAFS, WMO, USAID, UNDP, University of Reading and others; known as ENACTS (Enhancing National Climate Services); works with African national meteorological services (NMS) to produce reliable climate data and information products in a form and at a spatial resolution that is suitable for local decision-making. Combining data from the national observation network, with satellite (or reanalysis in the case of temperature) data, produces spatially and temporally complete historic time series at a high spatial and temporal resolution. Access to information products is enhanced by providing online tools for data analysis and visualization, and by sharing data with national stakeholders. The online tools are integrated into NMS web pages. Annex 2 and references therein provide more information about the approach.

Although several organizations are developing high-resolution data sets that combine satellite with some station data, a key strength of the ENACTS approach is that it works with national meteorological agencies to develop products that they fully own, using all available station data – most of which are not available outside the country. Because the accuracy of merged products depends primarily on the number and spatial distribution of station observations, the quality of the resulting data sets is far greater than any merged products that use only the very small set of globally available station data. The satellite rainfall products have performed well across several African countries, even in complex terrain, but performance degrades in coastal areas.

3.3.2 Options for flood risk index insurance

While excess rainfall is sometimes used as an index for flood-related losses, local rainfall is not likely to be a good proxy for flooding and its impact on crops. This is because flooding can be due to a range of factors unrelated to local rainfall. River flooding, which appears to be the greatest flood-related threat to agriculture in Nigeria, is often a delayed response to rainfall elsewhere in a watershed. Flash flooding and waterlogging are due to excess local rainfall interacting. Coastal flooding is associated with storm surge driven by offshore windstorms. Remote sensing and hydrological modeling – alone or in combination – might offer promising alternatives for developing index-based agricultural insurance that addresses flood risk, particularly for river flooding. However, well-qualified expertise should be involved in any plans to develop insurance based on these tools.

Satellite remote sensing can be quite effective at mapping inundation of large flood events that persist several days. A number of optical and radar remote sensing products have been explored for flood monitoring and flood risk mapping. MODIS products seem to be used most widely for river flood applications, including by global flood observing systems such as one operated by the EUC Joint Research Center and Dartmouth College. In Nigeria, the National Centre for Remote Sensing, Jos, has experience using the country's own Nigeriasat-2 and Nigeriasat-X satellites to analyze floods. Limitations of available remote sensing approaches include: coarse temporal resolution (usually several days), short historical record (< 15 years), and for some, interference from clouds. A comparison of anomalies of inundated areas from the Surface Water Active Microwave Product Series (SWAMPS), and a Dartmouth Flood Observatory global database of reported flood events, suggests that remote sensing can capture large floods with long (5-20 days) duration in inland regions; but perform poorly for coastal regions, and shorter local or flash flood events.

Process-based hydrological models can be used to simulate the spatial extent and timing of floods in response to excess rainfall and runoff. One of the advantages of hydrological

modeling over available flood remote sensing products is that they can be driven by the type of gridded historic rainfall data described above, and can therefore simulate sufficient history to estimate flood risk and appropriately price insurance. They can also potentially capture events that are too short to be observed through remote sensing. These models are quite intensive in their data requirements, although suitable spatial data sets are readily available for, e.g., topography, soil characteristics and land use. Calibration and validation of model-based flood estimates is essential, and can be supported by remote sensing of inundated areas.

Using hydrological models or remote sensing for flood-related agricultural insurance would require substantial expertise. Relevant experience seems to be available, for example:

- Within the CCAFS network: The International Water Management Institute (IWMI) is working with FMARD on a 3-year project to develop flood risk mapping (using 2000-2013 MODIS data), flood forecasting tools (using remote sensing with hydrological modeling tools developed by the U.S. Army Corp of Engineers), and analysis of flood impacts along the Niger and Benue rivers (<http://frdsan.iwmi.org/home>). IWMI also leads a new 4-year (2015-2019) CCAFS project to use remote sensing and hydrological modeling to develop index-based, meso-scale flood insurance for agriculture in Bangladesh and India.
- The Nigeria Hydrological Services Agency (NIHSA) began in 2014 to use two hydrological models for their annual flood outlook (NIHSA, 2014): Geospatial Stream Flow Model (GeoSFM) developed by the U.S. Geological Survey, Centre for Earth Research Observation and Science (USGS/EROS); and the Soil and Water Assessment Tool (SWAT) river-basin model developed by Texas A&M University.
- Nkeki et al. (2013; Univ. of Benin and Delta State Univ.) used MODIS data from the NASA Terra satellite to map flood risk in the Niger-Benue basin, map the extent of the 2012 flood, and analyze vulnerability to flooding.

4 Conclusion: short- and medium- and long-term ways forward

Agricultural insurance has been a feature in Nigeria for over two decades. The Federal Government has plans to expand agricultural insurance in the Country as part of several initiatives under the Agricultural Transformation Agenda (ATA). The Government wishes to extend crop insurance to those farmers benefiting from fertilizer subsidies under the Growth Enhancement Support Scheme (GES). The Government also wishes to implement weather index insurance (parametric insurance) in selected parts of the country susceptible droughts and floods.

Experiences from index insurance initiatives worldwide provide important lessons for the development of crop index insurance in Nigeria. Experiences from India, Kenya, Rwanda, Ethiopia and Senegal suggest that there is demand for index insurance; that the bundling of insurance with key farm inputs e.g. improved seed and fertilizer, makes the insurance package more attractive to farmers; but that several challenges still to overcome, including data management, basis risk, logistical and client communication. CCAFS could play a role in working with the Federal Government to overcome some of these challenges.

Areas of potential collaboration include:

- Innovative ways, including use interactive radio programming, in which the complexities of (index) insurance can be explained to farmers;
- Experience of working with farmers and other key stakeholders, such as the insurance and re-insurance industry, in the design of indexes;
- Development and use of merged satellite-station rainfall and perhaps temperature data sets as an alternative to sparse ground-based observations;
- Further development of expertise in using either hydrological models or remote sensing for flood-related agricultural insurance applications; and
- Identification of suitable climate smart agricultural technologies (e.g. drought tolerant seed bred for different agro-ecological zones in Nigeria, that lend themselves to bundling with crop insurance initiatives.

Immediate ways forward include the further development of this briefing document so that it becomes a roadmap for the medium- and long-term implementation of more crop insurance initiatives in Nigeria (including index insurance).

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Annex 1: Crop insurance bundled with climate smart agricultural technologies: the potential of drought tolerant maize in Nigeria

Jon Hellin

We highlight the potential of crop insurance to enhance farmers' access and use of drought tolerant maize varieties. With more than 5.56 million ha of land planted to maize in 2013 (or about 16% of all of Africa's maize area combined), Nigeria has the right to claim the position of the giant of maize production in Africa. Only Tanzania claims a distant second position, with about 4.1million ha. However, productivity of maize has not kept pace with the rate of growth in area. For example, the national average yield increased gradually from 1.2 MT/ha in the 1980s to 1.9 MT/ha in 2013. Constraint to higher productivity include drought. Nigeria is one of the target countries of The Drought Tolerant Maize for Africa (DTMA) project which is funded by the Bill & Melinda Gates Foundation (B&MGF).

The synergy between DTMA and the objectives of the Nigerian government is obvious. Great scope now exists for minimizing deficit in Nigeria's maize production and demand, estimated at about 6 million tons in 2013. The key factor for a maize revolution in Nigeria will be a massive increase in its fertilizer and improved seed use. The national program in Nigeria, in close collaboration with DTMA, has released a total of 22 drought tolerant maize varieties between 2007 and 2013 (see Table 1). Much could be learnt from India (WBCIS and NAIS), ACRE and the R4 programs as to how crop insurance can be used to enhance further Nigerian farmers access to and use of drought tolerant maize varieties.

Table 1 Drought tolerant maize varieties released under DTMA in Nigeria (2007 to 2013)

| No. | Release name | Year of release | Hybrid/OPV | Maturity Range | Suitable agro-ecologies | Grain yield |
|-----|--------------|-----------------|------------|----------------|-------------------------|-------------|
| 1 | Sammaz 15 | 2008 | OPV | Medium-late | Moist savannas | High |
| 2 | Sammaz 22 | 2009 | Hybrid | Medium-late | Moist savannas | High |
| 3 | Sammaz 23 | 2009 | Hybrid | Medium-late | Moist savannas | High |
| 4 | Sammaz 24 | 2009 | Hybrid | Medium-late | Moist savannas | High |
| 5 | Sammaz 25 | 2009 | Hybrid | Medium-late | Moist savannas | High |
| 6 | Oba Super 7 | 2009 | Hybrid | Medium-late | Moist savannas | High |
| 7 | Oba Super 9 | 2009 | Hybrid | Medium-late | Moist savannas | High |
| 8 | Sammaz 18 | 2009 | OPV | Early | Guinea & Sudan Savanna | High |
| 9 | Sammaz 19 | 2009 | OPV | Medium-late | Moist savannas | High |
| 10 | Sammaz 20 | 2009 | OPV | Early | Guinea & Sudan Savanna | High |
| 11 | Sammaz 26 | 2009 | OPV | Medium-late | Moist savannas | High |

| | | | | | | |
|----|-------------|------|--------|-------------|------------------------------|--------|
| 12 | Sammaz 27 | 2009 | OPV | Early | Guinea & Sudan Savanna | High |
| 13 | Sammaz 28 | 2009 | OPV | Extra-early | Guinea & Sudan Savanna | Medium |
| 14 | Sammaz 29 | 2009 | OPV | Extra-early | Guinea & Sudan Savanna | Medium |
| 15 | Sammaz 32 | 2011 | OPV | Extra-early | Guinea & Sudan Savanna | Medium |
| 16 | Sammaz 33 | 2011 | OPV | Extra-early | Guinea & Sudan Savanna | Medium |
| 17 | Sammaz 34 | 2011 | OPV | Early | Guinea & Sudan Savanna | High |
| 18 | Sammaz 35 | 2011 | OPV | Early | Guinea & Sudan Savanna | High |
| 19 | SAMMAZ 38 | 2011 | OPV | Extra-early | Guinea & Sudan Savanna | Medium |
| 20 | Ifehybrid 5 | 2013 | hybrid | Extra-early | Guinea & Sudan Savanna | High |
| 21 | Ifehybrid 6 | 2013 | hybrid | Extra-early | Guinea & Sudan Savanna | High |
| 22 | Sammaz 40 | 2013 | OPV | Late | Southern & northern savannas | Low |

Annex 2: The ENACTS approach to improving availability and access to climate information in Africa

Tufa Dinku and James Hansen

There are critical gaps in availability climate data in most of Africa. The state of the current station network is seriously inadequate with the number and quality of weather stations in many parts of the continent in decline. The available stations are unevenly distributed with most of the stations located along the main roads. This seriously limits availability data and services to rural Africa. This, for in stance, has been one of the major challenges to providing weather index insurance to smallholder farmers in Africa. Index insurance requires good historical time series as well as reliable current rainfall observations. Where station records do exist, data quality and access is often lacking and records suffer from gaps in space and time. These challenges need to be addressed if index insurance is to reach those who need it most.

Satellite-based estimates of rainfall and other weather data offer a potential alternative to sparse ground-based observations. Satellite rainfall estimates, which now go back more than years, offer complete coverage in time and space. However, most satellite products are constrained by some combination of coarse spatial and temporal resolution, short period of record, inhomogeneity when sensors or methods were changed, and poor or unknown accuracy due to lack of calibration with ground observations.

An effort by the IRI and partners (including CCAFS, USAID, WMO, Univ. Reading, UNDP), known as ENACTS (Enhancing National Climate Services), works with African national meteorological services (NMS) to produce reliable climate data and information products in a form and at a spatial resolution that is suitable for local decision-making. Combining data from the national observation network, with satellite (or reanalysis in the case of temperature) data, produces spatially and temporally complete historic time series at a high spatial and temporal resolution. The high-resolution, gridded historic data sets provide a foundation for producing a range of climate information products and tools, which are made publically available on the NMS websites in the form of online “maprooms,” built on a highly customizable, freely available software platform

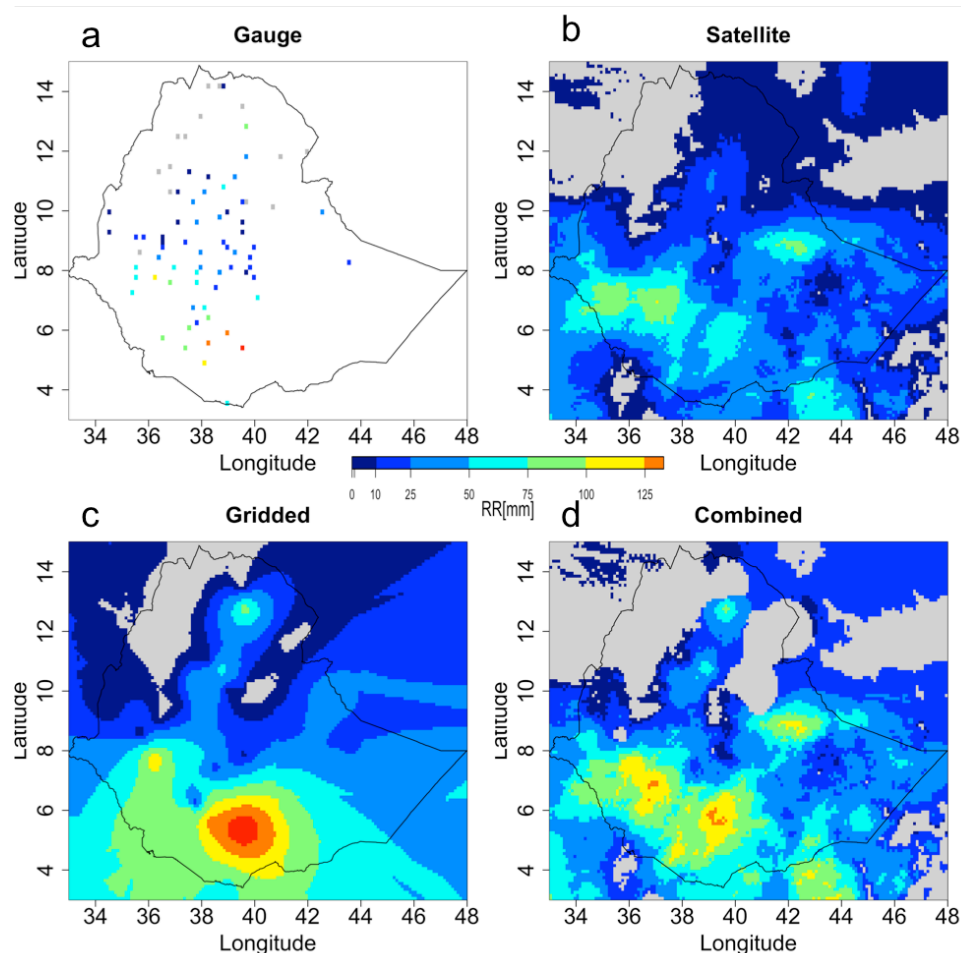
The first step in reconstructing historic time series data is quality control of station data, including verifying station location, checking and addressing outliers and discontinuities, and spatial and temporal checks for consistency. Suspect data are flagged and excluded in the subsequent merging process.

In the next step the quality-controlled station data are combined with spatially complete, regularly updated, freely available satellite or reanalysis gridded data sets. METEOSAT thermal infrared (TIR) images used for rainfall estimation across Africa are available from 1981, while reanalysis products start even earlier. When ENACTS was first implemented in Ethiopia, only TIR data from the METEOSAT satellite were used in order to ensure temporal consistency of the satellite rainfall estimate. Raw METEOSAT data going back to 1981 were obtained and processed by TAMSAT (Tropical Application of Meteorology using Satellite and other Data) program at the University of Reading, for all of Africa.

Station observations are used to correct the errors in the satellite products while satellites products are used to fill gaps in station observations. This approach uses Regression Kriging,

and (for temperature) ancillary digital elevation and averaged MODIS Land Surface Temperature) data, to merge quality-controlled station observations with satellite and/or reanalysis estimates. The final products are moderately high-resolution gridded datasets with >30 years of historic rainfall and temperature, covering every 4 km grid cell across a country, on either a dekadal (10-day) or daily time step. Monitoring applications, including weather index insurance, require updating the data set in near real time on a sustained basis.

Figure 1 illustrates how the resulting merged rainfall data in Ethiopia (d) compare with (a) the station observations, (b) raw satellite data, and (c) gridded data based on interpolating station data; for a single dekadal in mid-April 1996. Major gaps in observations are apparent in some parts of the country. The satellite product conveys the general spatial structure of the rainfall reasonably well, but underestimates rainfall amounts over most of the country. The gridded gauge field depicts the overall spatial structure of rainfall as shown by the gauge data, but with unrealistic smoothing, and unreasonable values over lowland areas. The combined product overcomes, to some degree, the lack of stations over the lowlands, the problems with gridded data, and the underestimation by the satellite product.



ENACTS has so far been implemented nationally in Ethiopia (Dinku et al., 2011, Dinku et al. 2013; Dinku et al. 2014a), Tanzania (Dinku et al 2014b), Madagascar, Rwanda and The Gambia; and regionally for the CILSS countries through AGRHYMET.

Although several organizations are developing high-resolution data sets that combine satellite and station data, a key strength of the ENACTS approach is that it works with national meteorological agencies to develop products that they fully own, using all available station data – most of which are not available outside the country. Because the accuracy of merged products depends primarily on the number and spatial distribution of station observations, the quality of the resulting data sets is far greater than any merged products that use only the very small set of globally available station data. The satellite rainfall products have performed well across several African countries, even in complex terrain, but performance degrades in coastal areas.

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