Market outlook for satellite-based RE index insurance in agribusiness

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Preface

Food Early Solutions for Africa (FESA) Micro-Insurance aims to accelerate the activities towards reaching the Millennium Development Goals with respect to food security. The objective of the FESA project is the development of a micro-insurance product based on relative evapotranspiration (RE) data collected by the Meteosat satellite. The FESA project is co-financed by the Dutch Ministry of Foreign Affairs, Direction Sustainable Economic Development (DDE).

In the current report a market outlook for satellite-based RE index insurance is elaborated on. Special thanks for the contributions of Andries Rosema of EARS Earth Environment Monitoring BV and Erik Klaassens of ECORYS Nederland BV. Also the views of experts who were consulted are acknowledged (see for the list of experts Appendix I).

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Summary

S.1 Key findings

Food Early Solutions for Africa (FESA) Micro-Insurance aims to accelerate the activities towards reaching the Millennium Development Goals with respect to food security. The objective of the FESA project is the development of a micro-insurance product based on relative evapotranspiration (RE) data collected by the Meteosat satellite. In the current report a market outlook for satellite-based RE index insurance is elaborated on.

Competitive advantage of using remote sensing technology in Africa mainly originates from supply opportunities. An advantage is that RE indices take into account run-off and ground water storage in comparison with rainfall indices. Limited availability of historic local data together with its limited resolution impedes implementing ground-based index insurance in Africa. Both are temporarily limiting supply factors from a technical point of view. Insurers can install a dense network of local weather stations but bottlenecks are foreseen during the scaling-up phase. Scaling up is crucial for keeping costs under control, and remote sensing technologies can improve efficiency with relative limited investment.

Table S.1 Limiting factors for implementing index-based insurance in Africa

Case name	**Ground-based**	**Satellite-based**
Supply issues		
Availability of historic data	• [1]/•••	•
Grid size of measurement	• [1]/•••	•
Cost of measurement	•• [2]/•••	•
Up-scaling possibilities	•• [2]/•••	•
Demand issues		
Ease to understand	•	••
Trust	•	••

• No limiting factor, •• somewhat limiting factor, ••• limiting factor. 1 Under the condition that pilot areas are chosen because of their close proximity to existing weather stations. 2 Under the condition of many farmers/intense farm production per village or region.

The market outlook for satellite-based micro-insurance and thus also for RE indices are positive and can be turned into a (financially) sustainable activity. However, it is too early to determine which specific technology will prevail.

S.2 Complementary findings

A one-size-fits-all approach is not expected since specific remote sensing technologies and indices might work under some conditions, while ground-based indices are preferred under other conditions.

S.3 Methodology

Research includes a literature review and interviews with the main stakeholders. Selected stakeholders are involved in one or more index-based crop insurance cases in Africa.

1 Introduction

1.1 Introduction

Farmers can raise their production and income considerably by applying improved tillage techniques, better seeds, fertiliser and pesticides. For this purpose most farmers need a loan. However, financial institutions are reluctant to offer credit. Because of climatic disaster, in particular drought, famers may lose their crop and would not be able to pay back the loan. Micro-insurance addresses or partially addresses this problem. There are millions of smallholders with only a few acres of land and a production of about 1-2 tonnes of millet or maize annually. The loan to be insured may be in the order of USD200 and the insurance premium some USD10 to USD40. To provide a viable micro-insurance scheme to these smallholders the need for an insurance with low transaction costs is of eminent importance.

1.2 FESA

Food Early Solutions for Africa (FESA) Micro-Insurance is a project commissioned by the Netherlands Minister of Development Cooperation with the aim to accelerate the activities towards reaching the Millennium Development Goals with respect to food security. The objective of the FESA project is the development of a micro-insurance product based on data collected by the Meteosat satellite. In the FESA project a processing system has been developed that translates the satellite data into climatic and crop yield indices for every location in Africa.

Weather index insurance is considered an important risk-sharing mechanism to assist farmers in resisting the vagaries of climate, to increase their production and income and thereby escape from poverty. Index-linked insurance products eliminate the need to individually verify claims, reduce transaction costs and make it easier to offer products and services in rural communities and in frontier regions.

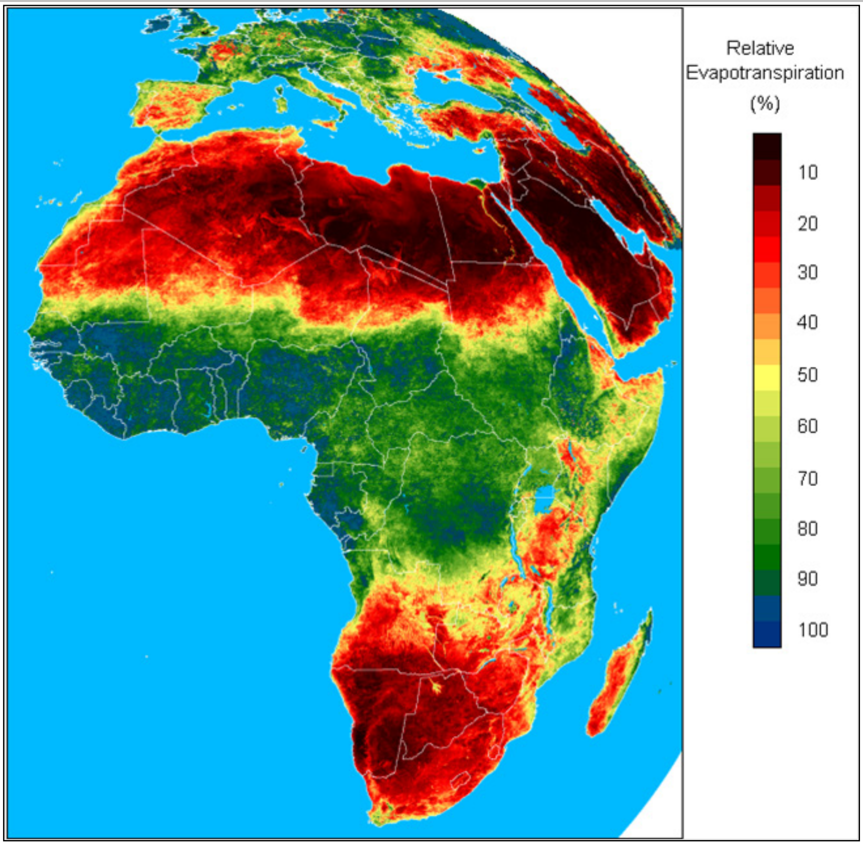
The initial and straightforward drought insurance indices are based on rainfall. Pay-outs to farmers are triggered if rainfall during the growing season does not meet certain pre-defined levels. In Africa, however, there are few rainfall stations. A very dense and costly network would be required to adequately represent the spatial variability. Moreover, adding rain gauges to the existing network of rainfall stations would not provide for a long precipitation history that is required to assess the drought risk and to price the policy.

Another limitation is that rainfall is not a good measure of actual crop water use. A considerable part may run off or may percolate into the subsoil. It is also possible that rainwater is stored in the soil for considerable time and used by the crop with months of delay. Therefore, using rainfall data for micro-insurance involves considerable basis risk (Rosema, 2010). Basis risk associated with a rainfall-only index might be high, and inclusion of other variables such as temperature might be warranted (Burke et al., 2010).

By means of remote sensing at the end of the 1990s it became possible to use visual and thermal infrared satellite data in mapping temperature, radiation, evapotranspiration and precipitation from space. Systems and services are currently provided for satellite-based drought monitoring, crop yield forecasting and river flow forecasting.

FESA does not using precipitation for drought insurance, but uses the relative evapotranspiration (RE) index. The RE data developed in the FESA project cover 30-year data series at 3 km resolution and can be extracted for any location on the African continent (Rosema et al., 2010). Since evapotranspiration is hardly measured on the ground, this index is not yet well known as a potential agricultural drought indicator. RE is proportional to crop yield (Stewart, 1973; Doorenbos and Kassam, 1979) in some contexts, although it is important to quantify the level of error in the relationship for each context. Ongoing research in the field of evapotranspiration focuses on improving its accuracy and addressing existing limitations (García et al., 2013).

Figure 1.1	Example of Meteosat relative evapotranspiration (RE) used for drought insurance in Africa (Rosema, 2012)



Since the start of the FESA project the examples of RE indices have shown to be as good as or even more accurate than crop growth predictors based on traditional rain gauges (Rosema et al., 2010). Yet as with all indices basis risk will remain inherent. Whereas the collection of rain gauge data is expensive, labour intensive and limited to the area where gauges are placed, satellite data for every area in Africa is readily available, thus opening up opportunities for significant efficiency gains, reduction of (micro-) insurance loading and consequently outreach (Rosema et al., 2010). In summary, remote sensing technology may overcome the challenges of traditional indemnity-based crop insurance, as well as shortcomings of (ground-based) parametric-trigger-based schemes.

1.3 Objectives

During the FESA project indices have been developed for a number of crops, for multiple countries in Africa, and in cooperation with various insurers. The resulting products are supported by a major re-insurance company. Currently, the FESA insurance products are piloted in African countries.

The FESA team is now working on the next step whereby the project is turned into a (financially) sustainable activity. In this market outlook study, the following two research objectives are studied:

- What is the competitive advantage of satellite-based micro-insurance in comparison with other index-based products which are marketed in Africa ?
- What is the market outlook for satellite-based micro-insurance in agribusiness ?

1.4 Method and outline

Research includes a literature review and interviews with the main stakeholders. Selected stakeholders are involved in one or more index-based crop insurance cases in Africa.

2 Overview of the micro-insurance market in agriculture in Africa

2.1 Stakeholders

In comparison with developed countries the insurance supply chain is underdeveloped in Africa, especially in the business line of agricultural insurances, being either indemnity-based or index-based. The insurance supply chain is made up of at least four stakeholders, namely:

- the reinsurer who provides protection for catastrophic risks;
- the insurer who carries the insurance risk;
- the entity in the delivery channel that sells the insurance policy and provides basic servicing;
- the policy holder who buys the product, whether an individual or a group (Roth et al., 2007).

Where in developed countries sufficient supply by insurers and demand by policy holders will enable insurance market development, this is hampered in most of African countries. Also, reinsurance does not yet play a substantial role in micro-insurance (Roth et al., 2007).

The market failure is addressed by several actors that want to facilitate market development in Africa (e.g. World Bank, IFC, EU, WFP, IFAD and NGOs). These actors do not restrict themselves to specific insurance designs being either indemnity based or index-based, yet in the past years they intensively explored the potential of index-based insurance. Also reinsurers (e.g., Swiss Re) are becoming more involved in the design and pricing of index-based products (Roth et al., 2007), and this also holds for international insurers (e.g., Allianz and MicroEnsure).

The World Bank, working with a range of partners, has implemented pilot projects in several countries in Africa including Morocco and Malawi (Roth et al., 2007). Also the Global Index Insurance Facility (GIIF) programme, part of the World Bank Group's insurance initiatives via the International Finance Corporation (IFC), responds to challenges presented by climate change, food security and disasters risk management. More specific, GIIF was established to promote the development of sustainable markets for index-based weather and catastrophe risk insurance in developing countries. The European Commission and the African, Caribbean, and Pacific Secretariat (ACP) are the primary donors to the GIIF Global Trust Fund. Additionally, the GIIF Global Trust Fund is supported by Japan's Ministry of Finance and the Netherlands Ministry of Foreign Affairs (IFC, 2012).

GIIF was launched operationally in December 2009 with an initial focus on Africa, where a number of projects have already started implementation. GIIF is, however, a global programme and has commenced expansion in Latin America and the Caribbean, South Asia, East Asia and the Pacific.

GIIF promotes index-based insurance, specifically within the broader agenda of the agricultural insurance framework implemented by the World Bank Agricultural Insurance Development Programme (AIDP), which aims to support the sustainability and scalability of agricultural insurance through public-private partnerships. On the IFC side, GIIF provides funding to support financial institutions and local capacity-building efforts on the development of market-based solutions. On the International Bank of Reconstruction and Development (IBRD) side, GIIF provides advisory services on policies and insurance regulations to develop index-based insurance.

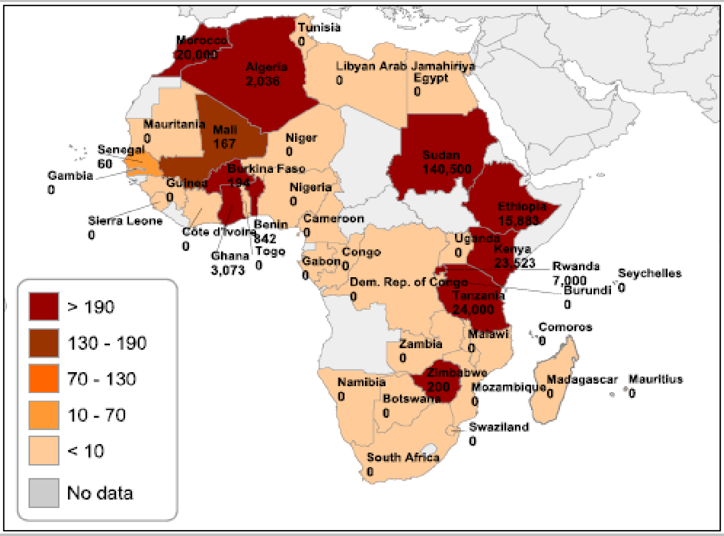
Also IFAD and WFP have been working on index insurance as part of their commitment to reduce the vulnerabilities of poor rural smallholders and open their access to a range of financial services with a view to improving their livelihoods. With a grant from the Bill and Melinda Gates Foundation, in 2008 IFAD and WFP launched the Weather Risk Management Facility (WRMF). The WRMF has conducted global research in government and donor best practice in weather index-based insurance, while supporting pilots in for example Ethiopia (IFAD and WFP, 2011).

Besides governmental organisations also NGOs are becoming more involved in the market development of index-based insurance to improve food security. For example, Oxfam has partnered with leading actors in the insurance sector to create weather-index insurance projects in Ethiopia and Senegal as part of the R4 Rural Resilience project (formally known as HARITA in Ethiopia).

2.2 Penetration

In 2011, the total agricultural micro-insurance industry in Africa generated a premium volume of USD6.61m. Compared with the total insurance industry in Africa with a premium volume of USD68bn, being either micro-insurance or traditional insurance, the premium volume generated in agriculture is marginal (McCord et al. 2012). Figure 2.1 presents the agricultural landscape of micro-insurance in Africa published by Making Finance Work for Africa and the Munich Re Foundation (McCord et al. 2012). The number of farmers insured amounted to approximately 0.22 million (McCord et al. 2012). On average, the annual insurance premium for smallholders in Africa amounts to approximately USD30 per farm. On a continent with such a need for agriculture risk management, the limited uptake underscores the need to find better tools for farmers (McCord et al. 2012).

Figure 2.1 **Number of farmers insured by micro-insurance in 2011**



Source: Making Finance Work for Africa and the Munich Re Foundation (McCord et al. 2012).

Although recent developments in index-based insurance products offer a tentative potential for coping with yield losses, indemnity-based insurance has a longer history with a broader outreach in Africa. For example, the Sudanese insurance is a comprehensive indemnity-based approach covering production costs. Among others, drought in rain-fed areas, floods, sandstorms, hail, fire, and pests and diseases are covered (El Sayed, 2013). Although the total number of insured farmers is substantial (145,000 in 2011), the coverage ratio is still marginal (0.42%). Note that apart from the political support there is commitment to subsidise the premium by 50% (El Sayed, 2013).

3 Index-based cases in Africa

Despite growing enthusiasm over index insurance, it is important to remember that these products are still being tested and generally have limited uptake. There remains a debate about the real potential for an index cover in micro-insurance (Matul, 2010). However, valuable lessons can be learned from index-based insurance cases in Africa. Ten index insurance products in Africa have been analysed for which basic summary data is publicly available. The description of the case studies focuses specifically on the alternative sources of information to design and price the index, being either ground-based or satellite-based. The ten analysed cases are quite diverse with respect to the *region* marketed and the *index-approach*.

Region
The main players pilot and market numerous index products in various African countries. For example, MicroEnsure is active in various African countries and a number of new pilots have been launched in Rwanda and Tanzania. Moreover, MicroEnsure has plans to launch drought insurance in Ghana (Matul, 2010). PlaNet Guarantee develops index-based insurance in four WAEMU countries. PlaNet Guarantee is setting up the first regional management platform dedicated to index-based insurance, which is based in Senegal, with satellite branches in other countries in West Africa. Moreover, in some countries in Africa numerous index-based products were piloted (e.g., Kenya and Ethiopia). In the current analysis we focus on the Kilimo Salama project in Kenya because of its high market penetration. The WFP project in Ethiopia has been chosen since it showed that it is feasible that there is an international market ready to absorb large systemic risks at country level.[1]

Index-approach
The relative evapotranspiration (RE) index monitored by EARS has been developed on request of numerous insurers and piloted and commercialised in Africa. Out of the ten analysed cases, two use the RE index, and one has used the RE index for one pilot year, while other index cases are based on rainfall measurements.

In each case description first the main supply issues associated with index insurance provision are characterised, before addressing design and pricing issues, followed by participation and outlook.

3.1 Description of the value chain of each index-based insurance scheme

The main issues associated with index insurance provision are characterised in terms of insured, insurer, reinsurer and other partners involved. Table 3.1 lists the stakeholders directly involved and those who facilitated market development.

Case 1: Planet Guarantee, Burkina Faso/Mali
In Burkina Faso, 6 micro-finance institutions marketed the PlaNet Guarantee cover in the growing season 2011/2012. Note that in this approach the credit agency insures their portfolio of loans whereby the lenders sign in addition to the loan contract an accompanying insurance contract. The payouts are made via the credit agency but are withheld if the credit is not returned. Although the insurance contract is optional, credit agencies are becoming more stringent in requesting this cover. Insured farmers without credit are rare. A similar design is applicable for the Mali case. The technical partners are Allianz Africa for

[1] The Ethiopian drought insurance was piloted in 2006 only. While it no longer exists as such, it formed the basis for the current Livelihood, Early Assessment, Protection (LEAP) programme, initiated by WFP and the Government of Ethiopia, in partnership with the World Bank. During LEAP's second phase (2011-2013), the Government and WFP, in partnership with international universities and research institutes, will refine and finalise the system and look at how to support other countries interested in a similar system, thereby creating a country pool (Balzer and Hess, 2010 and WFP, 2012).

insurance, CVECA and MECAP for credit, EARS for satellite tracking indices and Swiss Re, Cica Re and Africa Re for reinsurance. This experience is financially supported by Oxfam (2011-2015) and the World Bank via the Global Index Insurance Facility.

Case 2: HARITA, Ethiopia

Swiss Re, Oxfam, and the Relief Society of Tigray (REST) collaborated in a pilot project in 2009 to introduce index-based weather insurance for a staple cereal crop in the village of Adi Ha, Tigray. This HARITA project continues from 2012 onwards as part of the R4 Rural Resilience project ('R4 Rural Resilience Initiative' 2012a). R4 is a 5-year partnership between Oxfam America, WFP and SwissRe. It started in Ethiopia and will now expand into 3 more countries including Senegal (2 other countries to be determined). A research partnership on index insurance between academic and development organisations is involved, including UC Davis, the Food and Agriculture Organisation, International Labour Organisation, and the US Agency for International Development (Index Insurance Innovation Initiative (I4)). The International Research Institute for Climate and Society (IRI) provides technical expertise in climate data and weather index design for rural farmers. The Rockefeller Foundation funds strategies that help communities build resilience to the impacts of current and imminent climate change ('R4 Rural Resilience Initiative' 2012b). Next to Rockefeller, USAID and Norway are funding WFP for R4.

Case 3: WFP, Ethiopia

The World Food Programme (WFP), World Bank, the government of Ethiopia, and the insurance company AXA Re have jointly developed a humanitarian emergency index insurance programme for Ethiopia (Roth et al., 2007). This scheme was the first index-based national disaster insurance programme of its kind. WFP pays a premium to AXA Re and if rainfall levels fall below the trigger, WFP receives a payout. In this case the donor pays a premium on an annual basis and when drought occurs the payment is swift and the impacts are alleviated much faster than before (Roth et al., 2007). A major part of the premium was covered by the United States Agency for International Development (USAID) (Balzer and Hess, 2010).

Case 4: GAIP, Ghana

In May 2011, the Ghana Agricultural Insurance Programme (GAIP) marketed GAIP's commercial drought-indexed insurance product, a product reinsured by Swiss Re (SwissRe) and endorsed officially by the National Insurance Commission (Karlan et al., 2012).

Case 5: Kilimo Salama, Kenya

The Kilimo Salama project is an index-based insurance product that covers farmers' inputs in the event of drought or excessive rainfall. It is a partnership between the Syngenta Foundation for Sustainable Agriculture and Kenyan insurance company UAP. In November 2010, the IFC's Global Index Insurance Facility (GIIF) entered (IFC).

Case 6: COIN-Re, Mozambique/Malawi

Cardano/COIN-Re intends to provide catastrophic risk coverage to rural communities in emerging countries. To test the business plan and to confirm the marketability of the product, a first step in the rollout of the COIN-Re concept is the execution of a few pilot cases. The cases of Mozambique and Malawi are elaborated on. COIN-Re focuses on capital-intensive agriculture as it also provides financing (COIN-Re, 2011). It is foreseen that diversified Tabaco growers in Mozambique and Malawi, who are clients of Universal Corporation, are offered crop insurance for their inputs. Tabaco is not insured since its risk exposure is relatively limited in comparison with maize.

Table 3.1	Value chain of analysed index-based insurance schemes				
Case name	**Country**	**Insured**	**Insurer**	**Reinsurer**	**Other partners**
1. PlaNet Guarantee	Burkina Faso / Mali a)	Farmers, MFI	Allianz	Swiss Re, Cica Re, Africa Re	PlaNet Guarantee, local banks, Oxfam, GIIF
2. HARITA (R4)	Ethiopia	Farmers	Africa Insurance Company	Swiss Re	Oxfam America, World Food Programme, I4, IRI, Rockefeller Foundation
3. WFP (EADI - Ethiopia Agricultural Drought Index)	Ethiopia	World Food Programme	-	AXA Re	World Bank, USAID, Government of Ethiopia, Norway
4. GAIP	Ghana	Farmers	GAIP	Swiss Re	Swiss Re
5. Kilimo Salama	Kenya	Farmers	Kenyan insurance company UAP	Swiss Re	Syngenta Foundation, GIIF
6. COIN-Re	Mozambique / Malawi	Farmers	-	-	COIN-Re / Cardano. Universal Corporation
7. World Bank	Malawi	Farmers	Insurance Association of Malawi	Swiss Re	World Bank, MicroEnsure, Opportunity International
8. MicroEnsure	Rwanda	Farmers	SONARWA, SORAS	Swiss Re	MicroEnsure, GIIF, Ministry of Agriculture, Rwanda Meteo Agency, Kenya Commercial Bank, Urwego Opportunity Bank
9. PlaNet Guarantee	Senegal	Farmers, MFI	CNAAS	Swiss Re, Cica Re, Africa Re	PlaNet Guarantee, GIIF, World Bank and Cirad
10. MicroEnsure	Tanzania	Farmers	Golden Crescent	Swiss Re	MicroEnsure, Tanzanian Cotton Board, Gatsby Foundation, GIIF

a) Pilot is conducted in Benin.

Case 7: World Bank, Malawi

The Insurance Association of Malawi, with technical assistance from the World Bank and Opportunity International, designed an index-based insurance contract for farmers in Malawi (Roth et al., 2007). Once the contract was issued, two banks, the Opportunity International Bank of Malawi (OIBM) and Malawi Rural Finance Corporation (MRFC), financed high yield variety seed (Roth et al., 2007). MicroEnsure and the World Bank Commodity Risk Management Group in Africa started the first weather index crop insurance pilots in Malawi in the 2005-2006 growing season (Matul, 2010). MicroEnsure is one of the pioneers in weather index insurance and launched its first products in 2004 in Malawi, working with the World Bank (Leftley, 2009).

Case 8: MicroEnsure, Rwanda

MicroEnsure and the IFC's Global Index Insurance Facility programme are working together to help bring affordable, flexible and responsive weather index insurance to low-income farmers in Rwanda. MicroEnsure is partnering on the ground in Rwanda with Kenya Commercial Bank, Farmer Federations and Urwego Opportunity Bank, which is a subsidiary of Opportunity International and is working with loans, savings, and insurance products; the Rwandan Ministry of Agriculture; the Rwandan Meteorological Agency; and local insurance companies SONARWA and SORAS (IFC , MicroEnsure).

Case 9: Planet Guarantee, Senegal

In 2012, index-based insurance was issued in Senegal. PlanetGuarantee, IFC's Global Index Insurance Facility programme, World Bank and Cirad are partnering.

Case 10: MicroEnsure, Tanzania

MicroEnsure's pilot project in Tanzania aims at providing weather index insurance to Tanzanian cotton farmers through the Tanzanian Cotton Board. The pilot is supported by the Gatsby Foundation, the local underwriter Golden Crescent, and reinsurance company Swiss Re in the context of its technical partnership agreement with IFC/GIIF (IFC, 2012). The Swedish Development Cooperation is funding the programme.

Summary

The ten analysed cases reveal that numerous stakeholders are active in Africa to market index-based insurance. The majority of index-based insurances are supported by several actors that want to facilitate market development in Africa.

3.2 Data sources used in each index-based insurance scheme

The main index design issues are characterised in terms of crops covered, index (i.e., peril covered), source of information, grid and data (Table 3.2). Source of data refers to either ground-based or satellite-based. Grid and data refers to the availability and reliability of historic sources of climatic data to design the index (e.g. density of rain gauges network).

Case 1: Planet Guarantee, Burkina Faso/Mali

The pilot scheme covers drought risks in maize. Maize is selected since it requires relatively high amounts of inputs and output is more volatile than for example millet and sorghum, which are more resistant to drought. The system works by a combination of crop insurance and a rural credit facility. Payouts are triggered based on satellite information (EARS method). The satellite index was used since ground information on rainfall was sparse in Burkina Faso. The grid size is 3 by 3 km. The payouts for index insurance in Burkina Faso and Mali are based on the decadal relative evapotranspiration.

Case 2: HARITA, Ethiopia

In the 2012 agricultural season, the weather index insurance options for farmers included short-cycle crops (teff and beans) and long-cycle crops (maize, wheat, barley, and sorghum) (Oxfam, 2012). IRI has been working to build a statistical methodology that will systematically compare and integrate information on remote sensing of rainfall, ground-based data measurements, and other data sets. In the Adi Ha pilot village rainfall was modelled at five neighbouring sites, where daily rainfall amounts have been recorded during different intervals for each site over the course of a 49-year time period, from 1961 to 2009. This methodology is intended to be further developed and packaged into tools for contract design and evaluation.

Table 3.2	Classification of the index-based insurance schemes					
Case name	**Country**	**Crops**	**Index**	**Source**	**Grid**	**Data a)**
1. PlaNet Guarantee	Burkina Faso / Mali	Maize, cotton	RE	Satellite	3km*3km	30 years
2. HARITA (R4)	Ethiopia	Teff, beans, maize, wheat, barley, and sorghum	Rainfall	Rain gauges	-	49 years
3. WFP (EADI - Ethiopia Agricultural Drought Index)	Ethiopia	Sum insured	Rainfall	Rain gauge	26 rain gauges	52 years
4. GAIP	Ghana	Maize	Rainfall	Rain gauge	5 rain gauges, maximum radius of 30km	-
5. Kilimo Salama	Kenya	Maize, beans, sorghum, wheat, coffee, potatoes	Rainfall	Rain gauge	Maximum radius of 15km	30 years
6. COIN-Re	Mozambique / Malawi	Maize	RE	Satellite	3km*3km	30 years
7. World Bank	Malawi	Maize, groundnut, tobacco	Rainfall	Rain gauge	Max. 20-30 kilometres from rain gauge	30 years
8. MicroEnsure	Rwanda	Maize, rice, potatos	Rainfall	Rain gauge	4 rain gauges	30 years
9. PlaNet Guarantee	Senegal	Maize, peanut	Rainfall	Rain gauge	17 rain gauges, maximum radius of 8km	20-30 years
10. MicroEnsure	Tanzania	Cotton	RE	Satellite	3km*3km	30 years

a) Years with data for ground-based indices either stem from pilot areas in close proximity of existing weather stations or years with data are synthetically created.

Case 3: WFP, Ethiopia
The policy is designed using rainfall data recorded by 26 weather stations across Ethiopia. Precipitation recordings are converted into crop water-stress indices and combined in a national basket Roth et al., 2007). The reinsurer and WFP used historical rainfall data from the Ethiopian National Meteorological Agency (NMA) and a crop-water balance model to develop the Ethiopia Agricultural Drought Index (EADI), which had a correlation of about 80% with the number of food aid beneficiaries between 1994 and 2004. Records from 1952 up to and including 2004 were included in the analysis. Analysis of the historical data revealed a one in 20 year probability of catastrophic drought in Ethiopia, as occurred in 1965, 1984 and 2002 (Balzer and Hess, 2010).

Case 4: GAIP, Ghana
Policies covered maize and were offered to farmers within 30 kilometres of one of the rain gauges. Five rainfall gauges were used (Karlan et al., 2012).

Case 5: Kilimo Salama, Kenya
Kilimo Salama is currently offering two policies in the market. One policy covers the investment in farm inputs such as seed and fertiliser and one policy covers farm output value, which is an estimate of the expected harvest value. The project uses weather stations to collect rainfall data and implements SMS-based mobile technologies to distribute and administer the payouts. Kilimo Salama normally use rain gauges

which have a maximum advised radius of 15 km. Kenya has a relative rich history of rainfall data. Historic data are for some locations 80 years, but on average this is about 30 years (IFC).

Case 6: COIN-Re, Mozambique/Malawi

The pilot project will demonstrate the feasibility of RE-based drought coverage to maize farmers. In this plan, EARS has a role as knowledge partner, data provider, and in the development of insurance products.

Case 7: World Bank, Malawi

Maize and groundnut farmers were initially targeted in 2005, and the pilot programmes were expanded in 2007 to cover loans provided to participating smallholder tobacco farmers (Kapondamgaga and Fisher, 2011). The Malawi index-based crop insurance measures the amount of rain recorded at local meteorological stations. In case of severe drought, it is assumed that all farmers within a 20-30-km radius will be similarly affected. The insurance contract is bundled with loans to farmers that cover the cost of high-quality seeds. The insurance pays out part or the entire loan in case of severe drought. The sum insured is the loan amount and interest payable (GFDRR).

Case 8: MicroEnsure, Rwanda

Maize, rice and potatoes farmers have been covered with index products in Rwanda. MicroEnsure has recently installed four automatic weather stations to help develop the weather station infrastructure in Rwanda. Installed in partnership with the Rwanda National Meteorological Service and the Ministry of Agriculture, the stations will be located near to existing manual stations, for example one will be located in Zaza in the Eastern Province. Supplied by LSI-SAT in Italy, a company engineer will assist local teams in installing the stations and provide training for ongoing servicing and maintenance. These public-private partnerships represent a strong foundation for the scaling up of weather station infrastructure in the coming years. When new automatic weather stations are installed, there is a need to provide farmers with index products without waiting for each station to gather years of data. Working with resources from the University of Reading, MicroEnsure is able to create synthetic data that allow gaps to be filled and new stations to be brought into use more quickly (MicroEnsure, 2012).

Case 9: Planet Guarantee, Senegal

The indices cover maize and peanut in Senegal. The meteorological agency provides reporting to the Pilot Project Unit on an agreed frequency concerning rainfall recorded at official stations in the pilot areas. However, the weather index payouts would be based on measurements made at automatic rain stations in each pilot area. The official weather stations would act as backup stations in the event of failure of the automatic stations (World Bank, 2009). The number of rain gauges will increase form 17 in 2012 to about 30 in 2013.

Case 10: MicroEnsure, Tanzania

In this pilot, GIIF support was utilised to cover the cost of data procured from EARS, using the satellite-based RE measurement. The use of an alternative index was deemed necessary because weather data sources were not sufficient enough to provide a robust index product in the country. For the remainder of the report only the RE index piloted is addressed which was only piloted one year and is currently replaced by a ground-based index.

Summary

The ten analysed cases reveal that most ground-based indices rely on limited number of rain gauges. Years with data for ground-based indices either stem from pilot areas in close proximity of existing weather stations or years with data which are synthetically created. The RE data developed in the FESA project cover 30-year data series at 3 km resolution and can be extracted for any location on the African continent (Rosema et al., 2010).

3.3 Pricing of each index-based insurance scheme

The main index pricing issues (Table 3.3) are characterised in terms of contract design, pure premium and gross premium (the latter is the premium smallholders have to pay). The pure premiums are also referred to as the expected claim cost or actuarially fair premium. Note that converting the pure premium into a gross premium requires the addition of the loading, which is intended to cover transaction costs and allowance for contingencies and profit.

Case 1: Planet Guarantee, Burkina Faso/Mali

Triggers below which payments are made correspond to the 5% percentile of historical long-running decadal relative evapotranspiration data. Threshold for full payment is adjusted depending on areas and crop development period. Payouts are dependent on three specific periods mimicking the different stages of maize production (contract of 2012). In Burkina Faso the first stage covers 30 days after seeding (1st of July), the second stage comprises 20 days and the last stage 40 days (in total 100 days). Payouts are proportional to the total covered amount for the three subsequent stages and amount to 30%, 100% and 100% respectively. Producers pay a premium of 10.80% of the loan amount requested for 2011/2012, while premium for 2010/2011 amounted to 9.40%. This includes an insurance tax of 8%. The premium is not differentiated between covered zones and regions, but each zone and region has its specific threshold level (and thus actuary fair). This implies that protection levels are better in the South, which is less drought-prone. A similar design is applicable to Mali.

Case 2: HARITA, Ethiopia

The index is designed to proxy an early end to the rainfall season. If the cumulative rainfall for the period 11 August to 9 October does not surpass the trigger value of 105mm (using ARC rainfall), the insurance policy will pay out. The direct source for ARC data is from NOAA2 (Osgood 2010). Payout increases linearly between 105mm to 60mm. In the 2012 approach, based on farmers' demand, the project continues to offer two different index options: dry and very dry. These indices are designed to insure against the two dominant drought perils of late onset and early end of rainfall. The Early Index targets weak or late onset of rainfall, which affects sowing and the establishment of long-cycle crops, like sorghum and maize. The Late Index targets weak or early end of rainfall, which affects flowering and grain filling of all crops. For each village, both indices are calibrated to the local crop calendar and rainfall amounts in the village. The start and end of each index is set by local experts through discussions with the design teams in each village (Oxfam, 2012). The dry (and more expensive) option would have had payouts about once in four years. The very dry option (based on the index established in 2009) would have had payouts about once in seven years. Farmers will be able to pay for their insurance premiums through labour in food-and-cash-for work programmes ('Insurance-for-Assets', IFA). Their labour will contribute to community projects such as irrigation or forestry to reduce the impacts of climate change on their villages. More prosperous farmers will pay their insurance premiums in cash. Over time, as the poorest farmers become more prosperous, they can graduate from the need to pay through labour, and begin paying in cash, helping to ensure the project's commercial viability and long-term success.

Case 3: WFP, Ethiopia

Payment is triggered when rainfall over a period from March to October is significantly below historic averages, indicating widespread crop failure (McCord, 2007). The contract provided USD7.1m in contingency funding in a pilot scheme during Ethiopia's 2006 agricultural season. The premium amounted to USD0.93m (www.wfp.org, www.axa-re.com and http://spectrevision.net/2012/04/27/weather-derivatives).

Case 4: GAIP, Ghana
The product was divided into three stages based on the maize plant's growth stage, and each stage included one or two types of drought triggers (cumulative rainfall levels over ten-day periods, or consecutive dry days). The product was offered at an actuarially fair price of USD7.90 per acre, as well as a subsidised price of USD4.00 per acre and a market price of USD11.90 per acre (Karlan et al., 2012).

Table 3.3	**Pay-outs and premiums of analysed index-based insurance schemes**			
Case name	**Country**	**Contract design**	**Pure premium**	**Gross premium**
1. PlaNet Guarantee	Burkina Faso / Mali	Drought index	5%	10.80%
2. HARITA (R4)	Ethiopia	Dry and very dry index	25% and 14.28%	In kind or cash
3. WFP (EADI - Ethiopia Agricultural Drought Index)	Ethiopia	Drought index	-	13%
4. GAIP	Ghana	Drought index	USD7.90 per acre	USD11.90 per acre
5. Kilimo Salama	Kenya	Drought and excessive rainfall	-	6% to 14%
6. COIN-Re	Mozambique / Malawi	Drought index	20% a)	25% a)
7. World Bank	Malawi	Drought index	-	3.5% to 8% (tobacco has the lowest premium and maize the highest)
8. MicroEnsure	Rwanda	Drought index Excess rain indexes	3%-10%	6%-14%
9. PlaNet Guarantee	Senegal	Drought index	-	11%-17%
10. MicroEnsure	Tanzania	Drought index	1.8% b)	7.5% (cotton)

a) Targeted premiums; b) In case of cotton pilot with RE index pure premium and gross premium amounted 1.8% and 7.5% respectively. Originally the index was designed given a 4.7% pure risk premium.

Case 5: Kilimo Salama, Kenya
The index products protect farmers' investments against extreme weather events; namely drought and excess rain at the end of the cropping season. Payouts are determined based on measurement at the weather station nearest to the insured farm. In the 2010 season farmers are paying a range of 6% to 14% of the sum insured. The sum insured can be based either on the costs of inputs or the expected income (Smith et al., 2010).

Case 6: COIN-Re, Mozambique/Malawi
Triggers below which payments are made correspond to the 20% percentile of historical long-running decadal relative evapotranspiration data. The average payout is once every five years, enabling the smoothening of cash flows of the farmer's risk management horizon. Payouts account for the loan for seed and fertiliser, interest and premium. In contrast to most other analysed index cases, payouts are not dependent on specific growing stages of a crop since COIN-Re believes that a multi-stage approach suggests more accuracy while this cannot be met because of limited yield data to adequately parameterise such an index. The foreseen scheme will have low operational costs since it takes advantage of the existing marketing, scouting and input supply chain of Universal Corporation. Total transactions costs are aimed at 5%.

Case 7: World Bank, Malawi
Like all other analysed index-based contracts, the contract is crop specific. For example, for groundnut the trigger is set at 60 mm (in the establishment and vegetative growth stage), 160 mm (in the flowering and pod formation stage) and 100 mm (in the pod filling and maturity phase) (GFDRR, 2011).

Case 8: MicroEnsure, Rwanda
The contract covers rainfall deficits. In 2012 maize and rice contracts were based on RE.

Case 9: Planet Guarantee, Senegal
The indices rely on the decomposition of the crop-growing period into three physiological growth phases. Pay-out structures are designed for each of the three phases. The frequency of pay-out is set at a level of once per five years.

Case 10: MicroEnsure, Tanzania
The Tanzania programme provides cover for the value of the inputs provided on credit to farmers. This enables farmers to increase their productivity, knowing that their loans will be repaid in the event of a drought (IFC, 2012). They first pilot covered drought (whole season). The second pilot had three triggers, covering crop establishment, flowering and harvest. Premiums depend on coverage; farmers can cover 50%, 75% and 100%. Pricing also depends on risk in the market. A rough estimate is one drought per 10 years. Per weather station, there is a different premium.

For the remainder of the report only the RE index piloted for cotton is addressed (this was a one-year pilot which has been discontinued).

Summary
The ten analysed cases reveal that pure premiums range from 1.8% to 25% (the first corresponds to infrequently occurring risks, while the latter corresponds to frequently occurring risks). Ground-based indices as well as satellite-based indices have both been developed for frequent as well as less frequent occurring risks.

3.4 Participation and outlook of each index-based insurance scheme

Participation and outlook for each case are listed in Table 3.4. Long-running projections are inherently subjective and are derived from publications of each insurer involved.

Case 1: Planet Guarantee, Burkina Faso/Mali
In Burkina Faso the scheme was launched by a pilot with 194 maize producers during the 2010/2011 season by PlanetGuarantee. For the next seasons, Planet Guarantee seeks to extend the experiment by contracting 10,000 producers. To do this, the organisation associated with the CPF as a new partner, so as to serve as a distribution channel, particularly through FEPAB which provides its network of Planet Guarantee endogenous facilitators. For subsequent seasons, Planet Guarantee aims to further expand the experience, with more producers, including new products (cotton, peanuts), by using indices yields for cotton (partnership with SOFITEX update provision of ongoing historical returns), and the inclusion of new technical partners (Coris Ecobank and Africa Re). Note that the Burkina Faso project is part of a larger project whose objective is to develop parametric agricultural insurance systems in four WAEMU countries, including Senegal, Mali and Burkina Faso. The number of insured maize farmers in Mali amounted to 167 and 13,843 in 2011 and 2012 respectively (Dubreuil, 2012). For Burkina Faso and Mali 20,000 farmers are expected to be insured (Muller et al., 2012). This facility should cover at least 60,000 people by the end of 2015 in West Africa and raise awareness to more than 165,000 farmers on agricultural insurance (also includes the case in Senegal).

Table 3.4	Participation and outlook of analysed index-based insurance schemes						
Case name	**Country**	**Farmers insured**					
		2009	**2010**	**2011**	**2012**	**2013**	**Long run**
1. PlaNet Guarantee	Burkina Faso / Mali	-		194/ 167	1,471/ 13,843	10,000 /10,000 a)	165,000 b)
2. HARITA (R4)	Ethiopia	200	1,308	13,195	19,000		-
3. WFP (EADI - Ethiopia Agri-cultural Drought Index)	Ethiopia	WFP was insured, maximum payout of USD7.1m in 2006					
4. GAIP	Ghana	-	-	655	-		-
5. Kilimo Salama	Kenya	200		23,000	73,000		-
6. COIN-Re	Mozambique / Malawi	-	-	-	250/ 1,000 c)	2400/ 3000 c)	30,000 in 2014 a)
7. World Bank	Malawi	2,600	-	-	1,100		-
8. MicroEn-sure	Rwanda	-	-	935	6,761	24,000	24,000 a)
9. PlaNet Guarantee	Senegal	-	-	-	60	10,000	165,000 b)
10. MicroEn-sure	Tanzania	-	-	-	6,208		24,000 a) in 2013 400,000 a)

a) Projection; b) Total projection for PlanetGuarantee in West Africa; c) Pilot farms.

Case 2: HARITA, Ethiopia
The project expanded from 200 farmers in the pilot village, Adi Ha, to over 13,000 farmers in 43 villages in 2011, in nine districts in the Tigray region of Ethiopia ('R4 Rural Resilience Initiative' 2012a). A total of 19,000 farmers in over 76 villages purchased insurance during the 2012 agricultural season.

Case 3: WFP, Ethiopia
The contract was issued in 2006 for one season and no payout was triggered. The WFP did not renew the cover after the initial year of launching it. However, initiators took this forward by developing the Ethiopia risk financing mechanism including LEAP.

Case 4: GAIP, Ghana
The insurance was offered to 1,095 farmers and a total of 655 policies (59.8%) were sold. Demand was 63.9% at the subsidised USD4.00 per acre price, 55.6% at the actuarially fair USD7.90 per acre price, and 40.0% at the market price of USD11.90 per acre (Karlan et al., 2012).

Case 5: Kilimo Salama, Kenya
The initiative has a measurable impact on lower income farmers helping them manage the risk of loss of income. In 2009 during the pilot phase, 200 farmers were insured; by January 2012 more than 23,000 farmers had purchased the product (IFC). The actual number of insured by the end of the 2012 long rains season amounted 73,000 farmers.

Case 6: COIN-Re, Mozambique/Malawi
COIN-Re aims to start its first pilot in 2012 in time for the planting season (COIN-Re, 2011). Number of pilot farms is expected to amount to 1,250 and 5,400 during the initial years of 2012 and 2013 (Rosema, 2011). During the initial years the index will be validated with maize yields of these pilot farms which are

monitored by staff of Universal Corporation. Pilot farms are not eligible for payouts nor do they have access to additional credit. The initiative aims at an insured portfolio of USD150m (COIN-Re, 2011).

Case 7: World Bank, Malawi
In 2005, 892 groundnut farmers purchased weather-based crop insurance policies for a total premium of USD36,600. As the crop insurance contracts mitigated the weather risk associated with lending, local banks came forward to offer loans to insured farmers. The farmers used these loans to purchase certified groundnut seed. This arrangement — lending coupled with crop insurance — allowed farmers in the pilot areas to access finance that would not have been available to them otherwise. Credit, in turn, allowed them to invest in higher yield, higher return crops. In 2007, the pilot was expanded to cash crops. By 2008, the number of participants had increased significantly, with 2,600 farmers buying policies worth USD2.5m (GFDRR, 2011).

Case 8: MicroEnsure, Rwanda
As of February 2011, 935 farmers were protected by insurance. As of March 2013, 6,761 producers are covered. The project aims to provide insurance coverage to 24,000 farmers by the end of December 2013 (IFC , MicroEnsure).

Case 9: Planet Guarantee, Senegal
In the initial year 60 farmers were insured. The expected premiums in the first pilot year amounted €1,615 (Dubreuil, 2012). The state subsidises the premium by 50% (SwissRe).

Case 10: MicroEnsure, Tanzania
As of March 2012, 6,208 maize and rice farmers have been covered with weather station. The project aims to provide insurance coverage to 24,000 by the end of December 2013. The programme intends to extend cover to 400,000 farmers in the long run (IFC).

Summary
The ten analysed cases reveal that the outlook foresees rapid market uptake for both ground-based indices as well as satellite-based indices.

4 Rationale for chosen index

Analysing the rationale for the chosen index per case is not solely based on the published sources of information but is complemented with personal views of stakeholders involved. The following actors in the value chain have been consulted (Appendix I); UN institutions (WFP, IFAD), research institutes (CIRAD, IRI), input suppliers (Syngenta Foundation), data suppliers (EARS), insurers (Cardano, MicroEnsure and PlaNet Guarantee) and reinsurers (Swiss Re). Limiting supply or demand factors are described that, either temporarily or permanently, impede implementing index-based insurance in Africa, and the difference between ground-based and satellite-based products is elaborated on.

4.1 Supply issues

Four main supply criteria to opt for either ground-based or satellite-based index insurance are availability of measurement, availability of historic measurements and corresponding uncertainty, cost of measurement and upscaling potential.

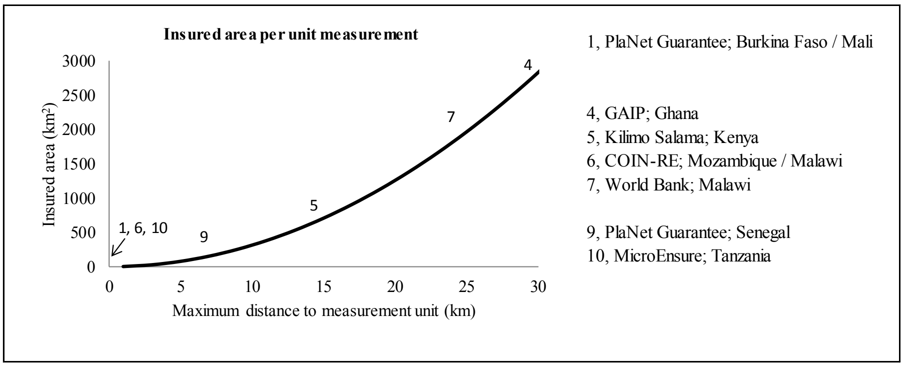
4.1.1 Availability of measurement

One barrier to implementation is the limited availability of data for the indices and thus the density of measurement. The density of measurement required depends on the risk underwritten (i.e. idiosyncratic risk versus systemic risk) and the allowed tolerance of basis risk present.

Weather stations are used as the source of information for ground-based indices. Often piloted areas are chosen because of their close proximity to existing weather stations, or otherwise rain gauges are installed. Note that a rain gauge to measure precipitation can be one of the measurements of a modular weather station locally installed, which can also include sensors to measure for example wind speed, wind direction, air temperature, relative humidity and barometric pressure. The area enclosed by these point measurements is equal to π multiplied by the radius squared. The grid used for remote sensing and thus insured area per measurement unit depends on the type of satellite used.

The analysed index-based cases differ substantially between the average distance and thus insured area (Figure 4.1). The RE data developed in the FESA project covers the entire African continent at a resolution of 3 by 3 km (Rosema et al., 2010), thus covering a maximum area of 9 km^2 per measurement unit. For ground-based indices even a stringent policy on the allowed maximum distance is far less accurate. For example, given the cases in Senegal and Rwanda with a maximum distance of 7 km and 8 km, the insured area already becomes 154 km^2 and 201 km^2. For the Malawi pilot, in which farms were only allowed to take out a policy if they were within 20 km of the weather station (Osgood et al., 2007), the insured area covers 1,257 km^2.

Figure 4.1	Insured area per unit measurement for index-based insurance



The problem of limited ground data can partly be overcome by more complex interpolation methods for several stations, but these carry with them uncertainties in the reliability of risk estimates, which are critical for the viability of index insurance products (Osgood et al., 2007). Ground data can also be merged with other sources of data, such as remote sensing data.

In summary, the availability of geographical information based on remote sensing has a higher resolution. This can be overcome for ground-based data by increasing the number of locations with measurement but this requires additional investments in more local weather stations.

The required density of weather stations is an area for further research, but one that could be undertaken with a cost-benefit analysis in mind, to estimate the value of varying densities of a data network (Osgood et al., 2007). Additional costs of a more dense network are relatively easy to estimate, although the costs of increased basis risk are more difficult to appraise. Moreover, the maximum distance to the measurement is not only constrained because of the costs of increased basis risk but also because it affects more intangible issues (e.g. trust).

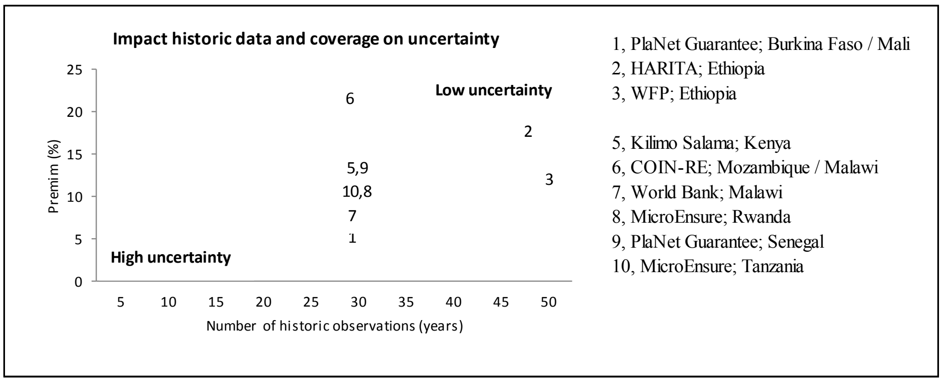
4.1.2 Availability of historic data and uncertainty

In order to design the index, long time series of relevant measurements are preferred. The advantage of satellite-based indices is that in general the length of time series is superior to ground-based recordings. Underwriting reinsurance companies require higher uncertainty loadings if the time span of relevant historic recordings are short. This is interlinked with whether the designed index is triggered frequently or not. Uncertainty loadings are relatively high for indices which are paramerised with a limited number of data to cover low frequency risks.

Note that the frequency of payouts is high from the perspective of the reinsurance market, since their core business is dealing with more catastrophic events. The reinsurance market requires no strict minimum with respect to time span. Ultimately it is up to the preference of the client (i.e., farmer and insurer) to determine the frequency of payouts since reinsurance companies are willing to also underwrite low-frequency covers with limited data.

The analysed index-based cases do not differ much with respect to the number of historic data (Figure 4.2). The RE data developed in the FESA project cover 30 years and cover the entire African continent (Rosema et al., 2010). Current marketed ground-based indices are paramerised based on 30 years up to 50 years. From the analysed ten cases one may deduct that the number of historic observations is not an issue for ground-based indices, but pilot areas are chosen because of their proximity to existing weather stations and availability of long time-series will become more often a problem in the upscaling phase. The frequency of payout ranges from once per 20 years to once per 5 years. Therefore the uncertainties are relatively low for all analysed cases.

Figure 4.2 Impact of available historic data and coverage of index-based insurance on uncertainty



Note that with respect to data, timeliness is not an issue anymore. Satellite products offer the prospect of spatially continuous information, with reliability in real-time provision (Dinku et al., 2007). Also, fully automated weather stations are currently able to distribute recordings by means of SMS-based mobile technologies. From the analysed cases, also tempering of local measurement is not a prominent issue. Currently used local weather stations often record numerous weather variables (e.g., precipitation, temperature, and humidity), so anomalies can be easily detected. If only precipitation is measured and not complemented with other weather variables this validity test is not possible.

A point of concern is the risk that local weather stations are temporarily out of order. A backup plan is essential and one has to rely on the national meteorological agency to arbitrarily complement local recordings. Geostationary meteorological satellites serve a large meteorological community and belong to the most reliable and stable satellites in the world. For Meteosat there is a permanent backup satellite in orbit. Therefore reception of the data is ensured (Rosema, 2012).

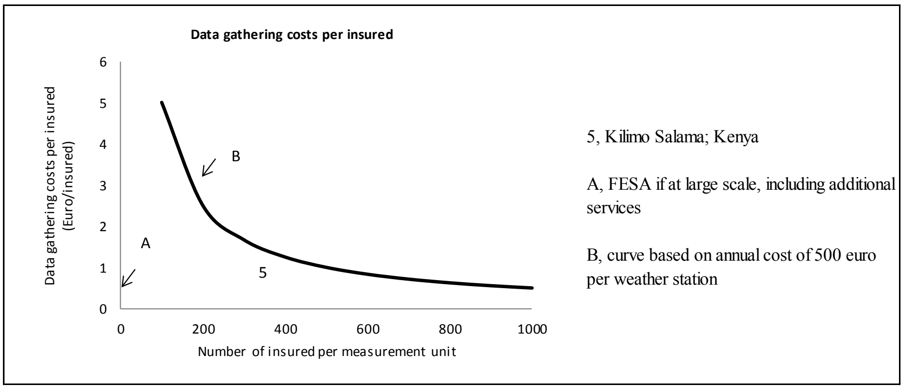
4.1.3 Cost of measurement

Station records also carry with them issues of expense. The cost of (automated) weather stations has gone down substantially the last decade. Nowadays it costs as little as €1,100 for an approved manual weather station. Data collection by an officer of the meteorological office depends on the number of sites to be visited (it amounts to approximately €1,500 per year for the case in Senegal). Besides these additional gathering costs, a manual weather station, often equipped with only a rain gauge, is also more subject to tempering. Fully automated weather stations are far more expensive but are able to distribute recordings by means of SMS-based mobile technologies. Depending on which sensors are installed (rain gauge complemented with speed, wind direction, air temperature, relative humidity and barometric pressure), the costs of a modular device range from €3,000 to €5,000. Depreciation is commonly based on an average life span of 8 to 10 years.

Remote sensing data from American satellites are freely available and can be used for operating rainfall-based or NDVI-based indices. Satellite-based RE data from EARS are not marketed as a separate module but are always bundled into an index insurance product. Current yearly costs of data collection, index development and index monitoring are expected to be less than €0.5 per covered farmer at large scale (Rosema, 2013).

The analysed index-based cases differ substantially with respect to the number of insured per measurement unit, thereby affecting the data gathering costs per insured (Figure 4.3). Data costs are for example low in the Kilimo Salama scheme in Kenya since the product is marketed in densely farmed communities (with a maximum of 500 smallholders). On the other hand pilot schemes with a limited number of insured farmers carry high transactions costs. To break even, the density argument is a serious one to consider.

Figure 4.3 **Data gathering costs of index-based insurance**



4.1.4 Upscaling possibilities

Most initial feasibility and pre-feasibility projects are donor-funded pilot projects. The ultimate objective is that the market develops itself into a sustainable and mature weather market with a diversified geographical portfolio. A mature weather market is characterised with exchange-traded standard contracts, free online data dissemination, online weather insurance contracts and mobile phone use for notification and settlement (Balzer and Hess, 2010). The intermediate phase is the scale-up phase with insurance capacity building.

The analysed schemes range from prefeasibility schemes (i.e., COIN-Re), feasibility schemes with a limited number of insured with a limited number of years of experience, and upscaling schemes. To go beyond the pilot phase into the scale-up phase raises the questions what kind of information is to be used for more wide-scale products. For ground-based indices problems arise with respect to poor quality of local data, inconsistent data and the need for historical data which are often absent (these shortcomings also often hold for meteorological offices). On the other hand, remote sensing data are available at high resolution for the African continent and can be used for rainfall-based or NDVI-based indices. The same holds for RE data developed in the FESA project. Thus remote sensing based insurance can truly reach every farmer (Rosema, 2012).

Some of the schemes use satellite data, to complement data from weather stations and national weather data (e.g., MicroEnsure in Tanzania). But after a few years with experience, they can start doing calculations with the local weather station data and switch to ground-based indices in those areas. However, offering the product in other areas would imply starting this procedure over again. Other insurers might switch from ground-data indices to satellite-based indices at the time of up-scaling. For example PlaNet Guarantee will maybe switch in Senegal, and market RE-based indices in Mali and Burkina Faso because the number of insured per measurement unit is low.

4.2 Demand issues

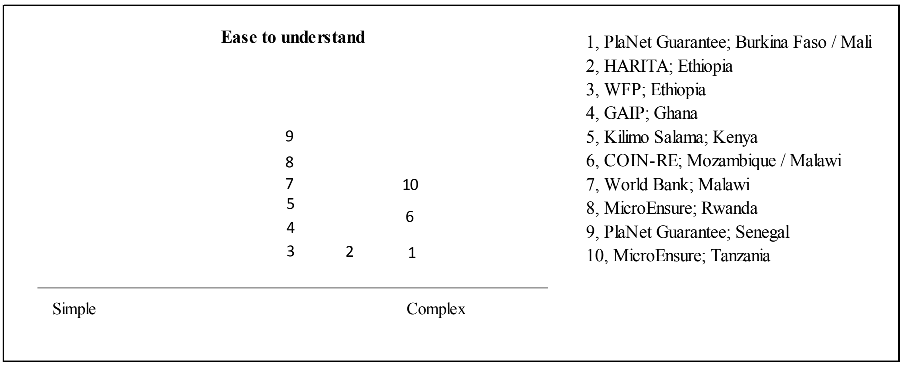
One can argue that market supply issues are less of a concern relative to demand issues. Two main demand criteria to opt for either ground-based or satellite-based index insurance are easy to understand by customers and trust in the index product purchased.

4.2.1 Ease to understand

Clients expect that yield losses are eligible for compensation as is the case for traditional indemnity-based insurance. However, when index-based products are being sold to small households, it is possible that the household will experience a loss and not receive a payment or they may receive a payment when they do not have a loss (i.e., basis risk exists). Therefore, the concept of an index is more difficult to be marketed since the client (often smallholders) should be aware of characteristics of the financial product he or she is purchasing.

Ground-based indices based on rain gauges are more tangible than satellite-based indices. Since evapotranspiration is hardly measured on the ground, this index is not yet well known as a potential agricultural drought indicator (Rosema, 2012). Explaining the complex satellite technologies and the components of the RE algorithm to clients in Africa is a challenge (Figure 4.4). The essence is that smallholders understand the advantage of using evapotranspiration rather than using solely rainfall. Explaining the use of satellite-based recordings for RE is in principle not different than explaining satellite-based recordings for rainfall.

Figure 4.4 **Ease to understand index-based insurance**



The experience of MicroEnsure is that farmers usually do not understand satellite data, but they can understand weather stations. In Kenya these are called 'truth tellers'. It is felt that the index cannot be explained to the client other than by referring to the weather station that can be touched. Also Syngenta Foundation and PlaNet Guarantee experience that explaining to the client how RE index works is difficult, while rainfall is much easier to understand.

For some of the insurers the issue of the complexity of satellite-based indices is a major and permanent limiting factor, and is a principle hurdle that cannot be taken. Another permanent limiting factor is that some insurers prefer a locally collected, designed and renewed index rather than relying on non-local stakeholders.

4.2.2 Trust and coverage

Trust in the solvency of the insurance company and its offered coverage is particularly important in the context of insurance. The policy holder relies on the insurance company to honour the contract of a payout in case the index is triggered (Cole et al., 2012).

Specifically with respect to claim settlement, the verification possibilities differ between the RE index versus the other used indices. Besides company adjustors, also independent adjustment agencies can settle the other index-based claims. The insured as well as the insurer or re-insurer have a relatively easy option to rely on third party verification in case of a dispute. For example, national and international meteorological offices can verify claims with respect to ground-based rainfall indices. Also, many institutes in the field of remote sensing can verify claims with respect to NDVI or satellite-based rainfall indices (under the condition that the algorithm used is publically available). A disadvantage is that the EARS company is the only party that reports the RE data since the RE algorithm is not publically available. However, what matters mainly is the reproducibility of the RE data, which could be verified by an expert visitor.

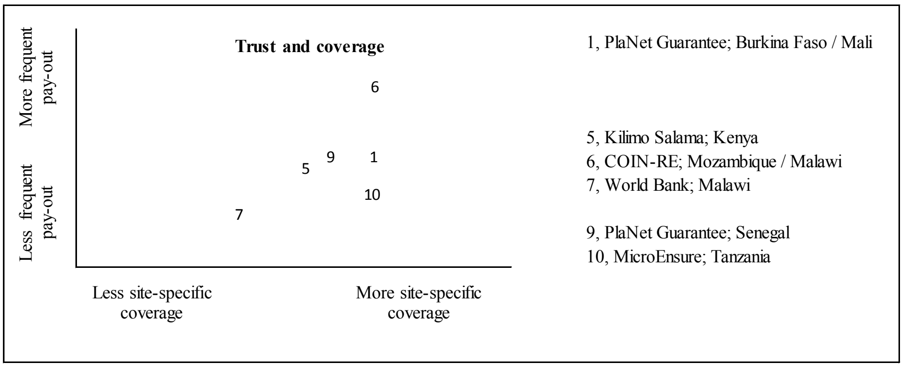
A more general challenge with index-based products is the inherent basis risk. Given that index-based insurance is a relatively new product, trust in the offered cover may be an important determinant of participation in insurance markets (Cole et al., 2012). A high correlation between weather index shortfalls and crop yield shortfalls is an important precondition for introducing a successful weather-based index insurance to reduce farmers' crop yield risk. The ultimate goal is to model yield and more specific shortfalls. Variation in basis risk may exist between ground-based and satellite-based products. An advantage is that the examples of RE indices have shown to be as good as or even more accurate than crop growth predictors based on traditional rain gauges (Rosema, 2010) since it takes into account run-off and ground water storage. A bias might be introduced because of intercropping and the natural vegetation (i.e., trees), affecting the evapotranspiration measured by the satellite. However, this is only a concern if natural vegetation is altered over time.

A discrepancy for all index products is that the variable used to drive the index may not accurately reflect the measure of the index variable at the farm site (i.e, spatial basis risk). A more spatially refined index with site-specific triggers can address this problem adequately.

Besides basis risk also the frequency of payouts affects trust in the product by the clients. One of the lessons learned is that farmers in Africa prefer an insurance product with more frequent payouts, even if it is more expensive (Qureshi and Reinhard, 2012). Frequent and early payouts contribute significantly to educating farmers about the product, meeting their expectations of it, and building trust by helping them recover as fast as possible (Qureshi and Reinhard, 2012).

The analysed index-based cases differ substantially between the availability of site-specific coverage and the frequency of payouts (Figure 4.5). Some indices use one rain gauge to cover a large region while others are specially designed at village level. The frequency of payout ranges from once per 20 years to once per five years. Note that although some indices are more site-specific, the cover is still not as farm-specific as traditional indemnity-based insurance.

Figure 4.5 Coverage of index-based insurance



Satellite-based indices can easily accommodate a more site-specific approach since primary data are measured at a dense resolution, while for the ground-based index approach this would require a dense network of rain gauges and will hamper upscaling possibilities. Ultimately, it should be up to the client how refined the index is designed.[1]

[1] The level of risk-based transfer is an issue that holds for all index-based products. In a more 'agronomical approach' payouts are more frequent in more riskier zones (e.g. more drought-prone). As a result premiums are also differentiated. Given a 'percentile approach', triggers can be site-specific but the probability of pay-outs is equal for all zones. This implies that even with insurance the risk prone zones remain less protected. The 'percentile approach' is not as precise as the 'agronomical approach' from the viewpoint of the client but is sometimes preferred by the insurance provider since it reduces the administrative burden.

5 Conclusion and discussion

5.1 Conclusion RE indices

In this market outlook study the main competitive advantages of satellite-based micro-insurance in comparison with other index-based micro-insurance are identified. The main empirical results deduced from market products are synthesised in Table 5.1.

Competitive advantages of using remote sensing technology in Africa mainly originate from supply opportunities. Limited availability of historic local data together with their limited resolution impedes implementing ground-based index insurance in Africa. Both are temporarily limiting supply factors from a technical point of view. Insurers can install a dense network of local weather stations but bottlenecks are foreseen during the scaling-up phase. Scaling-up is crucial for keeping costs under control, and remote sensing technologies can improve efficiency with limited investment (Qureshi and Reinhard, 2012). Satellite-based indices represent a major breakthrough towards affordable crop insurance.

Table 5.1 Limiting factors for implementing index-based insurance in Africa

Case name	Ground-based	Satellite-based
Supply issues		
Availability of historic data	• 1/•••	•
Grid size of measurement	• 1/•••	•
Cost of measurement	•• 2/•••	•
Up-scaling possibilities	•• 2/•••	•
Demand issues		
Ease to understand	•	••
Trust	•	••

• No limiting factor, •• somewhat limiting factor, ••• limiting factor. 1 Under the condition that pilot areas are chosen because of their close proximity of existing weather stations. 2 Under the condition of many farmers / intense farm production per village or region.

Despite distinct advantages of satellites, there is a need to consider each context carefully. Main bottlenecks of using remote sensing techniques originate from demand issues. For some of the insurers the issue of the complexity of satellite-based indices is a major and permanent limiting factor. It is felt that a remote sensing index cannot be explained adequately to the client, while with respect to rainfall indices one can easily refer to the locally installed weather station. Another permanent limiting factor is that some insurers prefer a locally collected, designed and renewed index rather than relying on non-local stakeholders.

5.2 Discussion of RE indices

Three main issues with respect to RE of EARS are identified and focus on validation, services provided and design.

To demonstrate the comparative advantage for specific satellite-based indices further scientific validation is essential. Validation encompasses remote sensing data, ground-based rainfall data as well as crop yield assessment. Validation should be conducted in several regions in Africa (such the WFP and IFAD programme in Senegal, which is a project under the WFP-IFAD Weather Risk Management Facility (WRMF)). By means of cross-checking the advantages and limitations of RE data can be quantified.

The strength of EARS is the value added FESA service. FESA comprises a bundle of services including data collection, index development and index monitoring (Rosema, 2013). For some segments of the insurance market this is a preferred option. Large-scale insurance companies with a geographically diversified portfolio might prefer specific elements of the bundle since they are less inclined to outsource their core business activity. From obtained RE data they can design the indices themselves for each location. Therefore a more flexible bundle will better address the needs of the client (i.e. insurance company or broker).

One of the greatest challenges related to ground-based approaches is to calibrate the index. Up scaling requires adding rain gauges to the existing network of rainfall stations. To calibrate a site-specific drought index requires a long precipitation history, which is not available. The quality of historical ground-data can be enhanced through cleaning, filling and data interpolation to create synthetic historical data surfaces (MicroEnsure, 2013). However, generated synthetic data to represent the authentic data are only approximations and are thus not as accurate as actual recordings. Some of the schemes use satellite data, to complement data from local weather stations and national weather data. So in some cases RE data might be used to assist a ground-based design. Note that an indirect approach of creating synthetic data is not required since the RE data developed in the FESA project cover 30 years of actual remote sensing recording at 3 km resolution for any location on the African continent.

Many indices were launched only recently, and it is too early to judge their success. As a result there is a large evidence gap on the impact of index-based insurance (Cole et al., 2012). However, many schemes show promise and, although not yet at full scale, are providing valuable lessons for the future (Balzer and Hess, 2010). Up till now research focused on design and piloting index-based weather insurance. To become a meaningful market one should focus on creating value for the insured. Insurance should be part of a bundle of related services that cover broader agricultural development (Balzer and Hess, 2010). For example, linking of credit and insurance potentially offers important advantages. In general, if insurance provision is planned where credit operations are present, linking these contracts will be beneficial to the sustainability of the credit schemes and will improve access to credit by smallholders.

The market outlook for satellite-based micro-insurance and thus also for RE indices are positive and can be turned into a (financially) sustainable activity. However, it is too early to determine which specific technology will prevail. A one-size-fits-all approach is moreover not expected since specific remote sensing technologies and indices might work under some conditions, while ground-based indices are preferred under other conditions.

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Appendix 1

Consulted experts

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Dubreuil, M., PlaNet Guarantee.
Goslinga, R., Syngenta Foundation.
Gosselink, F., Cardano.
Hess, U, MicroEnsure.
Lynch, R., MicroEnsure.
Muller, B., CIRAD.
Osgood, D., IRI.
Rosema, A., EARS.
Souleymane, A., PlaNet Guarantee.
Stoppa, A., Consultant.
Ulardic, C., Swiss Re.
Weber, S., PlaNet Guarantee.

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