The International Finance Corporation
The World Bank Group

# Private Sector Investment to Build Climate Resilience in Niger's Agricultural Sector: Agricultural Insurance Market Assessment

## Final Report

For public release

March 2013

Submitted by

RMSI
A-8, Sector 16
Noida 201301, INDIA
Tel: +91-120-251-1102, 2101
Fax: +91-120-251-1109, 0963
www.rmsi.com
Contact: Uttam Singh, Senior Technical Specialist
Email: Uttam.Singh@rmsi.com

NB: Names of institutions, companies, projects and products in the report have been replaced with letters e.g. Company A, B, C or Product 1, 2 3 in order to maintain confidentiality of entities, projects and products involved.

For the attention of:

Wambui Wairimu Chege
Task Team Lead
International Finance Corporation
14 Fricker Road, Illovo, 2196
Johannesburg, South Africa
Email: WChege@ifc.org

Anthony Mills
Task Team Lead
International Finance Corporation
14 Fricker Road, Illovo, 2196
Johannesburg, South Africa
Email: amills@ifc.org

# Preface

The IFC (International Finance Corporation) Advisory Services in Africa as part of the pre-implementation phase of the "*Private Sector Investment to Build Climate Resilience in Niger's Agricultural Sector"* has undertaken three investment projects with the financial support of Strategic Climate Fund (SCF) under the PPCR program for Niger. The PPCR focuses on piloting interventions in developing countries for managing climate-induced risks and building climate resilient agriculture.

The PPCR is structured into two phases. Phase 1 will support the preparation of a Strategic Program for Climate Resilience (SPCR), which aims to integrate climate resilience into national priority development plans, budgets and investments. Phase 2 will focus on the implementation of the SPCR, specifically on programmatic support, investment in priority sectors, and support to on-the-ground adaptation activities identified during Phase 1.

In the context of the Niger SPCR, the following three investment projects have been identified by the government, multilateral development banks, and other stakeholders:

- Project for the Mobilization and Development of Water Resources (PROMOVARE), led by the African Development Bank.
- Climate Information Development and Forecasting Project (PDIPC), led by African Development Bank.
- Community Action Project for Climate Resilience (PACRC), led by the World Bank.

IFC is responsible for sub-components of the above projects that focus on engaging the private sector in the PPCR and catalyzing investment in climate change adaptation activities. For Niger, increased climate resilience and improved food security are closely interlinked. Unless adaptation measures are put in place, climate change is likely to increase the risk of famine and social collapse. Towards building climate resilience in Niger's agricultural sector through mobilizing private sector, investigations in three areas through engaging consultant was taken up in the below mentioned areas.

1. Increasing the use of improved irrigation systems and introducing climate resilient seeds to farmers;
2. Creating a climate information platform for agricultural producers and other stakeholders such as insurance providers; and
3. Developing insurance products suitable for SMEs active in the agricultural sector with opportunity to extend insurance benefits to small-scale farmers and livestock holders.

The present study pertains to point 3 above and focuses on the development of weather index based insurance for crops and livestock in Niger. Such insurance will increase the resilience of the agricultural sector (including small-scale farmers and livestock holders) to climate change impacts.

This study analyzes the feasibility of weather index based insurance in Niger and provides recommendations for the development of sustainable market interventions for the agricultural sector in Niger. The study also involves conducting a needs assessment and the feasibility of introducing the required crop insurance products in the country.

# Acknowledgements

RMSI and ACTUARIA would like to acknowledge and sincerely thank the Honorable Minister of Planning Dr. Amadou Boubacar Cisse for taking out time and initiating the project discussions with various stakeholders and the project team. We also thank the Ministry of Agriculture and Ministry of Planning, Niger for providing support and introducing the project team to various public and private stakeholders. We appreciate the effort of Mr. Dan Bakoye Chaibou, the country focal point of this study, who has extended his supported and facilitated meetings with various stakeholders during the country mission for the stakeholder consultation and data collection. We also thank Mr. Abdou Noma, Director of Insurance Control at the Ministry of Finance and Mr. Djibrilla Balo of the Insurers' Committee for providing information about the insurance sector in Niger and introducing us to the insurance companies in the country.

Special gratitude is extended to various government departments particularly the Agriculture Department, Meteorology Department, Chamber of Commerce, Livestock Department, INRAN, ONAHA, various financial institutions, insurance companies, insurance brokers, farmer's cooperatives, NGOs, and agri-business organizations in Niger for sharing information to execute this study. The farmers, who met team met in the six regions and took out time to provide information during the questionnaire survey, also deserve appreciation.

We are grateful to Mr. Anthony Mills and Ms. Glwadys Gbetibouo, for providing their valuable advice and comments during all the stages of the project. We also appreciate the colleagues of IFC Africa office who were involved in the discussions during the finalization of our recommendations of the study.

The following team of IFC staff and consultants was involved in preparing this report.

- IFC: Mr. Anthony Mills (Task Team Lead and technical expert) and Ms. Glwadys Gbetibouo (technical expert), Noleen Dube (ex-IFC Task Team Lead), Wambui Wairimu Chege(Task Team Lead) and Russell Sturm (Technical Expert)
- RMSI: Dr. Uttam Singh (Team Leader and Agro-metrological expert), Dr. Muralikrishna, (Project Manager and Social Science Expert), Dr. Abdellatif Khattabi (Agro economist), Mr. Saidou Amadou Moussa (Field support), Mr. Tapas Roy (Data Analyst), Ms. Minal Swant (Vulnerability Expert) and Upamanyu Mahadevan (Technical Editor).
- ACTUARIA: Denis Chemillier-Gendreau (Actuarial science expert) and Alexandre Foulon (Insurance and Finance expert)

The principal authors of this report are Dr. Uttam Singh, Mr. Alexandre Foulon and Dr. Muralikrishna.

# Table of Contents

# List of Figures

# List of Tables

# Acronyms Used

| | |
|---|---|
| ARSM | Agence de Régulation du secteur de la micro-finance |
| AWS | Automatic Weather Stations |
| CCA | Cellule Crise Alimentaire |
| CILSS | Interstate committee of Struggle against drought in Sahel |
| CIMA | Conférence Inter-africaine des Marchés d'Assurance |
| CNEDD | Conseil National de l'Environnement pour un Développement Durable |
| CRCA | *Commission Régionale de Contrôle des Assurances* |
| DFI | Decentralized Finance Institutions |
| DMN | National Directorate of Meteorology |
| EIA | Equity Insurance Agency |
| ENSO | El Nino Southern Oscillation |
| EVI | Enhanced Vegetation Index |
| FANAF | Fédération des sociétés d'assurances de droit national africaines |
| FSD | Financial Sector Deepening Trust" |
| GIIF | Global Index Insurance Facility |
| HARITA | Horn of Africa Transfer for Adaptation |
| HSNP | Hunger Safety Net Program |
| IAM | Insurance Association of Malawi |
| ILRI | International Livestock Research Institute |
| INRAN | National Agronomic Research Institute |
| IPCC | Intergovernmental Panel on Climate Change |
| IRR | Internal Rate of Return |
| LEAP | Livelihood, Early Assessment, Protection |
| LRLDS | Long Rain Long Dry Season |
| MDR | Mean Damage Ratio |
| MPCI | Multi-Peril Crop Insurance |
| NASFAM | National Association of Small Farmers |
| NDVI | Normalized Difference Vegetation Index |
| NISCO | Nyala Insurance Share Company |
| ONAHA | Irrigation and water resources management |
| PACRC | Community Action Project for Climate Resilience |
| PDIPC | Climate Information Development and Forecasting Project |
| PPCR | Pilot Program for Climate Resilience |
| PPP | Public-Private Partnership |
| PROMOVARE | Project for the Mobilization and Development of Water Resources |
| PSNP | Protection Safety Net Program |
| RECA | National network of agricultural chambers |
| RGAC | Recensement General de L'Agriculture et du Cheptel |
| RP | Return Period |
| RWS | Reference Weather Station |
| SAP | Systèmed' Alerte Précoce |
| SCF | Strategic Climate Fund |
| SPCR | Strategic Program for Climate Resilience |
| SPI | Standard Precipitation Index |
| SRSDS | Short Rain Short Dry Season |
| TLU | Tropical Livestock Unit |
| UMOA | Union Monétaire Ouest-Africaine |
| UNFCCC | United Nations Framework Convention on Climate Change |

| | |
|---|---|
| WICI | Weather Index Crop Insurance |
| WII | Weather based index insurance |
| WSVI | Water Supplying Vegetation Index |

# 1 Executive Summary

Niger is highly vulnerable to climate induced hazards particularly the drought hazard. The drought hazard impact the agriculture sector, which affects the livelihood and food security of the country and in-turn curbs the development of the country. The IFC Advisory Services of Africa, under the Niger Pilot Program for Climate Resilience (PPCR), through this study want to assess the market potential for agriculture insurance as a safety net against the climate change induced risk for the farmer's livelihood. Thus, the study explores the possibility of building climate resilience in Niger's agricultural sector through facilitating private sector investment. The study also explores the potentials of developing insurance products suitable for SMEs active in the agricultural sector with opportunities to extend insurance benefits to small-scale farmers and livestock holders to increase climate resilient agricultural practices.

The study carried out in-depth examination and assessment in the following areas:

- Assessment of hazard and vulnerability for agriculture sector
- Assessment of existing agricultural insurance products
- Assessment of existing and potential users/buyers of agricultural insurance products
- Review of global best practices of weather index-based insurance for the agricultural sector to identify the products most relevant to Niger
- Assessment of existing agricultural and climate data in Niger
- Recommendations on potential insurance business model options for introducing and implementation in Niger.

The whole exercise was carried out in consultation with various stakeholders. The study resorted to farming community field surveys, in-country data collection, and analyses to assess climate induced agricultural risks, suitability and market potential of agricultural insurance products to safeguard the farmers against the climate induced crop losses along with examining and determining appropriate business model options for launching and implementing agriculture insurance in the country.

The key findings and recommendations of the study are summarized below:

- Niger is highly vulnerable to climate change induced hazards, particularly due to drought. Most regions of the country are likely to face minor drought conditions once in a 3 to 10 year period, and moderate drought conditions once in a 6 to 10 year period. Large parts of Maradi, Tahoua, and Tillaberi are likely to face severe drought conditions once in an 11 to 15 year period. Probability of severe drought affecting majority of Niger is once in 21 to 25 years and extreme drought once in 26 to 30 years. As the main hazard is drought, product based on index based on water availability/deficiency is appropriate for Niger.

- In terms of data required for developing WII product, Niger has reasonably good weather data. The country has 15 meteorological stations and 154 rain-gauge stations distributed mostly in the inhabited southern part of the country. Weather data for the country is available for the last 30 years. Crop data of major crops are available for the last 17 years with missing values for some years. There is a lack of livestock mortality data in the country. Satellite data is a good proxy for meteorological data and can be used to build WII index. However, AWS data is the most accurate one and 75 AWS are required to develop a reasonably good density of weather station across the country and will cost USD 900,000. Agronomic data prior to 1995 available in Niger should be collected in order to refine agronomic data and reduce basis risk. For livestock insurance, NDVI method explored in Kenya is an

option that can be tried in Niger. However, it needs in-depth survey focusing on one or two districts to understand the mortality rate at households' level and causes to set the premium and pilot it at district level as the country lack production and mortality statistics.

- The vulnerability analysis for key crops shows cowpea is the most vulnerable crop to water deficit followed by sorghum, peanut, and onion while millet is the least vulnerable to water deficit condition.
- There is a low penetration of banks in rural Niger as financing agriculture sector is not seen as very lucrative. Farmers do not have land titles or financial capacity to give collateral or credit guarantees, which restrain credit in the sector. Niger does not have any agricultural insurance product. There are four companies in Niger working mainly in the general insurance sector and relying on a captive market made of legally compulsory insurance products. Two of them, Company M and Company L, appear to be promising potential players. The recent developments in Niger and West African region represent an opportunity to launch WII schemes in the entire CIMA region, which was forbidden until April 2012.
- Farmers have heard about insurance mechanisms and are interested to avail it to protect from major losses due to drought. The awareness among farmers is low though. Even though the farmers are willing to pay for the insurance the financial capacity of farmers are low.
- The premium considered per hectare is USD 25 (FCFA 12,500). The premium for millet would be lowest, USD 9, sorghum USD 16, cowpea USD 19, and peanut USD 54 per annum. Rough calculations (PML/AAL, etc.) show evidence there is a strong need for reinsurance to transfer excess loss that will not be able to be retained at insurers' level. WII should pilot either in Maradi or Zinder based on hazard and vulnerability crops that can be included in the pilot would be sorghum, cowpea and peanut. A detailed actuarial study using long-term crop data to calibrate the premium must be launched. It will need constant revisions based on additional data obtained each year from the farmers' field.
- It is essential to develop awareness and training for insurance companies in Niger. Ideally, a coinsurance pool, gathering the most proactive insurers on WII, should be created to underwrite premiums, and share risks and benefits of insurance among the active players in the country. Pooling risks, while isolating agricultural insurance from other insurance businesses already underwritten by these insurance companies, is a strong motivation as it prevents this product from jeopardizing the insurers' other activities. Company L and Company M expressed their interest and have consistent technical partners (respectively Company O and Company N) to discuss the operational implementation of WII. These entities will be best suited to help them express their needs and handle the issues of WII. Reinsurers have to play a leading role on the market and provide the technical skills to launch WII.
- DFI has a good presence in the rural Niger can play a key role in the distribution of WII in the country. Company E and Company F, which are the two main DFIs in Niger, are believed to be the main willing institutions to distribute WII products. Bundling credit and insurance has an option, which is successful in many countries. Along with this alternative distribution channels like input providers, aggregators and cooperatives are also options.

# 2 Objectives and Study Area

Niger is a Sahelian country with three quarters of its territory being desert. Recurrent droughts, soil erosion, and increasing population have caused a loss of vegetative cover resulting in loss of fertility of agricultural land. A large portion of Niger's population depends on rain-fed agriculture for food and livelihood.

The regional climate models predict that the impact of climate change is going to be strongly felt in Niger in the coming decades with increased intensity and frequency of droughts and floods. The country has experienced seven droughts in the last 40 years, leaving it extremely vulnerable to the effects of hydro meteorological hazards and climate change. Historical disaster data shows an increasing trend, both in the frequency and intensity of these events. Development agencies are working towards strategies to control and/or reduce the problems associated with climate change and to ensure that the society itself does not contribute to aggravating the problem.

The objective of this study is to build climate resilience in Niger's agricultural sector by facilitating private sector investment. The selected investments will enhance the agriculture sector's adaptive capacity and contribute to food security in Niger despite an increase in the frequency and intensity of climate change-induced hazards through development of insurance products suitable for SMEs active in the agricultural sector with opportunities to extend insurance benefits to small-scale farmers and livestock holders.

To achieve the objectives of the study the following tasks are being carried out:

1. Assessment of existing agriculture insurance products in Niger, which includes assessment of the awareness and planning regarding climate change in the insurance sector, cataloging of all types of agri-insurance products currently available (government or commercial) along with associated market coverage, growth potential, advantages and disadvantages, the extent of climate risk cover offered, and the leading players and partners and their associated constraints
2. Assessment of existing and potential users/buyers of agricultural insurance products in Niger in terms of their typology, drivers/needs for risk transfer, risk they normally seek coverage for, average cost of the insurance products, the channels available for purchasing insurance products and their preferences, benefits in terms of claims received, buyers' satisfaction levels, and their willingness and capacity for better and more robust insurance cover
3. Review of global best practices in index-based insurance for the agricultural sector to identify the products most relevant to Niger
4. Assessment of existing agricultural and climate data in Niger, finding the gaps and estimating investment needs to generate appropriate data needed for development of commercially viable index based products
5. Recommendations on potential insurance business model options for implementation in suitable regions and specific crops and livestock in Niger based on the role of PPP stakeholders, and the agricultural sector's risk and vulnerability to climate change impact.

The study area considered is the entire country. However, considering the intensity of agriculture activities, availability of weather data, and potential takers of any insurance products, the focus was on seven regions of Niger namely – Niamey (C.U.N), Talibery, Dosso, Tohoua, Maradi, Zinder, and Diffa.

# 3 Methodology

## 3.1 Identification of Data Elements

As a first task of data collection, the team has identified the secondary data sources (key government departments and other organizations) for the collection of various data required. In addition to this, primary data has also been collected through questionnaire surveys among farm communities.

To assess agricultural insurance products, one essential task includes developing an understanding of the risks associated with climate hazards in Niger. For this, historical weather data (monthly level, temperature, rainfall, solar radiation, wind speed and relative humidity) of the country has been collected and analyzed. Exposure elements considered here are crops and livestock.

The crop statistics at regional level have been analyzed to identify the major crops for each region. Two staple crops, two cereals, and two cash crops have been identified along with fodder crops in each region. Historical and spatial distribution of these identified crops, both in terms of acreage and productivity, have then been analyzed to assess the trend and yield over time and across the region.

Information of government relief and credit protection available to farming communities, the financial and strategies of financial institutions like national banks, micro finance institutions and DFIs were also collected. Information related to available products, level of penetration, constraints of marketing has also been collected from all existing agriculture insurance companies in Niger.

Information on crops, production yields, use of modern technologies, access to credit and insurance, risk experience, etc. have been collected at the farm level through a questionnaire survey. Additional information on awareness on technology, access to training, perception to modern irrigation, climate resilient seeds, and insurance have also been collected. This primary field level information has been used to complement the analysis of secondary data collected.

The information related to existing policies on agriculture, livestock, and seed as well as information on other key initiatives in this sector have been collected as learnings from such development projects. These are important to build synergy with ongoing projects.

## 3.2 Information Collection and Compilation

### 3.2.1 Literature Review and Data Collection

Literature on agriculture in Niger and weather based insurance in Africa and elsewhere available in the public domain have been collected. This exercise provides first level information on agriculture activities in Niger, and the best practices and experiences of weather index-based insurance and their applicability in Niger. The team carried out a country visit to meet the key stakeholders for discussions and information gathering. The country focal point facilitated the meetings with the key stakeholders. Meetings were conducted among key government departments supporting agricultural operations, financial institutions (banks, micro finance and DFIs), farmer's cooperatives and federations, NGOs, and major private agri businesses in the country. Information was collected using guiding questions. Published quantitative data related to agriculture, risk protection, financial credits programs of banks and other financial institutions and hazard relief program of the government, were collected from the stakeholders.

During the country visit and interaction with various stakeholders, data was collected from various departments and organizations. The key data collected and its sources are summarized in Section 9.1 Annexure 1: Additional Support Information.

National level policy documents, reports on agriculture development projects implemented in Niger, and information on business strategies and investment interests of private players in the agri-businesses were also collected.

### 3.2.2 Questionnaire Survey among Farming Communities

A questionnaire survey was conducted among 180 farmers (see sample questionnaire Section 0 9.2 Annexure 2: Questionnaire for farming community and guiding questions). The farmers were randomly selected in the Sahelian agro climatic zones of Niger where 80% of agriculture activities of the country takes place. The four livelihood zones selected for the survey are zones 3, 4, 5, and 6[1]. The districts considered in these zones were Niamay, Tillabery, Dosso, Tohoua, Maradi, Zinder, and Diffa. As livelihood zones are geographic areas in which households share, on average, similar livelihood patterns, or generally have access to the same set of food and cash income sources and markets, these zones can be considered as homogenous region. Furthermore, in every Nigerien livelihood zone, a combination of cereals, roots and tubers, and dates are grown. In each district, 30 samples were administrated at three different locations with a total of 180 questionnaires.

While selecting farming communities within each district, the following criteria were used:

- Presence of irrigation and livestock farming to complement the deficits of rain-fed agriculture in a changing climate
- Presence of private investments and insurance services to support irrigation
- Priority sites of Niger Government and funding agencies.

The uniqueness within districts are:

- Diffa: near the Lac Chad. Area where climate change challenges emerging irrigation opportunities (fertile land, ground water) can be observed
- Zinder: Area facing water scarcity issues
- Maradi: Area facing food insecurity challenge and relatively densely populated
- Dosso: Area where Niger Government is promoting irrigation. Lots of investments have been made
- Niamey: Cases on irrigation and group farming
- Tahoua: District has relatively better water resources. Niger Government encourage Tahoua population to do irrigation and invest in it. Many funding agencies are also intervening in Tahoua to promote irrigation

Three sites in each district were selected. A combination of household farmers, group farmers, women's groups, and commercial farming were included in the sample. After data entry, 10% of the questionnaires were picked and quality checked to ensure data quality.

## 3.3 Data Analysis and Validation

Statistical and GIS techniques were used for assessing the agricultural insurance market. Hazard and risk mapping was carried out using weather data. This forms the basis of risk assessment and assessment for investments required for developing good weather data for developing insurance products, and for identifying the most suitable Weather Index-based Insurance (WII) product relevant to Niger.

[1] USAID 2011, Livelihoods zoning "Plus" Activity in Niger: A Special Report by the Famine early Warning System Network (FEWS NET).

Necessary data validations were made to ensure data quality before analysis. Validations include analyzing anomalous data; for instance weather data of a month with very high values being compared to other months and years. Before eliminating or fixing this data, it was cross checked with figures from other sources. The crop data was summarized at the regional level and dominant crops where identified on the basis of area and production.

Quality checks were also performed on survey data in addition to supervision of data collection during survey. A 10% of the questionnaire were verified after the data entry to ensure data quality.

The methodological steps involved in hazard and risk analysis are elaborated in the subsequent section.

### 3.3.1 Hazard Analysis

The assessment of the drought hazard requires quantification of its severity by using some standard index. The Standard Precipitation Index (SPI) has been adopted for this study as the drought hazard index. The primary reason for selecting this index is that it is computed based on rainfall data only. The index is detailed along with its potential advantages below.

SPI computation for a specific time scale and location requires long-term daily time series precipitation records (ideally for 30 years or more). The long-term record is fitted to a gamma probability distribution as the gamma distribution has been found to fit the precipitation distribution quite well. This is done through a process of maximum likelihood estimation of the gamma distribution parameters, α (shape parameter) and β (scale parameter). Subsequently, it is then transformed into a standard normal distribution, which, by definition, has zero mean and unit variance[2]. Positive SPI values indicate greater than mean rainfall, while negative values indicate less than mean rainfall. Because SPI is normalized, wetter and drier climates can be represented in the same way, and wet periods can be monitored using SPI. The computational methodology of SPI is given in Section 9.4 Annexure 4: Standardized Precipitation Index.

The advantage of this index is that it facilitates comparison of different stations in different climatic regions regardless of the fact that they may have different normal rainfalls. Therefore, two areas with different rainfall characteristics can be compared in terms of how badly they are experiencing drought conditions. In addition, SPI can be computed for rainfall totals of different time scales, namely, seasonal, monthly, and phenophase level rainfall totals. In the present study, SPI has been computed based on seasonal cumulative rainfall values (June-October). Table 3-1 shows how various drought, normal, and wet conditions are categorized based on SPI ranges.

**Table 3-1: Categorization of drought, normal and wet conditions based on SPI**

| Drought Classification | SPI Range |
|---|---|
| **Extreme Drought** | < -2.0 |
| **Severe Drought** | -2.0 to -1.5 |
| **Moderate Drought** | -1.5 to -1.0 |
| **Minor Drought** | -1.0 to -0.5 |
| **Normal** | -0.5 to 0.5 |
| **Wet Conditions** | > 0.5 |

[2] Edwards, D. C. and T. B. McKee, 1997. Characteristics of 20th Century drought in the United States at multiple time scales. Climatology Report Number 97-2, Colorado State University, Fort Collins, Colorado

Drought return period (extreme, severe, moderate, and minor) maps were prepared by using the SPI ranges given in Table 3-1. For example, for minor drought return period, frequency of drought years having SPI value between -1.0 and -0.5 has been calculated and the return period map was generated. Likewise, drought return period maps for moderate, severe, and extreme droughts were generated.

### 3.3.2 Vulnerability Analysis

This section details the steps followed as part of drought vulnerability analysis in the study area. Modeling vulnerability of a system to natural hazards involves establishing a relationship between the potential damageability of critical exposure elements to different levels of hazard. The hazard and exposure modules enable the determination of vulnerability or susceptibility of the elements of the asset(s) to the hazard. The degree of rainfall deficiency represents the drought intensity or hazard, the magnitude of loss in crop production represents the potential damageability to crop.

The present study adopts the statistical regression approach, as it is easy to develop and validate, is less data intensive, less tedious, and is less time consuming. In this approach observed crop production losses are correlated with adverse weather parameters, the approach being guided by a prior expert knowledge on the crop response in such situations. The data prerequisites are as follows:

Long-term daily time series precipitation records (ideally for 30 years or more),

Long term records of crop area and production statistics corresponding to the above period of rainfall data availability.

The drought vulnerability model consists of establishing a relationship between crop yield loss and the meteorological hazard (SPI). The steps involved in the development of damage curves for the major crops in Niger, namely, Millet, Sorghum, Cowpea, Peanut, and Onion are described below:

**Step 1: Hazard assessment**

The cropping season in Niger stretches between June and October [3, 4,5].

Seasonal SPI for all the regions in Niger was determined

**Step 2: Crop production loss assessment**

For a given region, the reduction in crop production during the drought years was assessed by determining the difference in the crop production (during the drought year) with that during a year that was not affected by drought or flood (potential production). This procedure was adopted to estimate the region level losses in crop production for all the drought years.

**Step 3: Model development**

The region-level agro-meteorological hazards (SPI) and the estimated total loss in crop production for the selected drought events were tabulated.

[3] FAO, 1996. PART II: Position by sub-region, Food supply situation and crop prospects in Sub-Saharan Africa, Global Information and Early Warning System (GIEWS), No. 3/96, October 1996, Food and Agricultural Organization (FAO) United Nations, http://www.fao.org/docrep/004/w2896e/w2896e00.htm

[4] FAO, 1997. PART II: Position by sub-region, Food supply situation and crop prospects in Sub-Saharan Africa, Global Information and Early Warning System (GIEWS), No. 1/97, February 1997, Food and Agricultural Organization (FAO) United Nations, http://www.fao.org/docrep/004/w4285e/w4285e05.htm

[5] FEWS NET, 2011, Niger Food Security Outlook Update, Start of the growing season marked by a low planting rate, Famine Early Warning System Network (FEWS NET), USAID, http://www.fews.net/docs/Publications/Niger_FSOU_2011_06_final_en.pdf

Separate drought risk models were developed for each crop at the country level and their losses were assessed separately.

### 3.3.3 Market Analysis for Insurance

The secondary data collected from various government departments and financial organizations like – financial credit programs, risk protection, government relief schemes, market penetration of insurance products and potential demand of such products were analysis.

The market assessment for agricultural insurance was based on the vulnerability and risk assessment. Farming community perception, awareness to product, willingness to pay, etc. were collected during the questionnaire survey among farming communities.

# 4 Climate Change Vulnerability and Risk Analysis in Agriculture Sector

## 4.1 Assessment of Existing Agricultural and Climate Data in Niger

This sub sections presents the weather and crop data status in Niger. Historical and well-distributed weather data and crop data are required for development of any index-based insurance products.

### 4.1.1 Data Status in Niger for Development of Index-based Insurance Products

#### *4.1.1.1 Ideal weather data criteria for development of Weather Index Insurance (WII) products*

The following general benchmarks are required for the development of WII products and for the subsequent implementation of the products[6] (ISMEA, 2006) in any region:

- At least 20 years of historical weather data
- Limited missing values and outlier values (preferably less than 3 percent missing data from the entire historical dataset)
- Availability of a nearby station for fallback verification purposes
- Consistency of observation techniques – manual versus automated
- Limited changes in instrumentation/orientation/configuration
- Integrity of weather-data recording procedure
- Little potential for measurement tampering

Furthermore, boundaries of the area covered by weather stations are critical, so that WII contracts can be written for specific areas tied to a specific station. Usually, farms that purchase the weather index based insurance to protect against one or more hazards should be located within a 20-30 km distance from the local weather station, which is the commonly adopted criterion in many countries, such as Malawi, India, Kenya, and Ukraine (FAO, 2008[7]). However, in many cases the applicable area is smaller. In addition, if there is a variation in the terrain, the acceptable distance from a station should be lesser to give better results.

#### *4.1.1.2 Status of weather data collected from Niger*

The weather and crop data availability and their quality were reviewed, as these data sets are the primary data source for weather index-based crop insurance product development.

For Niger, there are 15 meteorological stations and 154 rain-gauge stations, mostly distributed in the inhabited southern part of the country. The spatial distribution of these stations is given in Figure 4-1. The northern part of the country has a fewer number of weather stations. Bilma and Arlit are sparsely populated with very little agriculture activities and have only one meteorological station and two rain-gauge stations. The meteorological

[6] ISMEA.2006. *Risk management in agriculture for natural hazards.* Rome: Istituto di Servizi per ilMercatoAgricoloAlimentare.

[7] FAO (Food and Agriculture Organization). (2008). Weather indexes in agriculture: A review of theoretical literature and low income countries' experiences. AAACP (All ACP Agricultural Commodities Programme) Paper Series – No. 1.

station at Bilma, located too remotely from the rest of the stations has been excluded for the hazards and risk analysis since its inclusion is likely to give skewed results.

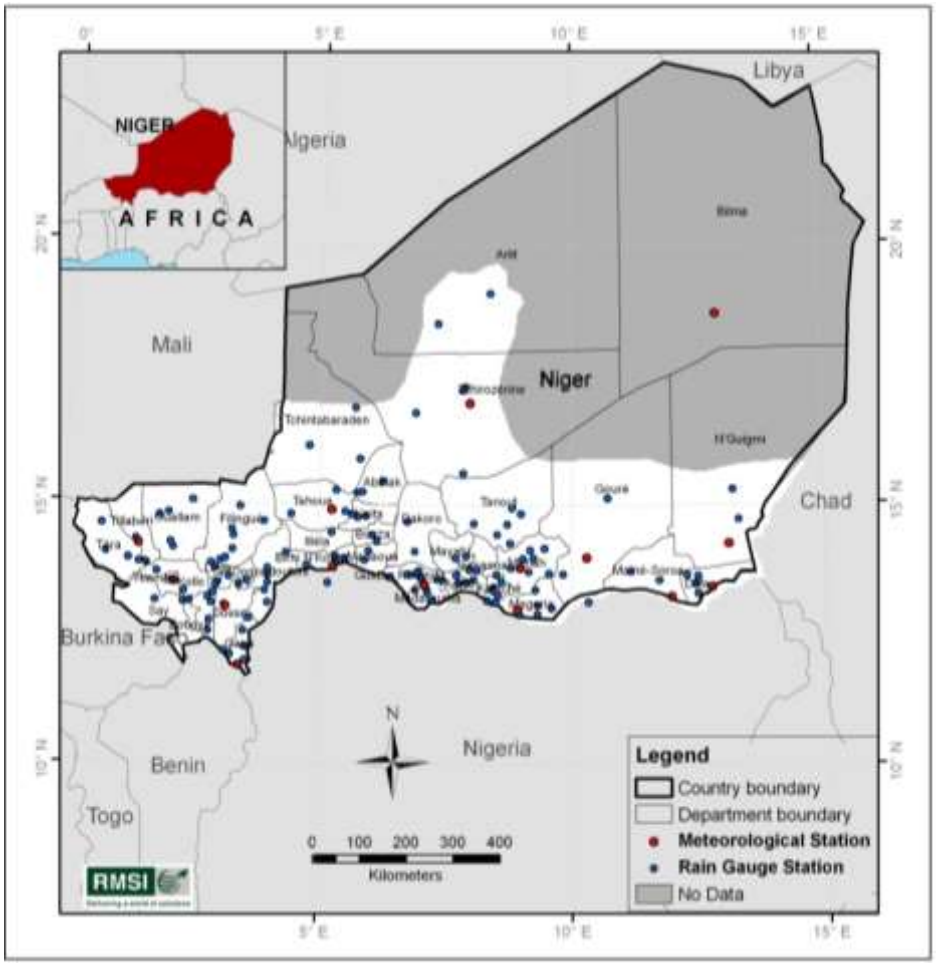


**Figure 4-1: Locations of meteorological and rain gauge stations in Niger**

The temporal resolution of the historical data available was also evaluated and it has been found that data from both meteorological and rain-gauge stations are available since 1982. It was also observed that values in some years were missing in the available data lengths (see Table 9-5 to Table 9-12 in

Annexure 3: Weather and Crop Data Status in Niger).

It can be seen that the average distance between rain gauges is around 28 km (for the 154 stations) while the average distance between meteorological stations is 158 km in Niger (see Table 9-13 and Table 9-14 in

Annexure 3: Weather and Crop Data Status in Niger). The rainfall data from nearly 160 stations (20 years data available from 154 rain gauge + 15 meteorological stations) is sufficient to design WII products that address only the drought and flood hazards. However, only the 15 meteorological stations record the full set of weather data (rainfall, temperature, wind speed, relative humidity, and sunshine hours) and these are too spread out to support the development of insurance products that could address other hazards like pest, disease, wind damage, and temperature stress. Ideally, there should be at least one weather station (that records the full set of weather parameters) in each department for the design of robust WII products that address all the hazards, namely, drought, flood, pest and disease, wind damage, and temperature stress.

The crop data for major crops are available since 1995 for the entire country. However, it has been found that there are missing values in some years in the available data lengths (see Table 9-15

Annexure 3: Weather and Crop Data Status in Niger). Ideally, to generate a good vulnerability curve (i.e. statistical relationship between hazard and crop production loss) one requires 20 years of crop data corresponding to the period for which weather data is available. The available crop data length is insufficient to generate robust vulnerability curves.

### 4.1.2 Investment Cost and Feasibility Analysis for Developing Commercial Index-based Products

Quality weather data is a prerequisite input for developing a robust WII product. Besides, the weather station network is very crucial in developing realistic WII products. In addition to this, a good weather station network can benefit farmers to obtain information to decide on the crop phenological activities and take preventive steps to protect the standing crops from weather-induced stresses.

As mentioned earlier, the existing spatial distribution pattern of rain gauge stations in Niger is sufficient for designing WII products only for the drought and flood hazards. However, it is not sufficient to support the design of WII products for other hazards like pest, disease, wind and temperature stress. Hence, it is recommended that an additional 75 meteorological stations (which record temperature, wind speed, relative humidity, and solar radiation, besides rainfall) be set up in order to attain the FAO norm (30 km). This will reduce the existing distance between meteorological stations from the present 158 km to the required 30 km and will be sufficient to support the development of robust WII product. It is important to note that these additional stations need to be installed in agriculturally active areas in Niger. Furthermore, the feasibility of setting up these meteorological stations, such as initial investment cost, maintenance, and their usefulness needs to be assessed.

There are various types of meteorological stations available, such as manual, semi Automatic Weather Stations (AWS), fully AWS. However, in the case of Niger, we recommend the setting up of an AWS network across the country. This has multiple advantages over other types of weather stations. The advantages are summarized below:

- Standardization of network observations (both in time and quality);
- Real-time continuous measurement of parameters on a 24/7 basis;
- Higher accuracy;
- Generally more reliable;
- Conducts automatic data archiving;
- Provides higher data resolution;
- Collection of data in a greater volume;
- Adjustable sampling interval for different parameters;
- Generally free of reading errors;
- Generally free from subjectivity;
- Automatic QC (Quality Control) applied during collection and reporting stages;
- Automatic message generation and transmission;
- Access to archived data locally or remotely; and
- Data collection possible in harsh climate conditions.

In addition to above advantages, the initial cost is not very high and maintenance cost is low.

With an estimated initial cost of setting up each AWS at USD 12,000 (FCFA 6 million), the total cost of setting up of 75 AWS would be USD 900,000 (FCFA 450 million).

### 4.1.3 Hazard Analysis

The northern part of the country (dark grey shaded areas in Figure 4-1) has not been considered for interpolation, as it does not have sufficient data. There is only one weather station in this area (Figure 4-1).

Figure 4-2 shows that the southwestern parts of Niger (Dosso and Niamey regions) receive the highest rainfall (about 690 mm), whereas the northern (Agadez region) and some eastern (some parts of Diffa region) parts receive the lowest rainfall (about 60 mm) in the June to October season.

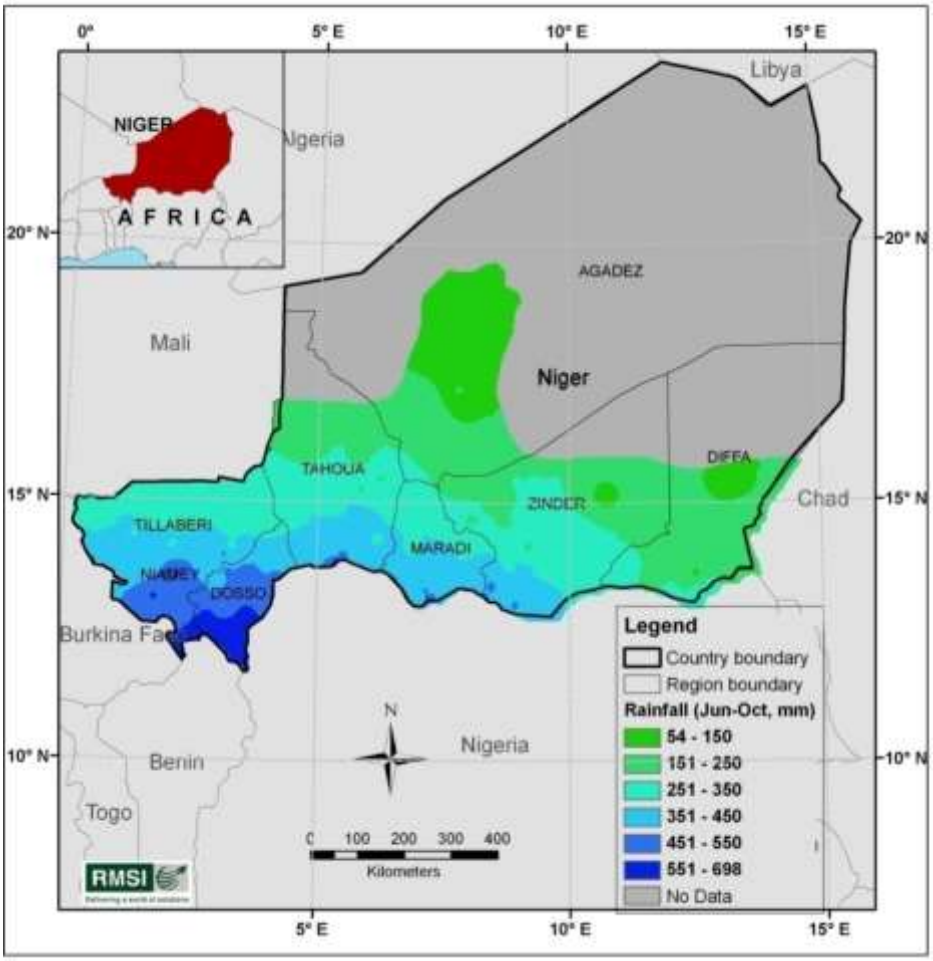


**Figure 4-2: Rainfall Distribution map of Niger**

It can be observed that major parts of Agadez, Diffa, Dosso, Maradi, Niamey, Tahoua, and Tillaberi regions; and some portions of Zinder are likely to face minor drought conditions once in a 3 to 10 year period. The probability of occurrence of minor drought for each region is summarized in Table 4-1.

**Table 4-1: Area vulnerable to minor drought and probability of occurrence**

| Region/RP | % Area having Return Period (RP) (Years) | | | | | |
|---|---|---|---|---|---|---|
| | 3-10 | 11-15 | 16-20 | 21-25 | 26-30 | Not Studied |
| **Agadez** | 16% | 0% | 0% | 0% | 0% | 84% |
| **Diffa** | 35% | 6% | 1% | 0% | 0% | 57% |
| **Dosso** | 61% | 16% | 11% | 9% | 4% | 0% |
| **Maradi** | 83% | 15% | 1% | 0% | 0% | 0% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Niamey** | 100% | 0% | 0% | 0% | 0% | 0% |
| **Tahoua** | 63% | 12% | 5% | 3% | 0% | 17% |
| **Tillabery** | 82% | 11% | 3% | 3% | 1% | 0% |
| **Zinder** | 39% | 29% | 8% | 3% | 1% | 21% |

The map showing the spatial distribution of minor drought event based on SPI value computed using historical rainfall data is provided in Figure 9-1.

However, not all parts of the country will experience such conditions simultaneously. In other words, the areas may experience droughts at different times within the time bands they are expected to occur. It can be observed that major parts of Diffa, Dosso, Maradi, Tahoua, Tillabery, and entire Niamey are likely to face moderate drought conditions once in a 6 to 10 year period. The probability of occurrence of moderate drought for each region is summarized in Table 4-2.

**Table 4-2: Area vulnerable to moderate drought and probability of occurrence**

| Region/RP | % Area having Return Period (RP) (Years) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **0-5** | **6-10** | **11-15** | **16-20** | **21-25** | **26-30** | **Not Studied** |
| **Agadez** | 0% | 12% | 4% | 0% | 0% | 0% | 84% |
| **Diffa** | 1% | 41% | 1% | 0% | 0% | 0% | 57% |
| **Dosso** | 0% | 81% | 7% | 7% | 4% | 2% | 0% |
| **Maradi** | 1% | 49% | 35% | 10% | 3% | 1% | 0% |
| **Niamey** | 0% | 100% | 0% | 0% | 0% | 0% | 0% |
| **Tahoua** | 2% | 68% | 10% | 3% | 1% | 0% | 17% |
| **Tillabery** | 0% | 81% | 18% | 1% | 0% | 0% | 0% |
| **Zinder** | 0% | 10% | 38% | 21% | 8% | 2% | 21% |

The spatial distribution of moderate drought event based on SPI values computed using historical rainfall data is shown in Figure 9-2.

However, not all parts of the country will experience such conditions simultaneously. In other words, the areas may experience droughts at different times within the time bands they are expected to occur.

It can be observed that large parts of Maradi, Tohua, and Tillaberi are likely to face severe drought conditions once in an 11 to 15 year period. Probability of severe drought affecting majority of Niger is once in 21 to 25 years. The probability of occurrence of severe drought for each region is summarized in Table 4-3.

**Table 4-3: Area vulnerable to severe drought and probability of occurrence**

| Region/RP | % Area having Return Period (RP) (Years) | | | | | |
|---|---|---|---|---|---|---|
| | **8-10** | **11-15** | **16-20** | **21-25** | **26-30** | **Not Studied** |
| **Agadez** | 0% | 7% | 6% | 2% | 1% | 84% |
| **Diffa** | 0% | 0% | 43% | 0% | 0% | 57% |
| **Dosso** | 0% | 12% | 66% | 15% | 8% | 0% |
| **Maradi** | 1% | 68% | 29% | 2% | 1% | 0% |
| **Niamey** | 0% | 0% | 11% | 74% | 15% | 0% |
| **Tahoua** | 0% | 47% | 25% | 9% | 2% | 17% |
| **Tillabery** | 1% | 33% | 41% | 17% | 7% | 0% |
| **Zinder** | 0% | 10% | 47% | 17% | 5% | 21% |

The spatial distribution of severe drought event based on SPI values computed using historical rainfall data is shown in Figure 9-3.

However, not all parts of the country will experience such conditions simultaneously. In other words, the areas may experience droughts at different times within the time bands they are expected to occur.

It can be observed that major parts of Dosso, Maradi, Niamey, Tahoua, and Tillabery are likely to face extreme drought conditions once in 26 to 30 years. The probability of occurrence of extreme drought for each region is summarized in the Table 4-4.

**Table 4-4: Area vulnerable to extreme drought and probability of occurrence**

| Region/RP | % Area having Return Period (RP) (Years) | | | | |
|---|---|---|---|---|---|
| | 10-15 | 16-20 | 21-25 | 26-30 | Not Studied |
| Agadez | 0% | 0% | 0% | 15% | 84% |
| Diffa | 0% | 5% | 6% | 32% | 57% |
| Dosso | 0% | 3% | 6% | 92% | 0% |
| Maradi | 0% | 1% | 3% | 97% | 0% |
| Niamey | 0% | 0% | 0% | 100% | 0% |
| Tahoua | 0% | 7% | 24% | 52% | 17% |
| Tillabery | 0% | 3% | 14% | 83% | 0% |
| Zinder | 0% | 19% | 45% | 16% | 21% |

Figure 9-4 shows the spatial distribution map for extreme drought event return period based on SPI values (i.e., for SPI values less than -2.0) computed using historical rainfall data.

However, not all parts of the country will experience such conditions simultaneously. In other words, the areas may experience droughts at different times within the time bands they are expected to occur.

Hence, it can be summarized that most of Niger is likely to experience minor drought (SPI between -0.5 and -1.0) once in 3 years. Similarly, it is likely to experience a moderate drought (SPI between -1.0 and -1.5) once in 6 years, a severe drought (SPI between -15 and -2.0) once in 16 years and extreme drought (SPI between < -2.0) once in 26 years. It can also be seen that parts of Tahoua, Tillaberi, and Zinder regions are likely to experience the highest number of extreme drought events (i.e., once in 16 years).

It is recommended, therefore, that the Zinder region and some pockets in the Tahoua and Tillaberi regions (most susceptible to extreme drought) should be taken up for pilot agricultural crop insurance programs.

### 4.1.4 Vulnerability Analysis

#### *4.1.4.1 Vulnerability analysis on crops*

SPI has been calculated for the vulnerability analysis for the rainy season i.e. June-October in Niger. The Mean Damage Ratio (MDR) has been calculated with reference[8] to potential[9] crop yields.

$$MDR = \frac{(Reference\ Year\ Yield - Potential\ yield)}{Potential\ Yield}$$

As a next step, SPI (hazard) is plotted against MDR (loss) for the major crops in Niger (millet, sorghum, cowpea, peanut, and onion). The relationships between SPI and MDR for

[8] Reference year yield is the particular year recorded crop yield (e.g., crop yield for the year 2000)

[9] Potential yield is the maximum crop yield obtained during the historical time series data. For example, crop yield for a particular year (i.e., normal yield) is "N1" and maximum crop yield (i.e., potential yield) during the last 15 years is "P" then MDR = (N1-P)/P

major crops are shown below. The following graphs show the relationship between SPI and MDR for different crops from Figure 4-3 to Figure 4-7.


**Figure 4-3: Relationship between SPI and MDR for millet crop in Niger**


**Figure 4-4: Relationship between SPI and MDR for sorghum crop in Niger**


**Figure 4-5: Relationship between SPI and MDR for cowpea crop in Niger**


**Figure 4-6: Relationship between SPI and MDR for peanut crop in Niger**

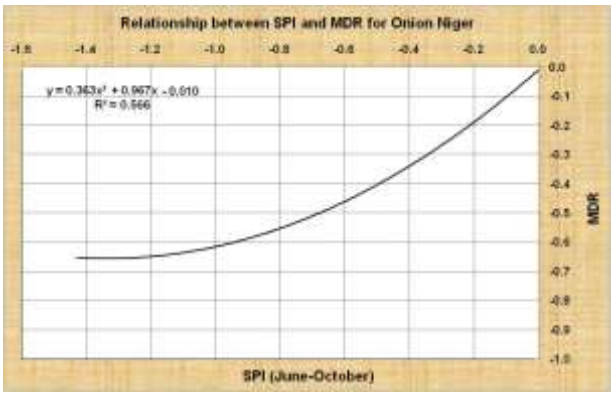


**Figure 4-7: Relationship between SPI and MDR for onion crop in Niger**

A non-linear (second-degree polynomial) relationship was found to best fit the drought-induced production losses. Table 4-5 shows the equations, which highlight the functional relationship between the agro-meteorological hazard (SPI) and consequent crop production loss (MDR).

**Table 4-5: Functional relationship between the agro-meteorological hazard (SPI) and crop production loss (MDR)**

| Crop | Relationship between SPI and MDR | $R^2$ |
|---|---|---|
| **Millet** | $MDR = 0.406 \times (SPI)^2 + 0.986 \times (SPI) + 0.000$ | 0.527 |
| **Sorghum** | $MDR = 0.646 \times (SPI)^2 + 1.492 \times (SPI) - 0.028$ | 0.616 |
| **Cowpea** | $MDR = 0.986 \times (SPI)^2 + 1.881 \times (SPI) - 0.007$ | 0.630 |
| **Peanut** | $MDR = 0.461 \times (SPI)^2 + 1.188 \times (SPI) - 0.027$ | 0.543 |
| **Onion** | $MDR = 0.363 \times (SPI)^2 + 0.967 \times (SPI) - 0.010$ | 0.566 |

As seen from the SPI-MDR relationships, cowpea is the most vulnerable crop reaching an MDR value 0.9 at - 0.9 SPI value. Sorghum is second most vulnerable crop (-0.9 MDR at -1.1 SPI) followed by peanut (-0.8 MDR at -1.2 SPI). Millet (-0.65 MDR at -1.2 SPI) and onion are the least vulnerable crops (-0.6 MDR at -1.2 SPI). Onion shows a lower vulnerability because the crop is supplemented by irrigation. However, the curve shows that onion is vulnerable to water deficit.

#### *4.1.4.2 Vulnerability analysis of livestock*

The impact of climate change is expected to heighten the vulnerability of livestock systems and aggravate the existing factors that are affecting livestock production systems. For rural communities particularly in Niger, the loss of livestock could trigger a collapse into chronic poverty and have a lasting effect on livelihoods.

Furthermore, climate change is likely to have far-reaching consequences for dairy, meat, and wool production, mainly arising from its impact on grassland and rangeland productivity. Heat distress suffered by animals is expected to reduce the rate of animal feed intake and result in poor growth performance. The presumed impact of climate change on livestock can be grouped into two categories, viz., direct and indirect.

**Direct impact:** Direct impact of climate change includes higher temperature and change in the rainfall distribution patterns. These changes could translate into the increased spread of existing vector-borne diseases and macro parasites, accompanied by the emergence and circulation of new diseases in livestock, and the heat stresses suffered by them.

For example, warmer temperatures will bring about the extinction of animal species through heat stress, which in turn will lead to reduced livestock diversity and a shortage of production (dairy, meat, and wool). Climate change is also expected to decrease the beef cattle and an increase in sheep and goats. Consequently, it is anticipated that farmers will switch from beef cattle to the more heat-tolerant goats and sheep. Similarly, scenarios with less precipitation are predicted to be less harmful. Lower precipitation may help reduce animal diseases that are quite significant for livestock in Africa. Thus, as long as there is sufficient moisture to support grasslands, a reduction in precipitation from high to moderate levels appears to be beneficial for livestock. In wetter places, farmers can switch from cattle and sheep to goats and chickens. Thus, the large commercial livestock operations specializing in beef cattle will be hard hit from climate change whereas small farmers who can easily switch to goats and sheep will be more resilient[10],[11],[12].

[10] S. Niggol Seo, Robert Mendelsohn, 2008. Measuring impacts and adaptations to climate change: a structural Ricardian model of African livestock management, Agricultural Economics, Volume 38, Issue 2, pages 151–165, March 2008

[11] S. Niggol Seo, Robert Mendelsohn, 2007. The Impact of Climate Change on Livestock Management in Africa: A Structural Richardian Analysis, World Bank Policy Research Working Paper 4279

**Indirect impact:** Indirect impact of climate change on livestock includes changes in feed resources such as grasslands and rangelands, the buffering abilities of ecosystems, intensified desertification processes, increased scarcity of water resources, and decreased grain production due to variations in rainfall and increasing temperature patterns. Some other indirect impacts will be linked to the expected shortage of feed arising from the increasingly competitive demands of food, feed and fuel production, and land use systems. In addition, the frequency of extreme events such as severe droughts will have many negative impacts on the spatiotemporal dynamics of ponds, which occupy a strategic place in the Sahel in pastoral societies. They are critical in the definition of transhumance routes and campsites for pastors, and they provide a leadership role in the ecosystem balance.

Both direct and indirect impacts of climate change tend to reduce the livestock production. The recent trends of climate, urbanization and livestock production index (meat and milk) are shown in Figure 4-8. In this figure, all variables are aggregated at "Central-Eastern Sahel" level by combining data from Mali, Niger and Chad[13] (Gommes and Petrassi, 1994).

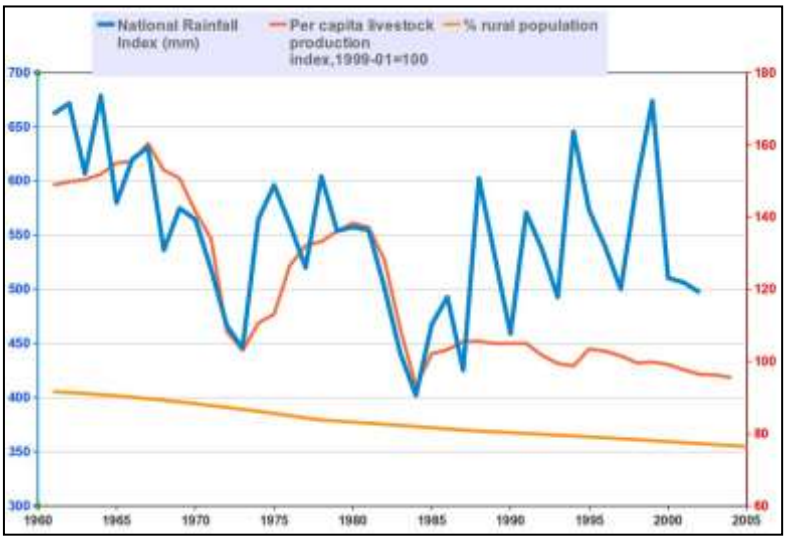


**Figure 4-8 Recent rainfall and cattle trends in the Central-Western Sahel**

(Source: Gommes and Petrassi, 1994[14])

Pastoralism is affected by the effects of climate change due to declining production from pastures in arid and semi-arid West Africa. This was the case of the 2008/2009 cropping season because of the high spatial and temporal variability of rainfall. It was observed in the countries of the Atlantic front (Senegal, Mauritania) that fodder production had shown a large surplus, while in the other Sahel countries (Niger, Chad) the result was negative. Particularly in Niger, it resulted in a very deficient condition. This situation has led to sizeable transhumance, characterized by massive movement of livestock to the coastal areas and has been a chief contributor to exacerbate conflicts between farmers and pastoralists[15].

[12] Chiara Calvosa, Delgermaa Chuluunbaata, Katiuscia Fara, 2009. Livestock and climate change, International Fund for Agricultural Development, http://www.ifad.org/lrkm/factsheet/cc.pdf

[13] R. Gommes and F. Petrassi, 1994. Rainfall variability and drought in sub-Saharan Africa since 1960. FAO Agrometeorology working papers series N. 9, 100 pp, http://gommes.net/wergosum/?p=618

[14] Ibid

[15] Issa Garba, 2010. Impacts on pastoralism, A challenge for sustainable development, Monthly Bulletin, Permanent Interstate Committee for Drought Control in the Sahel, AGRHYMET Regional Centre

A study conducted by AGRHYMET showed that the 2009 rainy season was characterized by very deficient fodder production in Niger. The fodder deficit in Niger was estimated at more than 16 million tons. Consequently, this situation led to sizeable transhumance, characterized by massive movement of livestock to the coastal areas.

Hence, it can be summarized that climate change is likely to cause an adverse impact on the fodder production in Niger, which will directly negatively affect the livestock sector. Furthermore, this new climatic environment would be conducive to the outbreak of climate-sensitive animal diseases resulting in disability and premature death of livestock in Niger.

## 4.2 Index-based Insurance for the Agricultural Sector

Index-based insurance (Table 4-6), which has been rapidly growing since the past few years especially in developing countries, is an agricultural insurance relying on the realization of an event (index) and not on the assessment of individual losses. In the traditional approach, agricultural insurance is based on the individual loss of each policyholder, which then has to be precisely assessed through costly on-site investigations. In the index-based approach, losses are based on an index, which is assumed to proxy actual losses, and the policy is thus correlating the benefit with the value of the financial loss, relying on the occurrence of an event. There is no need for onsite inspection.

This index could be a weather index (rainfall, temperature) or a combination of weather factors (evapo-transpiration, rainfall, temperature, etc.) or other aggregated statistics, such as area yields at a regional level. Index insurance is made of a defined threshold and includes a limit (the "trigger") establishing the range of values over which indemnity payments are made. Whatever the index is, its realization generates the indemnity process and determines the amount that will be paid, notwithstanding the actual loss on the insured's crops, plots, or herds.

On the global scale, index insurance is at its nascent stage. In many countries index-insurance is still at a pilot stage or is highly subsidized by donors and/or national and international agencies (Kenya, Ethiopia, Malawi, Burkina-Faso, Benin Republic, etc.). In these countries, it has been a successful alternative to the availability of historical meteorological or yield data, as it is less data consuming and does not require loss assessments at field level.

Key characteristics of index based product, area-yield and satellite data based products are detailed in Section 9.1.4.

**Table 4-6: Main options in index insurance**

| Option | Principle | Risk insured | Index | Countries where it is in use | Reasons for choosing it | Reasons for not choosing it | Appropriateness to climate change |
|---|---|---|---|---|---|---|---|
| **Weather Index based insurance** | Insurance is based on the occurrence of a weather event assumed to cause crop or livestock losses, measured over a time frame in defined locations.<br>Indemnity is paid each time the index is above or below a triggering threshold.<br>Insurance policy specifies a defined insured amount of money per unit of index. | Drought<br>Excessive rainfall<br>Frost and cold temperatures<br>Strong winds | Index may be solely based on meteorological (for example, rainfall) data or may include other parameters such as ETP, moisture, etc. and be agro-meteorological, according to the data availability and level of granularity required. | India<br>Ethiopia<br>Rwanda<br>Malawi<br>Mexico<br>Dominique<br><br>Sainte-Lucie<br>Mongolia<br>Kenya<br>Philippines<br><br>And many others | Cost-effectiveness<br>Suitable if losses can be linked only to the risk insured and the parameter.<br>Suppression of moral hazard and adverse selection<br>Easier and cheaper control and loss adjustment than area-yield | Lack of historical meteorological data<br>Lack of crop yields and livestock production data<br>Insufficient meteorological network<br>Limited impact if crop/livestock losses are affected by more than one factor<br>Basis risk depends on the extent to which the insured's losses are accurately correlated with the index | ☆☆☆ |
| **Area-yield index insurance** | Payouts are made if an insured yield (a percentage of an average historical yield in a particular area) is below average yields, regardless of the insured's actual yields. | All weather risks causing crop losses. | An average yield aggregating crop yields on a particular location over an historical period. | USA<br>India<br>Peru | Low adverse selection and moral hazard risks<br>Wide index including all climate risks in the final yield results and suitable to regions confronted to several risks<br>Cost-effectiveness | Lack of crop yields data<br>Requires homogenous climatic zone suffering similar events in similar proportions<br>Time spent between losses and payouts (usually 4 to 6 months) | ☆☆ |
| **Satellite index-based insurance** | Payouts are made when satellite imagery observes gaps between average vegetation | Water related risks (drought, | Satellite historical imagery measuring NDVI (Normalized difference vegetation | Iran<br>Mexico<br>Canada<br>Spain | Insufficient correlation between meteorological and yields data (high | Dependence on the satellite imagery provider (FAO, US, etc.) | ☆☆☆ |

| Option | Principle | Risk insured | Index | Countries where it is in use | Reasons for choosing it | Reasons for not choosing it | Appropriateness to climate change |
|---|---|---|---|---|---|---|---|
| | cover and actual cover, in such proportion that it is assumed to cause crop and livestock losses. | excessive rainfall, floods, moisture, etc.) | index) | Malawi<br>Burkina-Faso. | basis risk)<br>Reliable real time data<br>Basis risk limited due to fine granularity level | | |

### 4.2.1 Main Technical Options for Index-Based Insurance

#### *4.2.1.1 Distribution*

In many African countries, including Niger, insurance companies do not have an efficient network to target rural areas and the agricultural population, and they usually do not even target farmers at all, who are considered as insolvent customers. However, usually the companies' own agents and brokers are the sole efficient distribution channels and the only ones to market insurance, as is the case in Niger for compulsory insurance products. Unlike Europe, the Americas or even Asia, African insurance companies, especially in the CIMA zone, do not have close ties with the banking sector, cooperatives, input providers, or DFIs.

Ideally, in Niger, insurance companies should rely on existing distribution channels, in order to reduce delivery costs, which could be otherwise prohibitive, especially in a country where a huge number of small producers are spread across the territory.

These low-cost main delivery channels may cover various techniques:

a. **Credit-linked index-based insurance is usually considered as a cost-effective solution.** Banks and especially DFIs are the main stakeholders "connected" to the agricultural sector in Niger and could thus play a lead role in distributing agricultural insurance through bundle loans. This channel is usually cheaper than other means of distribution in contexts where the majority of production units are made up of small farms.

   Besides, while linked to credit, index-based insurance allows banks and/or DFIs to manage risks. If the insured suffered a loss for which insurance is not triggered, he should be able to borrow money from the bank to cover this loss. This would help tide over one of the concerns of index insurance where the insured may incur losses and not be paid due to the index design.

b. **Professional organizations (farmers' organizations, cooperatives, etc.) often play a key role in marketing the insurance products**, as they can deduct index-insurance premium at the source, on the producers' sales income. This solution is sometimes efficient to promote the products, remit collected premiums to the insurers, and facilitate both enrolment and payouts. It exists in many countries, such as in the Caribbean for banana producers' index-insurance against winds or in India for potato crops insured against parameters generating late blight (moisture and temperature) in localized areas.

c. **Input providers could also be involved in index-insurance distribution**. Input suppliers (seeds, fertilizers, etc.) may be involved in distribution of index-based insurance through contract farming for instance, covering at least the value of inputs purchased. Resilient seeds for instance, which are a mean to tackle the climate change issue, may come, when provided to farmers, with a compulsory (or voluntary) drought index-insurance covering the financial risk in the event of a drought-related crop failure. In general, this kind of insurance is optional, though it may be mandatory for credit insurance.

#### *4.2.1.2 Reinsurance*

The reinsurance capacity defines the underwriting ability of an insurance company to underwrite weather index-based insurance. Besides, weather-index crop and livestock insurance programs are highly exposed to catastrophic risks, whether these risks include weather shocks such as extreme and severe drought, locust invasion, or various diseases and pests.

The companies' capital is never sufficient to conserve these catastrophic risks, as theoretically and legally the maximum liability must not exceed 20% of the companies' own

funds. It is thus in their interest to cover these retained risks through proportional treaties, before looking for (non-proportional) reinsurance.

Covering retention has a variable cost, depending on the level of retention as well on the type coverage (excess loss or stop loss) and on the range of the envisaged capacity. Reinsurance costs might be excessively high for new companies, which do not have any results or background losses. That is the reason why reinsurance is sometimes subsidized by the states in which companies are operating. It may consist of granting enhanced reinsurance to these agricultural insurance companies.

Finally, the choice of the leading reinsurer is limited to the few reinsurers specialized in agricultural insurance. Nonetheless, the choice of following reinsurers is more open and African reinsurers (as well as international ones) are often part of the treaties in African experiences of weather index-based agricultural insurance.

#### *4.2.1.3 Data*

*Reliable historical data:* The principle of index-base insurance is to bind the value of a parameter (indicating the risk occurrence) to a certain level of payouts. Theoretically, indemnities could be totally independent from losses to productions[16]. However, it would result in dissatisfaction of the insured.

Indeed the payout function has to be calibrated at least to a level of indemnities close to the actual losses. Practically, the calibration links the parameter (index) value to the amount of loss at a particular granularity level requested by the considered risk. The losses value recorded as well as any elements related to cost, allow assessing payout levels that have to be determined *ex ante*, according to the index value.

It is thus necessary for index-based insurance to rely on accurate and reliable historical data: the finer this data, the less uncertainty in the product design there will be, and consequently the less expensive insurance will be.

In-depth data analysis is required to actuarially assess index-based insurance potentialities in a country such as Niger. Pricing an index-based insurance product will rely on this historical data, to calibrate the statistical features of the defined parameter as well as the likely payouts. Minimum required data to allow the launch of weather index-based insurance are mentioned in section 4.1.1.*Process for data collection in the future:* A defined data collection process has to be set up in the future to measure the index that is the basis of the insurance product. The process must be elaborated and must guaranty that nobody will distort or falsify the records. In many cases, the promoter of the insurance contract must set up a written and audited detailed process.

Besides, the process must specify how to adjust time series when data is temporarily missing from the official source of the underlying index. Many contracts include a backup source of data. These backup sources or "fallback" stations are used in the event of missing data from the primary Reference Weather Station (RWS) and detail exactly how fallback station data will be adjusted to infer and fill in the missing data. Depending on the ground situation, it may even be necessary to keep at hand alternative solutions when fallback stations are not available.

[16] Indeed, what is at stake here is to define the correlation between a parameter and a payout, based on the risk occurrence. For this reason index-based insurance could only associate a premium to a maximum payout based on the occurrence of the event observed actuarially priced notwithstanding its actual consequences on crops. Practically, as it is said it could only result in dissatisfaction of the insured, and has to be priced while remaining close enough to average losses caused by the event.

Investments in performing instruments such as meteorological stations are usually required for further refining and making necessary adjustments to data in order to spread insurance products over the whole country, following the first pilot phase during which the existing network is used. The stake is then to define a development plan. This process is not only necessary for the insurers' credibility but also for the reinsurance programs and investments in order to access international markets.

In Morocco and some other developing countries where there is a lack of State meteorological stations in certain areas, private players have established private meteorological networks in order to produce real-time data, which then allows producers access to financial services such as credit or insurance. However, this kind of model is not available in Niger and only exists where there is an agribusiness sector strong enough to invest in such a network of meteorological stations.

#### *4.2.1.4 Brief assessment of Niger data*

In Niger (see section 4.1.1) the public network recording full meteorological data is rather narrow, which could help envisaging rainfall based index insurance rather than other index-based index insurance relying on additional meteorological data. As mentioned earlier the data in Niger is sufficient to design any rainfall index and could be completed with satellite data.

Major crops yield data are fully available since the mid 90's, which would restrain the use for insurance purposes. To overcome the limitation, other solutions might be envisaged in Niger. These may include strengthening the existing network and collecting data over a longer period or relying on household level data.

There is a lack of livestock mortality data in the country and only recently, the country started organizing its statistics on fodder production. Besides, most of the livestock produced in Niger is exported to neighboring markets (especially Nigeria) through unofficial trade networks and is not statistically consolidated at the State level or at bordering posts.

#### *4.2.1.5 Legal and regulatory issues*

From a legal point of view, index-based insurance products can be considered as either insurance, derivatives or even gaming contracts, depending on the legal framework of the country. From this point of view, one has to bear in mind that the CIMA region, to which Niger belongs, covers a homogenous range of countries. The CIMA zone jurisdiction is a civil law jurisdiction, based on the Napoleonic Code. It is only recently that CIMA countries adopted a legislation that expressly contemplates index-based insurance.

Till April 5th, 2012 contrary to the countries where the jurisdiction falls under common law and where there were already index-based insurance programs running (for example, Tanzania, Ethiopia, Kenya, Malawi), there was not enough flexibility to allow parametric insurance to be launched. The two main reasons were that the CIMA code clearly prohibited index-based insurance:

- Insurance was clearly linked to the indemnity paid by the insurance company to the insured and the loss that the insured faces: "*pour les assurances autres que les assurances contre les risques de responsabilité, les polices d'assurance doivent indiquer la procédure et les principes relatifs à l'estimation des dommages en vue de la détermination du montant de l'indemnité*" (article 8)
- More specifically, Article 31 of the CIMA code states that payment made under an insurance contract shall not exceed the amount of the loss sustained by the insured: "*L'assurance relative aux biens est un contrat d'indemnité ; l'indemnité due par*

*l'assureur à l'assuré ne peut pas dépasser le montant de la valeur de la chose assurée au moment du sinistre*".

In many countries where such a situation prevailed, laws had to be changed before index-insurance products could be introduced. This has been the case in Mongolia to introduce index-based livestock insurance against cold temperatures.

**The CIMA (Conférence Inter-africaine des Marchés d'Assurance)**

CIMA is a regional treaty signed in 1993 by 14 countries from Africa (Cameroon, Benin, Burkina-Faso, Central African Republic, Comoros, Congo, Côte d'Ivoire, Gabon, Equatorial Guinea, Mali, Niger, Senegal, Chad, Togo), together with France, in order to create a single market for insurance in these countries.

The insurance market of these countries is therefore regulated by a unique legislation (CIMA Code), while the supervision is performed by the CRCA (*Commission Régionale de Contrôle des Assurances*). Although CIMA only covers 14 countries, it has a wide influence, since many ACP countries, although not formally members of CIMA, are using the same code or a copy of it (Djibouti, Madagascar, RDC (Congo), Guinea, Mauritania).

The professional body gathering insurance companies of the CIMA zone is called FANAF (*Fédération des sociétés d'assurances de droit national africaines*).

www.cima.org and www.fanaf.com

Following recent studies[17] urging the CIMA zone to adopt an enabling framework to allow index based insurance products in the member countries, CIMA adopted a seventh book in the CIMA code by the regulation no.0003/CIMA/PCMA/PCE/2012 on April 5th, 2012 in Paris, France. This regulation is organizing micro-insurance operations in the CIMA member countries. Weather index-based insurance is thus authorized to insure agricultural risks:

- Article 705 mentions that insurance risks can be underwritten through index-based contracts: « *Les risques agricoles listés à l'article 55 du code des assurances, à l'exception des risques de responsabilité civile, peuvent être couverts par le biais de contrats de microassurance. Ces risques agricoles peuvent être souscrits sur une base indicielle. Les assurances indicielles tiennent compte de périls ou d'évènements spécifiques, à une échelle régionale, facilement mesurables par un organisme habilité. En cas de survenance d'un sinistre, l'indemnisation des assurés est effectuée sur la base du niveau de l'indice et des capitaux assurés.* »[18] Besides, article 706 of the new CIMA chapter includes measures favoring index-based insurance for non-agricultural risks and traditional damage insurance.
- Article 707 gives responsibility to the regional commission and national directorates to decide which organizations are responsible for the follow-up of the data used to calculate the index: « *La Commission Régionale de Contrôle des Assurances pourra préciser par voie de circulaire et par pays, une liste d'événements spécifiques et l'identité des organismes en charge du recueil et de l'analyse des données liées à ces événements.*

[17] Desjardins Développement internation, Etude sur la microissurance dans la zone CIMA, June 2011.

[18] "Agricultural risks listed at article 55 of the Insurance Code, notwithstanding civil liability risks, can be covered by micro insurance contracts. These agricultural risks might be underwritten on the basis of an index. Index insurances take into accounts perils or specific events, at a regional scale and easily measurable by an approved body. In the case of a claim, payouts to the insured are made on the basis of the index level and the insured capital."

*Lorsqu'une entreprise d'assurance ou de microassurance propose au public un contrat tarifé sur une base indicielle, elle devra fournir à la Direction Nationale des Assurances et/ou à la Commission Régionale de Contrôle des Assurances un dossier relatif aux événements spécifiques couverts, à l'identité des organismes en charge du recueil et de l'analyse des données liées à ces événements et un historique des mesures effectuées au cours des trois dernières années.»*[19]

However, this regulation calls for several remarks:

1. It completes the code rather than abrogating or modifying the preceding articles (art. 8 and 31) quoted above. Thus, it does not authorize all index-based operations, nor it allows payments exceeding the amount of the loss in general. On the contrary, it regulates specifically agricultural index-based insurance as long as it is part of a micro-insurance process. While it could limit some countries in offering weather index-based insurance on larger scales to agribusiness sector, it is nonetheless adapted to realities such as Niger's, given the vast majority of small farmers and the quasi-inexistence of an agribusiness sector.
2. The institutions in charge of data collection or treatment related to the index must be empowered in doing so and approved by regulation authorities that are the Directorate of Insurance and the Regional Commission for Insurance Control of the CIMA. It is thus introducing a certification process in order to certify the quality of data used in WII contracts at the regional level. In order to avoid products being rejected, it sounds necessary that insurance companies associate regulatory authorities all along the index design's process.

These recent developments represent an opportunity to launch WII schemes in the entire CIMA region, which was forbidden a couple of months ago. It provides the first regulatory framework for agricultural micro-insurance, explicitly contemplating index based insurance, in the region. Even though it is still limited to insure small farmers rather than agro-industry, it provides a sufficient legal basis in a country like Niger where WII addresses to its public.

### 4.2.2 Climate Resilience and Risk Reduction Measures in Agricultural Insurance Products

Climate change is a recent concern in the insurance industry, contrary to agricultural practices that have been including resilience to climate events since the mid 1990's. Literature on climate resilience and risk reduction in the insurance sector is relatively new, and we will try to review main tendencies and measures taken in particular in the agricultural insurance field. Most of those instruments and measures are, for now, located in western countries, but some are spreading to developing countries. The aim is to assess the extent it could also spread to a country such as Niger, where awareness of climate change in the insurance (and say financial) sectors is extremely low, as we understood while in Niamey.

The United Nations Framework Convention on Climate Change (UNFCCC) has underlined since 2010, through a program focused on loss and damage[20], the need to use risk transfer

[19] The Regional Commission for Insurance Control could precise by means of circular and by country, a list of specific events and identity of institutions in charge of collection and treatment of data related to these events.

Each time an insurance or micro-insurance company proposes an index-based insurance contract to the public, it has to provide the National Directorate of Insurance and/or the Regional Commission of Insurance Control with a file including details about the specific covered events, the identities of institutions in charge of collection and treatment of data related to these events, and a summary of the measures collected over the last three years"

[20] http://unfccc.int/adaptation/cancun_adaptation_framework/items/6010.php

instruments in developing countries as part of a global adaptation strategy towards climate change. The Intergovernmental Panel on Climate Change (IPCC) then backed similar strategies. This program advised member parties of the UNFCCC to adopt certain measures, such as:

- "*Possible development of a climate risk insurance facility to address impacts associated with severe weather events*;
- *Options for risk management and reduction, risk sharing and transfer mechanisms such as insurance, including options for micro-insurance, and resilience building, including through economic diversification*"[21]

IPCC also recommended risk transfer instruments as part of the strategy to "*increase resilience to climate extremes*[22]" rather than post-disaster recovery which is expensive. "*Micro-insurance, insurance, reinsurance, and national, regional, and global risk pools*" are thus quoted as "*mechanisms linked to disaster risk reduction and climate change adaptation*". Risk transfer mechanisms are indeed envisaged as cheaper solutions for governments than ex post aid, following extreme climatic events partly due to global climate change.

According to Dr. Surminski: "*There appears to be potential in many places and a growing recognition of the possible roles for risk transfer. Closer examination shows that the schemes are hugely diverse, often created to meet very specific needs in a particular community, with a wide range of stakeholders being involved, and differing levels of risk transfer being provided. While agricultural insurance is the most common form in all countries, a particular geographical preference for other types of insurance is noticeable – such as micro-insurance against natural disasters in Asia. This may reflect local tradition and possibly also cultural differences, while other factors, such as links to micro-finance schemes, may influence this.*[23]"

Agricultural insurance is thus now explicitly envisaged as one of the main tools to adapt to climate change and one of its goals is to integrate climate change related measures in its marketed products. Comprehensive literature review confirms that this could lead to various risk reduction and risk management measures.

### 4.2.3 Insurance and the Cost of Climate Change

#### *4.2.3.1 Adjusting premiums*

Insurance contracts are priced on a yearly basis, that gives the opportunity to adjust to risk changes on the global level such as climate change, or day-to-day (or say yearly) evolution of global predictions. As D. Crichton (CII, 2012) suggests, there are mainly two ways of adapting to climate change right now, as insurers are still mostly reactive to climate change than anticipating it. Either they price additional loadings on premium due to increased frequency and severity of climatic shocks that may result from global warming and climate change such as floods or droughts, or they simply withdraw cover.

However, forecasting climate change and pricing it, especially in index-based insurance schemes, may lead to potentially excessive high-costs, and to a kind of adverse selection in which insurers may charge this asymmetry of information, hardly understandable for the

[21] http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf

[22] https://docs.google.com/file/d/0B1gFp6Ioo3akYklZcWkwWHJud00/edit?pli=1

[23] Dr. Swenja Surminski, "*Climate change and extreme weather events in developing countries*", in *Future risk : Climate change and energy security - global challenges and implications*, CII, 2012

insured. On the other hand, as stated by F. De Nicola et al.[24] "*trends in yields or weather risk, such as those entailed in climate change, can modify the distribution of shocks, in particular increasing the probability of extreme events. As a consequence, focusing on historical data alone results in under-pricing insurance. De-trending techniques can be used to minimize these concerns, but research questions remain about whether de-trending techniques are sufficient and what is the best practice in pricing in the context of a changing climate*".

For this reason, more than charging premium taking into account long term impacts of climate change, insurers may prefer including discounts or penalties in underwritten premium as part of the general/specific conditions in the contract, according to the sustainable risk management techniques and incentives implemented by their customers. For instance, where customers invest time and money in building and using risk reduction instruments (dikes, etc.) in order to protect crops where climate change effects induce more frequent floods, the insurer may decide to give discount. On the contrary, if located in an area where floods due to CC prove to be on a constant rise and where crops are still cultivated in spite of this trend, the insurer may decide to charge it or not to insure it.

Actually, very few instances are available in this sense among the insurance sector and the question is still being studied by experts. State authorities in European countries for instance are guiding investments in climate change resilience practices, which could impact agricultural insurance, but the industry finds it hard, for now, to take part or finance such strategies on their own.

Sums up the various options for climate resilience building interventions and risk reductions as a course of measures within agricultural insurance products has been given in Table 4-7.

#### *4.2.3.2 Improving index insurance design*

One of the main stakes of index-based insurance is to set up insurance products that properly reflect the farmers' losses and price them accordingly. Therefore, the basis risk issue is obviously one of the main concerns for insurers, but also for the insured, in a context where climate risks are mainly covariant risks, and where index-insurance cover a large geographical areas onto which the basis risk increases as the areas covered increase. That is the reason why insurance policies should be closely linked to the level of losses on crops or livestock, even though the index is related to a parameter such as rainfall. One essential aim of an insurance product is to remain understandable to the customers, who could be illiterate. For this reason, pricing climate change, while taking into account the need to reduce basis risk, should keep farmers and all customers informed about the loss function specifications.

However, according to Osgood, reducing the vulnerability of subsistence farmers to droughts and climate change effects through insurance should lead to implement sustainable practices, such as the use of improved seeds, fertilizers or other inputs[25]. This index insurance design relies on both underwriters and distribution services. In this case, although climate change is tackled through resilient practices, insurance might be all the more difficult to understand for farmers. Indeed, while insurance is distributed through credit giving access to resilient seeds for instance, the loss function based on historical data, i.e. old seeds, will

[24] De Nicola Francesca, Index insurance for managing climate-related agricultural risk: toward a strategic research agenda, workshop report, IFPRI/Climate change agriculture and Food Security, December 2011.

[25] Osgood Daniel E. et alii, Integrating Seasonal Forecasts and Insurance for Adaptation among Subsistence Farmers: The Case of Malawi, Policy research working paper 4061, The World Bank, 2008

not be understandable for farmers[26]This field of study is relatively new as resilient seed are used more frequently. Some institutions are trying to tackle the question through particular calculations but it sounds that the phase of data collection over a long period cannot be avoided.

Agricultural index insurance is still at its very start, and the lack of historical data taking into account practices aiming at building resilience to climate change, leads to approximate loss functions, which need to be adjusted over the years following insurance implementation. This could, for instance, lead to contracts designed and priced according to the kind of inputs farmers are using, the number of years they have been using those inputs, etc. The search for optimal index insurance premiums is at the centre of index insurance, especially in developing countries where insurance induces changes in agricultural behaviors, which may affect vulnerability to climate change.

Besides, changes in premium may encourage shifts in agricultural practices. For instance, a drought insurance on a crop that the market judges nonviable and which therefore becomes more expensive, may lead farmers to move to crops judged reliable by the markets. Obviously, the danger of markets' orientated crops in regions that are highly dependent on subsistence farming should not be neglected and all stakeholders have to be involved, including State and regional authorities, in such policies.

#### *4.2.3.3 Alternative models: Ethiopia's "insurance-for-work" program*

Another opportunity has been studied and implemented in Ethiopia. It consists of in-kind payment of agricultural insurance premium. Launched by Oxfam, with the support of various stakeholders including Swiss Re, International Research Institute for Climate and Society; a local insurance company, etc., the *Horn of Africa Transfer for Adaptation* (HARITA) is a project which includes three components: conservation activities (risk reduction), insurance (risk transfer), and credit (prudent risk taking). As part of the "Government's productive safety net program", farmers who take part in this "insurance-for-work" project which includes weather index insurance are allowed to pay insurance premiums with their labor. This labor is part of the conservation activities to adapt to climate change impacts such as soil improvement through terracing or bunding, and water harvesting and composting, etc. All work is undertaken at community level.

However, it remains optional as farmers may choose to work on such risk reduction instruments for cash or for food, rather than for insurance. Besides, most wealthy farmers may be more interested in buying the insurance product against deficit rainfall. For now, Oxfam has been subsidizing the premiums, but governmental bodies and international donors, including climate change adaptation funds, shall take over.

These insurance-for-work programs may represent an opportunity in countries where there is insufficient solvency to purchase agricultural insurance and inadequate State and/or donors' support to fund such a project, which cannot obviously rely on the sole insurance market. However, the labor's cost has to be analyzed in order to avoid spillovers and price fair premiums.

### 4.2.4 Insurance and Lobbying

Lobbying is a main concern of index insurance regarding climate change as this question is new. During the two last decades, implementations of risk reduction or risk mitigation measures have been the only way to tackle this issue. Some conditions are thus included in those contracts, dealing with planning of specific practices and exclusions, purchase of

[26] De Nicola Francesca, Index insurance for managing climate-related agricultural risk: toward a strategic research agenda, workshop report, IFPRI/Climate change agriculture and Food Security, December 2011.

resilient inputs, investment in infrastructures or sustainable land use. That is only one way, consisting of changing the behaviors of the insured to take part in a global strategy of building climate change resilience. However, if the Nigerien farmers' behaviors may include, while covered by insurance, changes in their cultivation methods or in the crops they are growing, they cannot be held as the only agents of change regarding resilient practices. Indeed, causes of climate change are less due to individual farmers' behaviors than to industrial activities, including productive industries, into which the insurance industry may invest.

Therefore, behavioral changes have to be implemented by insurance companies as well. Lobbying is needed and some professional organizations[27] of insurers are already advocating for them to take into account recommendations from the World Economic Forum made in the Global Risk Report to tackle greenhouse gas emissions and climate change issues.

The insurance industry has two main advantages in this process and has a key role to play

- Through its modeling capacities, it can help governments avoid no-return situations into which temperature rise or ice melt will produce extremely frequent hazards. Insurers may help predict triggering thresholds and decision-making on preventive actions.
- Through their investment strategies, insurers may invest in new sustainable markets, based on long-term returns on investments, and strong (commercial) growth potential: renewable energy sources (solar, wind, hydro-electric rather than energy producing greenhouse gas emissions), new "sustainable" distribution channels, etc[28].

[27] Climate Wise, Munich Climate Insurance Initiative, Chartered Insurance Institute, etc.

[28] Climate Wise is for instance now working on Carbon Capture and Storage(CCS) "*to assess the regulatory and (pre-competitive) market conditions that would be required to make this technology commercially viable*"

**Table 4-7: Options for including climate resilience building interventions and risk reductions: measures within agricultural insurance products**

| | Measures | Stakeholders involved | Targeted Impact | Risks | Examples | Opportunity in Niger (if WII launched) |
|---|---|---|---|---|---|---|
| **Adjusting premiums** | Pricing the cost of climate change | Insurers | Assess climate change long-term costs through weather forecasts | Basis risk<br>Excessive premium cost | India (Andhra Pradesh) – Innovative catastrophic risk models assessing the impact of climate change | Risk of excessively high premium due to drought severity |
| | Withdrawing cover | Insurers | Avoid insuring non-insurable weather related hazards or pursuing insuring climate events in non-insurable areas | Increased vulnerability of the formerly insured to climate change | Morocco former drought insurance in the Marrakech region | Cannot be assessed yet |
| | Including discounts and or penalties in premiums | Insurers / Insured | Provoke changes aiming at building resilience to climate change in the insured behaviors through insurance | Insufficient incentives<br>Viability of index insurance in contexts where behaviors are changing (calculations made before these changes) | Many insurance contracts general/specific conditions<br>Contractual obligations to use resilient techniques/inputs | Interesting model, easy to implement and probably helpful for agriculture in Niger to encourage climate change management measures undertaken. |
| **Improving index design** | Designing index anticipating climate change related hazards | Insurers | Model index according to the knowledge status on climate change | Basis risk<br>Level of understanding among the insured | Pilot experience in Peru | Risks of misunderstanding among the insured |
| | Linking index insurance and its distribution to | Insurers / Insured | Design index through loss function taking into account resilient practices | Approximate loss functions<br>Lack of data taking into | Insurance products marketed by | Interesting model<br>Risks of misunderstanding |

| | Measures | Stakeholders involved | Targeted Impact | Risks | Examples | Opportunity in Niger (if WII launched) |
|---|---|---|---|---|---|---|
| | resilient practices and/or inputs | | | account new resilient practices | Syngenta Foundation for Sustainable Agriculture in Kenya | among the insured |
| | Authorizing in-kind payment of index insurance | Insurers / Insured / Donors | Allow the insured to pay premiums with work (usually aiming at building risk mitigation/reduction instruments) | Real financial cost supported by donors<br>Hazardous assessment of labor's price | Ethiopia's HARITA program | Interesting model<br>Risk of expensive costs for the State or donors |
| **Lobbying** | Helping decision-making towards risks related to climate change and anticipative risk reduction / mitigation measures | Insurers / State / Public authorities | Advocate for public authorities to implement risk reduction and risk mitigation measures towards climate change which could also serve as incentives for insurers | Insufficient interest of insurance sector to invest time and human resources in lobbying related to climate change | Many examples in Europe for instance on inter-state cooperation to avoid floods | Interesting model<br>Risks that Nigerien insurers do not have these advocacy capacities |
| | Investing in sustainable markets and non polluting industries | Insurers | Promote insurers' investments in clean energy and sustainable practices with strong commercial potential | Insufficient profitability on the short-term | Carbon Capture and Storage (Climate Wise) | Interesting model<br>Risks that Nigerien insurers do not have these financial capacities |

*Source: ACTUARIA*

### 4.2.5 Benchmark: Agriculture Insurance Case Studies

Selected insurance case studies in contexts close to Niger's context is elaborated in Section 9.1.8 and is summarized in Table 4-8. Ethiopia and Malawi explicitly addressed the question of climate change, whether through the "insurance-for-work" program or risk reduction related measures such as resilient seeds and inputs. All these countries mainly rely on agriculture and livestock, have an average 80% of the population dependent on these activities, and have had to find ways to target these smallholder farmers or herders, mainly through public-private partnerships with the involvement of donors. Though not directly targeting climate change, index-based livestock insurance is another way of addressing the question of index-based insurance, which had to be detailed given the weight of the livestock sector in Niger.

**Table 4-8: Summary of weather index-based insurance models (case studies)**

| | **Weather based crop index insurance** | | **Livestock index based insurance** | |
|---|---|---|---|---|
| | Malawi | Ethiopia | Kenya | Mongolia |
| **Crop / Production** | Groundnut (abandoned), maize, tobacco | Beans, teff, wheat, maize, sorghum | Livestock | Livestock |
| **Insured** | NAFSAM farmers first<br>Then individual farmers who are customers of trading companies | Bean producers from the participating cooperative unions<br>Teff farmers from Kola Tenben woreda in northern Ethiopia | Individual herders, mostly nomadic, from participating regions and districts in northern Kenya | Individual herders from participating soum (around 15% of the total) |
| **Peril covered** | Drought / Excessive water | Drought | Drought-related livestock mortality | Low temperatures – related livestock mortality |
| **Index** | Rainfall | Rainfall | Predicted livestock mortality calculated in measuring pasture availability (NDVI) and linked to drought related livestock mortality | Predicted livestock mortality due to cumulative low temperatures from January to May and assessed following |
| **Trigger** | Quantity of rainfall at different crop | Quantity of rainfall at different dekads of the crop growth | Threshold of 15% of predicted | Threshold of 6% above predicted |

| | | | | |
|---|---|---|---|---|
| | growth cycle | cycle | livestock mortality | livestock mortality |
| **Division of the crop growth cycle / production cycle** | Crop growth cycle is divided into 3 phases | Crop cycle is divided into 3 phases, and each of these phases are divided in periods of ten days (dekads) serving as reference | Two seasons per year:<br>Long Rain Long Dry Season (LRLDS): March-September<br>Short Rain Short Dry Season (SRSDS): October-February | January-May: period covered by policy<br>December: annual census<br>May-June: mid-term annual census (to be systematized)<br>July-August: payouts |
| **Duration of the policy** | One crop cycle | One crop cycle | Variable (year with 2 seasons or a season) | One year |
| **Maximum payout** | Loan given by bank | Percentage of total sum insured proportionally to this insured sum | Percentage of insured value of TLU (tropical livestock units) in pre-agreed limits | Percentage of insured value of livestock in pre-agreed limits |

# 5 Assessment of Agricultural Insurance in Niger

Climatic risks in Niger seriously hamper the development of agriculture and provoke frequent food crisis (Figure 5-1). Most agricultural risks are systemic and covariate risks affecting large parts of the territory and the agricultural population simultaneously and they generate huge losses in income, both at the national and household levels. Because of this systemic characteristic, agricultural risks are difficult to insure. They require huge insurance or reinsurance capacities to be able to face the cost of a climatic catastrophe that would affect all the insured at the same time and would jeopardize the natural pooling.

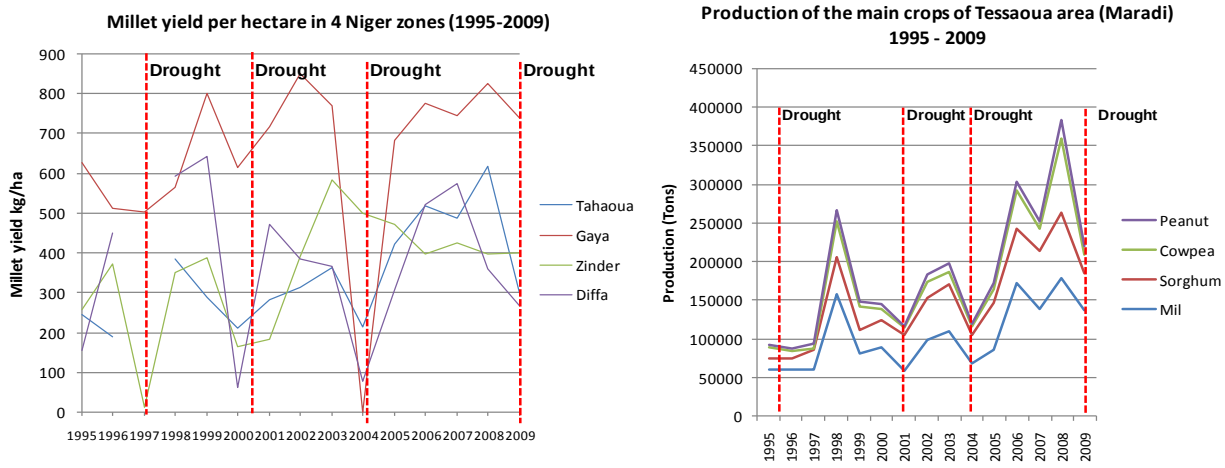


**Figure 5-1: Temporal variations in yield in Niger (1995-2009)**

Source: INRAN / National Directorate of Meteorology

Niger, which is suffering from frequent weather hazards and global climate change consequences, is at the forefront of the struggle against climate change and climatic risks and is trying, good times or bad, to implement risk management measures able to reduce these risks' impacts, with the support of various stakeholders. Post disaster aid represents a huge part of the government and international relief in a context where agricultural planning is hard to implement because of the very nature of agriculture, which mainly consists in subsistence activities. As a result, financial solutions to reduce the importance of losses of forthcoming events are very few.

Indeed, not only are most climatic risks covariant risks, but agriculture is also highly dependent on other kind of risks, including market or political risks (Figure 5-2).

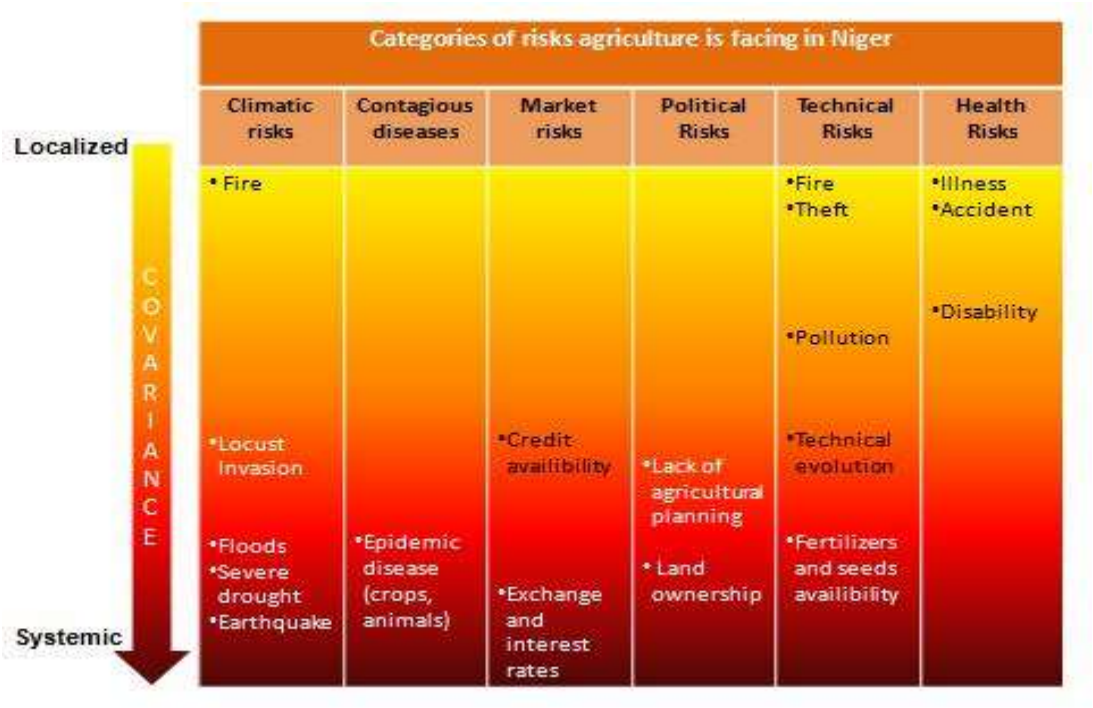


**Figure 5-2: Categories of risks agriculture is facing in Niger**

Source: ACTUARIA

Among all actions taken to fight these risks, agricultural insurance is becoming, in many countries, a possibility to relieve developing countries from the heavy burden of post disaster aid. In Niger, not only is agricultural insurance non-existent, but the insurance sector itself is extremely poor due to a general defiance against companies and low potentialities. Government relief and credit protection programs hardly include risk transfer measures, even though they tend to include more *ex ante* risk management measures in the past few years than in earlier periods.

## 5.1 Commercial Insurance and Informal Insurance

The insurance sector in Niger is made up of four general insurance companies and one life insurance company. The market is also made of 20 agents and 27 brokers.

Until 1984, Company R was the sole public insurance company. It was then privatized and its first CEO created Company M, while Company V (now Company W) invested in Company L which was then sold to Company O(1997). Company S began its activities in 1999 and Company T in 2000. Since 2000, the Nigerien market has not developed. It is only recently in 2012, with the political stabilization of Niger, that a second life insurance company, owned by Company M and Company S, is awaiting its approval from CIMA and the Directorate of Insurance Control. It should be starting its activities by the end of the year.

### 5.1.1 Insurance Market in Niger

The size of the insurance market in Niger is very small: the overall turnover represents about 0.6% of the GDP, which makes Niger one of the most underdeveloped countries in the CIMA zone to which Niger belongs (Table 5-1).

**Table 5-1: Main figures of the Nigerien Insurance Market (2006-2010)**

| | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| **GDP (million USD)** | 3,647.5 | 4,283.3 | 5,432.4 | 5,365.1 | 5,674.9 |
| **Annual Turnover of insurance sector (thousand USD)** | 21,328.5 | 25,619.4 | 27,885.3 | 32,818.1 | 35,477.4 |
| **Penetration rate (Premiums/GDP) (%)** | 0.58 | 0.60 | 0.51 | 0.61 | 0.63 |

Source : Rapport d'activités du Marché nigérien des assurances, exercice 2010, MEF/DCA

The market's turnover in 2010 was FCFA 18,576,000,000 (USD 35,477 million) that is well below other CIMA members including the Sahelian zone, in spite of continuous, though volatile, growth since 2004 (more than 20% in 2005 and 2007, and less than 10% in 2006, 2008, and 2010). Thus, the market is still very small compared with other countries in the region and in Africa in general (ten times lower than Ivory Coast, more than 4 times lower than Senegal, and lower than neighboring Mali that is relatively less populated).

Therefore, the penetration rate and density of insurance in Niger are the lowest in the region. The average premium paid per inhabitant in 2010 is USD 2.3 (Table 5-2).

**Table 5-2: Annual turnover in 2010 in CIMA zone**

| | Niger | Côte d'Ivoire | Togo | Mali | Benin | Senegal | Burkina-Faso |
|---|---|---|---|---|---|---|---|
| **Turnover (million FCFA)** | 18,576 | 192,802.1 | 28,621.25 | 22,982.5 | 32,809.1 | 86,703 | 36,544.2 |
| **Turnover (million USD)** | 35.477 | 368. 224 | 54.662 | 43. 893 | 62.661 | 165.59 | 69. 794 |
| **Population (million)** | 15.8 | 21.5 | 6.5 | 15.3 | 9.2 | 12.8 | 16.2 |
| **Density (Premiums/inhab.) (USD)** | 2.3 | 17.1 | 8.4 | 2.8 | 6.8 | 12.9 | 4.3 |

Source: Rapport d'activités du Marché nigérien des assurances, exercice 2010, MEF/DCA – FANAF, Brochures sur les marchés 2006-2010 – World Bank Data Statistics Population 2010

Niger is one of the poorest states in the region and in the world (GDP per capita is lower in Niger - USD 381 according to the IMF in 2010 - than elsewhere in the region - USD 1 036 in Côte d'Ivoire or USD 980 in Senegal). The insurance sector's contribution to the GDP is extremely low compared to other countries belonging to the CIMA zone (more than 1%) (Table 5-3). It is far less than African countries such as South Africa (more than 15%) or even Morocco (3.4%).

**Table 5-3: Density and penetration rates (World, Africa, CIMA 2009- Niger, 2010)**

| Zones | World | Africa | CIMA | Niger |
|---|---|---|---|---|
| **Global premium (life and non-life) in million USD** | 4,066,095 | 49.287 | 1342 | **32** |
| **Premium density per inhabitant** | 595 | 49 | 9.4 | **2.3** |
| **Penetration rate (Premium/GDP)** | 6.98 | 3.26 | 1.08 | **0.63** |

Sources : rapport sur l'ensemble des marchés d'assurances de la CIMA – exercice 2009, SwissRe (premiums), World Bank (Population, GDP) – Niger (MEF/DCA)

This small market accounts for a tiny part of Niger's GDP, compared to other sectors of importance to the Nigerien economy. For example, agriculture accounted for more than 48% of the GDP in 2010, and industrial activities represented 11.7% in the same year (Figure 5-3). Even among the third sector, insurance services are rather unimportant, as most of this sector activity is made up of commerce, transport, tourism, and public administration services.

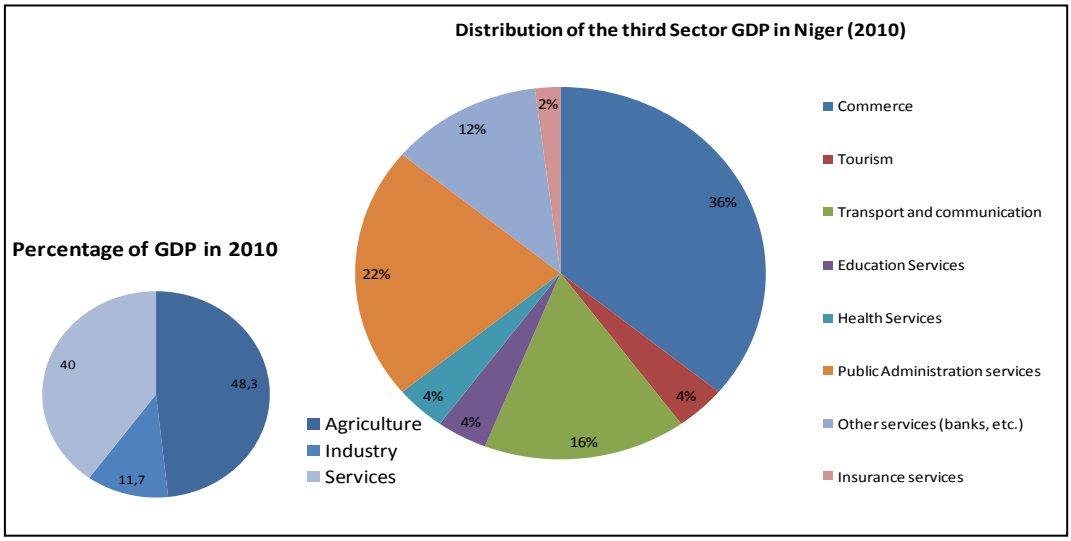


**Figure 5-3: Insurance sector in Niger's GDP distribution**

Source : Note sur la situation économique du Niger 2010, Chambre de Commerce, Oct.2011 - INS – Annuaire statistique du Niger 2006-2010

### 5.1.2 Weakness of Insurance Sector

The sector's configuration brings at first sight the question of its potential, as it sounds too weak to be developed. Indeed the real question is the general defiance of the Nigerien population against the insurance sector, notwithstanding the solvency issue.

#### *5.1.2.1 Life insurance weakness as a metaphor for the sector's performance*

The weakness of life-insurance sector confirms it. The life insurance market is, for now, still limited to the only life insurance company in Niger: Company T (a subsidiary of Company O). It represented 16.2% of the market in 2010, with a turnover of more than FCFA 3 billion (USD 5.7 million) seeing an increase of 25.3% a year since 2005, which is a faster growth than the general insurance sector. According to Niger's Insurance Committee, this remarkable growth in life insurance is highly linked to the marketing efforts made by Company T since 2009[29]. The market is thus open for new companies, as it is booming since 2006, though it slowed down between 2009 and 2010.

However, despite this first assessment, the average life insurance premium per inhabitant is rather insignificant compared to benchmarking countries. As life insurance is traditionally borne on the long-term, it has to arouse trust and confidence among the population to take off. In Niger, it remains extremely weak with an average premium per inhabitant of less than FCFA 200 (USD 0.4) (Table 5-4 and Table 5-5).

[29] Interview with Mr. Balo, its General Secretary on May 17th 2012.

**Table 5-4: Life insurance premium per capita – Benchmark (2009)**

| | Asia | Europe | America | Africa | Gabon | Niger |
|---|---|---|---|---|---|---|
| **Average premium per capita (USD)** | 180 | 1,111 | 632 | 32 | 16 | 0.38 |

**Table 5-5: Life insurance turnover and premium per capita in Niger (2006-2010)**

| | | | | | |
|---|---|---|---|---|---|
| **Turnover (USD)** | 2,347,974 | 3,658,560 | 4,711,232 | 5,633,991 | 5,733,336 |
| **Premium per capita (USD)** | 0.18 | 0.27 | 0.33 | 0.38 | 0.38 |

Source: INS (population) – MEF/DCA (life insurance figures)

The life insurance market is still at its early stages in Niger. Collective death insurance and supplementary pensions funded collectively are the products most widely sold by Company T. Capitalization premiums were first offered in 2008 and represented 36.8% of the sales in 2010. Often linked to credit guarantees made compulsory by the banking sector, this branch is nonetheless growing, but ordinary life insurance (Grande Branche) is still very low (0.2% of 2010 premiums) as its price is unaffordable for the vast majority of Nigeriens (Figure 5-4).

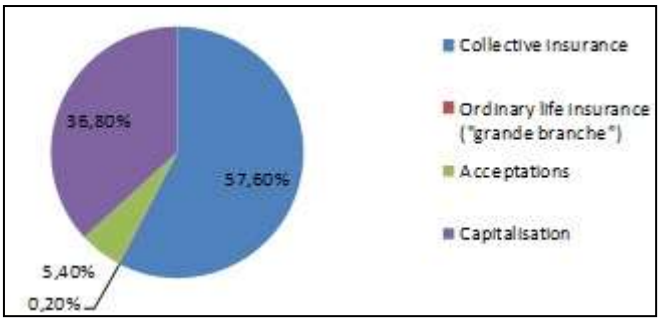


**Figure 5-4: Distribution of life insurance (2010)**

Source: Rapport d'activités du Marché nigérien des assurances, exercice 2010, MEF/DCA

Life insurance can only take-off in markets where the insured have enough confidence that the company will be carrying their assets in the long-term. Its weakness in Niger reflects the lack of trust in insurance companies that are in the market.

**Table 5-6: Solvency margins in Niger (2006-2010)**

| | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| **Life insurance** | 439% | 451% | 380% | 438% | 323% |
| **Non-life insurance** | 197% | 198% | 195% | 240% | 193% |

Source: MEF/DCA

Behind these seeming high performing results, the whole sector is in trouble. The market is small (USD 5.7 million in 2010), under-developed (0.2% of the global underwritten premium), and has little potential to grow (with only one life insurance company). Companies, confronted with fierce competition, allow themselves largess with insurance sector orthodoxy and the CIMA code, resulting in a lack of confidence by the Nigerien people, as will be apparent from the discussions in the following sections.

#### *5.1.2.2 Damage insurance almost only consists of compulsory motor vehicle liability*

General insurance companies represented USD 30.816 million gross premium in 2010 and all shared between 24% and 27% of the market distribution (Table 5-7 and [Figure 5-5 has been removed because it contains confidential information.]

). This shows that the market is rather stagnant and that none of these companies is really prevailing, although Company L (Company O) was the leading company until 2010[30]. Indeed, things have been stagnant till 2001 when the last approval was given to an insurance company in Niger.

**Table 5-7: Nigerien Insurance Companies and market distribution (2010)**

| Company | Group / Membership | Activity | Gross Premium (USD) | Market distribution (%) |
|---|---|---|---|---|
| **Company L** | Company O | General | 8,150,298 | 26.45 |
| **Company S** | Company OO | General | 7,467,220 | 24.23 |
| **Company M** | Company N | General | 7,654,601 | 24.84 |
| **Company R** | None | General | 7,544,601 | 24.48 |
| **TOTAL** | | | 30,816,183 | 100 |

Sources: CIMA statements C1 2010 for each company

This relatively high number of companies for a very limited market results in very small companies facing difficulties in attaining profitability. Although the loss ratio is traditionally good in the CIMA zone, the high level of fixed costs jeopardizes their profits.

**[Figure 5-5 has been removed because it contains confidential information.]**

The insurance sector is outdated and has a very limited range of products, 45% of which are compulsory motor vehicle liability products. Among the number of vehicles insured, it is usually considered that only 40% of the vehicles are actually insured and that almost none of the motorcycles and motorbikes in Niger are insured. Not only is compulsory insurance not attractive and weak, but it seriously questions the sector's ability to implement voluntary insurance. This statement is even worse regarding agricultural means of transportation or tractors. According to these same stakeholders, almost none are insured due to the lack of (police and State) control in rural areas. In 2008, for the first time, compulsory motor vehicle insurance started to represent less than half of the insurance portfolio unlike preceding years when it was representing between 50% and 70% of it.

The only other compulsory insurances on the market are the import insurance: insurance of marine cargo imports over FCFA 5 million (USD 9,552) and air cargo imports over FCFA 1 million (USD 1,910). These and the building construction ten-year damage insurance, which is still not always contracted by the building industry, represent around 11% of the general insurance sales.

Accident and health insurance in Niger represented around 14% of the sales in 2010 (Figure 5-5), while fire insurance accounted for 9% of Niger's general insurance portfolio, and civil responsibility insurance around 3% of it.

[30] 2011 and 2012 have been less favorable to the company, which is now in second position on the market. Though as 2011 report is still to be approved by the CIMA, we will be referring only to 2010 figures

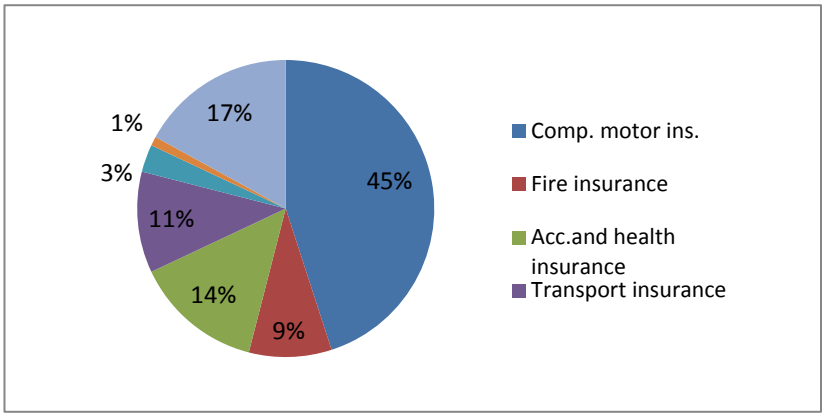


**Figure 5-5: General insurance turnover distribution in 2010 by category of products**

Source: Rapport d'activités du Marché nigérien des assurances, exercice 2010, MEF/DCA

The system does not offer products adapted to a market such as Niger's, which could be potentially made of micro-insurance, agricultural insurance, *takaful*[31], etc.

## 5.2 Extent of Awareness of Climate Change Impact in Insurance Sector

The factors mentioned above also complement the fact that there is a low awareness on climate change impact in the insurance sector. In addition to this, modeling climate change impact is still evolving and often restricted in giving a clear picture for a specific region. For a country like Niger, this will only develop as a second phase, after agriculture insurance catches up in the country. Between the two key groups, supporting the four insurance companies in this sector, Company N (Company M) has made some advancement in this regard elsewhere in Africa. For this to happen in Niger, the onus lies with the companies covering the Niger market. However, this is not among the strategic priorities of these companies, as various players confirmed during our meetings in Niamey,

## 5.3 Market Assessment

### 5.3.1 Insurance Available to the Agricultural Sector in the Nigerien market

In this market, the agricultural sector seems to be forgotten as almost none of the products available specifically targets rural areas and agriculture. The solvency of the agricultural sector and especially farmers is obviously at stake to explain this lack of penetration of insurance in rural areas, as insurance is not a priority for Nigerien farmers (Table 5-8).

**Table 5-8: Farmers' solvency figures in Niger**

| | |
|---|---|
| GDP per capita (USD) | 349 |
| Percentage of agricultural population | 80% |
| Average cultivated area per farmer | 0.44 ha |
| Cereal shortage per inhabitant in 2010 | -28 kg |
| Average percentage of population unable to eat daily | 47.7% |
| Average number of months during which subsistence farming is sufficient to feed households during a year | 3 |

[31] Islamic insurance based on particular profit-sharing systems close to mutual insurance.

| | |
|---|---|
| Percentage of whole expenditures spent in rural areas for millet and sorghum per household | 63,1% |

Source: World Bank (2010), and "Initiative 3N pour la sécurité alimentaire et nutritionnelle et le développement agricole durable", 2012.

Insurance companies themselves are present only in 6 out of 8 regions of Niger, as none is established in the rural regional capitals of Tillabéry (West) and Diffa (East), though these regions are known for their agricultural and livestock productions (Table 5-9 and Figure 5-6**)**.

**Table 5-9: Offices and agents' distribution of Nigerien insurance companies**

| Company | Number of agencies in Niamey | Number of offices/agents in regions | Total |
|---|---|---|---|
| **Company L** | 5 | 11 | **16** |
| **Company M** | 4 | 4 | **8** |
| **Company S** | 1 | 4 | **5** |
| **Company R** | 3 | 2 | **5** |

Source: ACTUARIA (number of agencies) – DCA/MF (number of agents)

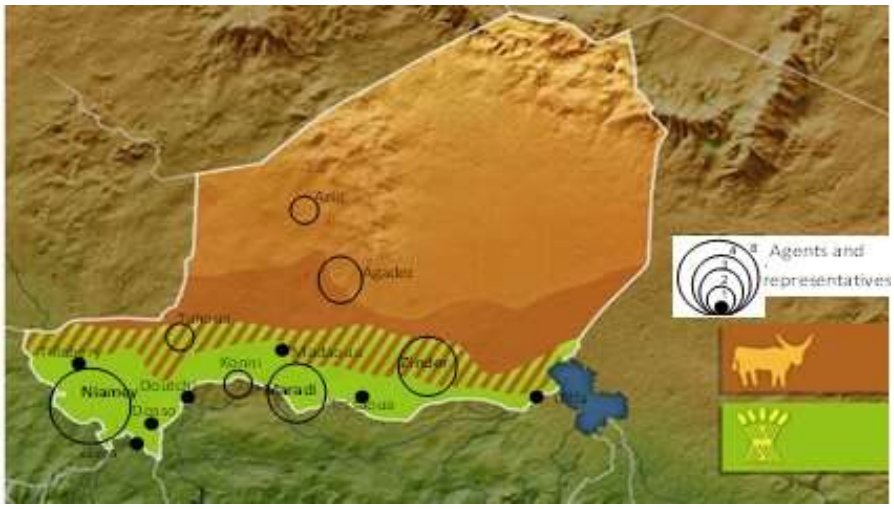


**Figure 5-6: Distribution of general insurance companies (2011)**

Source: ACTUARIA/ARTE

As could be expected, the distribution of insurance companies' agents around the whole Niger territory is more coherent with industrial activities than with agriculture and livestock productions.

Insurance companies are concentrated in Niger's biggest cities. Four of them are present in the three main cities of Niamey, Zinder and Maradi, which contribute between 70 to 90% of the companies' turnovers. In secondary cities such as Tahoua and Agadez, where populations are not fixed due to the large number of nomads in the pastoral Sahelio-Saharian zone, only two and three insurance companies are to be found. In the mining city of Arlit, where uranium is extracted, two out of the four companies have agents, mainly working with contractors and selling compulsory motor vehicle insurance, as mining companies are insured abroad.

In agricultural areas, very few insurance companies are established. In Dosso, Diffa and Tillabery for instance, only one agent is present to collect car insurance premiums for a tiny turnover or for commerce related insurance such as transport in the bordering cities of Doutchi, Konni, Tessaoua, or Gaya. This assessment clearly confirms that insurers do not

target the agricultural sector and that there is a patent lack of solvency in this sector, which could not facilitate insurance penetration.

### 5.3.2 Insurance Products and the Agricultural Sector

Experiences of insurance in the agricultural sector are very limited even regarding traditional damage insurance, which is rarely applied to the agricultural sector. The experiences mentioned for each general insurance company are detailed below.

According to these companies and their production in-charge, an average 1% of the annual turnover should be directly coming from the agricultural sector (and/or the embryonic agribusiness), i.e. less than USD 31,000 of premiums for the whole sector in 2010, mainly coming from traditional damage insurance sold to cooperatives and agribusiness companies.

- **Company S:** according to Company S, the only experiences the company has in insurance available to the agricultural sector is the policy they sold to the National Directorate of Plant Protection when a pilot of small planes dedicated to the struggle against locust invasion in spreading insecticide asked to be covered by insurance. Company S insures the three monoplanes. Another seed producing company also bought health insurance and a further quotation was made for the insurance of the whole site of production, but was eventually aborted.

  Company S portfolio is specialized in transport as they insure local small business airlines. Fifty percent of Company S turnover, without these air transport insurances, is made up of compulsory motor vehicle liability, among which almost none is considered to be agricultural vehicles and machines.

- **Company R**: out of 4 dairies in Niger, only one is insured against damages by Company R. Seventy percent of the Company R turnover comes from Niamey, although they have agents in inner cities and are the only one represented in Diffa and Tillabery. Eighty-five percent of its turnover is made up of compulsory motor vehicle liability, which is a serious limit to the existence of other insurance. Among the 12% of turnover dedicated to damage insurance, stakeholders related to the agricultural sector make a tiny part.

- **Company M:** Company M has a number of clients related to the agricultural sector but none of them are in production. An important part of the company's turnover is made up of transport insurance (especially compulsory import insurance). A part of these transport insurance policies have to do with agriculture. For instance some organizations like the FAO import improved seeds (potato, etc.) and insure the seeds transportation into Niger from neighboring countries. Other clients are from the distribution industry for agricultural products like shops and shopping centers but cannot be related directly to agriculture.

- **Company L**: Company L has the longest experience in the agricultural field. They are insuring dairies against multi risks and civil responsibility (in case of food poisoning), and research centre against damages, fire, etc.

  Company L also has two particular interesting experiences in insurance as they insured companies including Company Y that is dedicated to onion and potato production and stocking, and Company Z which produces food complements for children made with Nigerien cereals and exports them through UNICEF to countries confronted with frequent food crises.

  Company Y was producing around 20% of the Nigerien onion in 2007, buying a huge part of the rest of the national production and using mechanized sites to stock it: refrigerated warehouses, cold stores, etc. Company L provided several policies for them: multi-risks (buildings and contents), damages to electrical devices, flood

insurance, insurance against breaking of devices and machines, and civil responsibility and theft. .

These experiences represent a small part of the global premium collected over the past years by insurance companies and are still not able to contribute to the overall raising of the insurance sector. Indeed, on the short-term, the insurance sector's prospects are not encouraging.

### 5.3.3 Insurance Market Conclusions towards Agricultural Insurance

As already described, the Nigerien market is almost a captive market. Compulsory motor vehicle liability represents 45% of global premium, and reaches 63% if done does not take into account the main air transport insurance contract at Company S, which is reinsured 100% abroad. The insurance sector is thus very limited and is valued at only USD 27.8 million. This poor performance, linked with the weakness of life insurance, tends to prove the lack of ability of the insurance sector to overcome the difficulty of developing voluntary insurance products. This sector does not have, for now, the necessary credibility to launch new products and the marketing efforts needed, especially keeping in mind a population which is not used to insurance.

[Table 5-10 contains confidential information and has been removed.]

The companies' own funds are insufficient to cover agricultural risks. Their financing capacities are weak, as they represent less than USD 10 million for the whole sector (**Error! Reference source not found.**). In other words, in order to insure for instance agricultural risks such as drought, or excessive rainfall, insurance companies would have to mobilize their own funds. In the case of a climatic event which would require for instance 50% of these funds (which is already too much according to usually admitted international standards), the insurance companies' maximum financial capacities would be of less than USD 5 million, which is very low. Thus, a USD 5 million loss due to an insured climatic event would endanger the insurance sector and almost wipe out their financial capacities.

[Table 5-11 contains confidential information and has been removed.]

Indeed agricultural risks, as we already mentioned consist mainly of covariant risks and require important financing capacities. In the insurance market in Niger, notwithstanding individual risks such as health and accident on one side and vehicles insurance on the other, insurers are retroceding most of the collected premiums to reinsurers and have no capacity to underwrite these risks. Company M, which might be one – if not the most solid insurer as part of the Company N network, has for instance a ceding rate up to 83% in fire, 76% in air insurance, 52% in sea insurance, and 76% in "other risks".

The market's potential is thus very low. Almost none of the conditions that are requested to develop agricultural insurance in Niger are present at this stage. To bring more premiums to the sector, companies should have much more capital in order to retain more risks, to speed up the claim payments processes and to increase their returns. However, there is no interest to do so, given the high level of competition in the market. Main conclusions on the insurance sector has been summarized in Table 5-10.

**Table 5-10: Main conclusions on the insurance sector**

| Issues | Description and rational | Evidences | Potential solutions | Is Index Based insurance a solution? |
|---|---|---|---|---|
| **Distribution channel not adequate** | No ability of the insurance sector to reach agricultural population | Existing network focused on urban locations. Low | Alternative channels (micro-insurance, credit, | No |

| | | | | |
|---|---|---|---|---|
| | | banking penetration and network. | seed sellers, etc.) | |
| **Limited solvency** | Limited amount of capital and therefore low ability to underwrite systemic risks or big risks | Low capital, low retention (almost 100% of big risks are ceded to international reinsurance partners) | Reinsurance can provide the capacity but the price would be high | No |
| **Low credibility of insurers** | The insurance sector is suffering from a bad image, due to the slow claim repayment process | Low premium penetration of noncompulsory insurance, especially the life premium | Improvement of the claim payment | No |
| **High claim handling cost** | When a claim is reported, the assessment of the value to be repaid is difficult and costly (need to be assessed on the field) | Administrative costs ratio compared to premium above authorized CIMA norms | Parametric insurance | Yes |
| **Low appetite and financial capacities from the demand** | The absence of cash (agriculture of subsistence, no trade) is an impediment | GDP per capita is the lowest in the UMOA zone and the percentage of rural population is the highest. | Micro-insurance and state financial support (premium subsidy) Awareness raising program | No |
| **Absence of expertise from the supply side** | There is no expertise nor experience in the agricultural insurance business in Niger at this stage | No product, no premium | Foreign technical assistance | No |

### 5.3.4 Leading Players of Agricultural Insurance Market in Niger and Potential Roles

#### *5.3.4.1 Insurance sector*

A. Insurance companies

Insurance companies are the main stakeholders in the insurance market, which could play a role in offering agricultural insurance or increasing access to traditional damage insurance to the agricultural sector. The four main general insurance companies almost equally share the insurance market and, as already detailed above, have little experience of insurance specifically related to the agricultural sector (criteria 1), in spite of their intention to target this sector.

Their strategies have more to do with developing insurance where there are underlying commercial potentialities or hope to reach the 60% of vehicles still not insured today in Niger, than elaborating strategies to target the agricultural sector. However, while developing their networks and opening new offices in regions and cities distant from Niamey or from regional capitals, they have been approaching areas that are more rural and slowly building a proximity network. That could be an opportunity for agricultural insurance, as it would minimize possible delivery costs in the near future, if such products were launched in Niger (criteria 2).

Other advantages lie in their desire to embark on agriculture insurance (criteria 3), whether they choose to do it alone or through an insurance pool and with or without technical assistance from donors, government or reinsurers. As the market is rather restricted, any

choice to venture into agriculture insurance would have a knock-on effect on other stakeholders. For this reason, the Senegalese choice to create an agricultural insurance company must be challenged, as it is often quoted among those stakeholders in Niger as a good example and a solution to prevent insurance companies to engage in adventurous projects that could fail and jeopardize them. In countries like Niger, where there is no historical agricultural insurance company, it could on the contrary be a chance for the whole sector to diversify its activities. Awareness towards agricultural insurance from one company to another is not the same in Niger.

Although awareness could serve as a parameter to help identify leading and playing partners in Niger, it must be acknowledged that expertise in climatic risks is relatively poor for now among insurance companies. Expertise rather lies in institutions like National Department of Meteorology, INRAN, CILSS (Agrhymet) or International organizations. For this reason, reinsurers' expertise shall be considered, as they are usually the ones who help insurance companies seize the agricultural insurance question from the financial perspective and to elaborate risk models. Their expertise and knowledge to tackle this question will depend on the ability of their reinsurers to do so (criteria 4). Reinsurance companies, especially at the international level, represent credible stakeholders to be involved in the process. Company L (Company O), Company M (Company N ) and even Company S through the Company OO have leading partners among their reinsurers with strong experience in agricultural insurance. Company A, Company Q, and others have already shared their expertise with insurance companies in other contexts in Africa and can provide technical assistance or directly help elaborate potential insurance products in Niger.

On the quantitative side, their financial results have to be taken into account so as to assess their ability to penetrate the agricultural sector. Their performances regarding loadings on premiums will provide insight into the cost of their network's functioning and the resultant cost of delivery of insurance products to the agricultural sector, regardless of the kind of products that are launched (index-based or traditional damage insurance). Further, the ratio of compulsory motor vehicle written premium compared to the global written premium will provide insight into the extent to which their portfolio is diversified (criteria 6). Diversity is in the Nigerien market not only an asset because of the high dependence on motor vehicle insurance but it is also an indicator of the companies' ability to manage several products, and obviously to carry a project such as agricultural insurance.

Assessing each insurance company's advantages to approach the agricultural sector and tackle the tricky issue of agricultural insurance can be done using the six criteria shown in Figure 5-7 below. It results in a graph where all criteria are translated into a ranking from 0 to 4, with 4 representing the highest score. The broader the area covered, the more suitable the company is to provide insurance solutions to the agricultural sector. According to this method, Company L and Company M cover wider areas than Company S and Company R. These results confirm that the companies belonging to networks such as Company N and Company O have stronger capacities and could play a lead role.

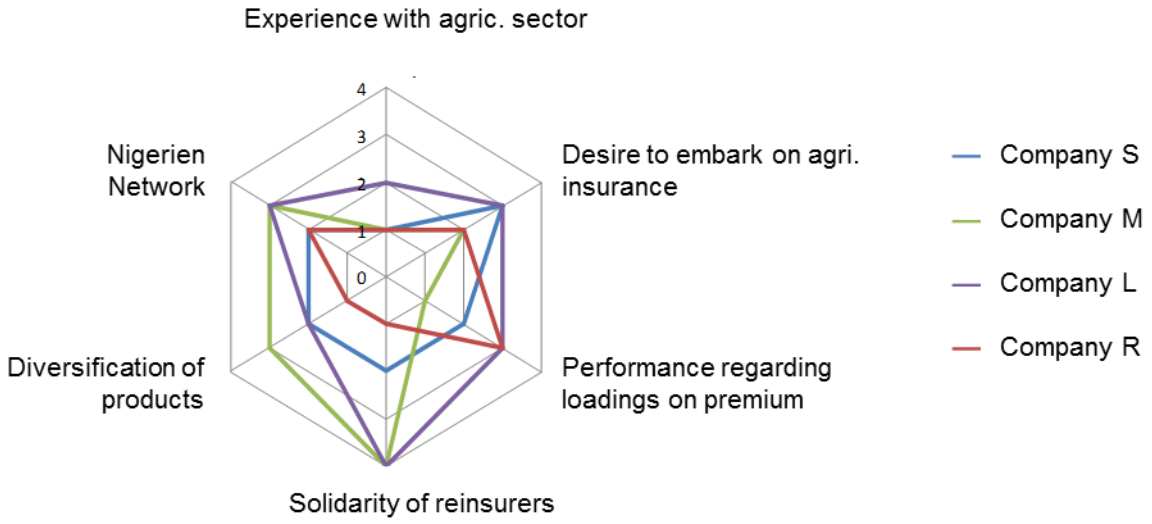


**Figure 5-7: Competitive advantages of insurance companies in Niger regarding agricultural insurance; Source: ACTUARIA with CIMA statements 2010 (C1), and 2010 Annual report of DCA/MF**

To temper this both qualitative and quantitative approach, one must note that in the Nigerien context differences are slight. Company L and Company M undoubtedly also have serious limitations regarding their expansion into providing insurance to the agricultural sector. Company M for instance had heavy loadings on premium in 2010 of more than 50% of global written premium and had very few customers in the agricultural sector. Company L, similarly, made around 43% of its 2010 turnover with compulsory motor vehicle insurance, contrary to the years prior to that.

B. Reinsurance companies

Reinsurance companies may also have an interest in offering agricultural insurance, as they could propose it to the market while relying on local insurance companies to implement agricultural insurance.

This partnership is rather usual in agricultural insurance services, as it is the case in Morocco, where Partner Re is using MAMDA (mutual agricultural insurance company) to provide multi-peril crop insurance and other insurance for on-farm exposures. In East Africa (Kenya, Tanzania), Swiss Re is developing a traditional indemnity-based MPCI product targeting medium-scale to large-scale commercial farming, especially in wheat, tobacco, sugarcane, and maize crops. Swiss Re is also reinsuring most of Planet Guarantee's micro-insurance programs in West Africa.

However, because of the market's narrowness and lack of possibilities to offer innovative products in Niger, numerous steps should be completed to attract the expertise of such big reinsurance companies.

### *5.3.4.2 Banks, DFIs and other input providers*

Although not part of the insurance market, banks and DFIs are potential stakeholders to involve, due to the role they could play in distributing insurance while increasing access to credit. They might have higher potential than the insurance sector. Input providers, such as for seeds or fertilizers, are also major partners as they have the best knowledge of agricultural sector in Niger and know the different stakeholders.

### A. Banks

Banks have to be involved in all preliminary discussions regarding agricultural insurance or insurance to the agricultural sector as main credit providers to the formal agricultural sector. Obviously, there are strong differences between banks as is summarized in the table below. Major banks do have an interest in approaching and financing the agricultural sector as a potential – and almost "virgin" market, though they are often reluctant to do so due to the reasons mentioned above. Banks' main advantages as regards to agriculture, include their actual portfolio of agricultural customers and their experience. However at this stage, and because this study focuses more on insurance companies than banks or DFIs and because measuring competitiveness in this sector would require additional assignments on the field, some other basic elements have to be taken into account. These include their network, their weight in the sector, their date of creation, etc. as enumerated in the tables below (Table 5-11).

**Table 5-11: Banking institutions in Niger, main figures**

| Commercial Banks | Capital (million USD) | Balance (million USD) | Network | Number of bank accounts |
|---|---|---|---|---|
| Company C | 9.5 | 259.2 | 8 | 39,335 |
| Company D | 13.4 | 239.8 | 8 | 35,515 |
| Company G | 9.5 | 264.2 | 16 | 42,698 |
| Company H | 9.7 | 220.8 | 11 | 56,550 |
| Company I | 12.4 | 213.8 | 13 | 23,537 |
| Company J | 19 | 27.8 | 1 | 8,845 |
| Company K | 13.8 | 84.4 | 11 | 5,878 |
| Company AA | 3. 8 | 28 | 7 | 16,345 |
| Company BB | 2.7 | 23 | 1 | 3,139 |
| Company CC | 3.3 | 1.3 | 1 | 649 |
| Company DD | 2.5 | 7.2 | 1 | 0 |

Source: UEMOA's Banking Commission (2010)

It is recommended, therefore, to involve stakeholders whose experience and network are developed enough to impulse credit policies that can pave the way for introducing agricultural insurance in Niger. As per currently available data and our knowledge of the sector, 6 of the 11 banking institutions of Niger, namely: Company C, Company G, Company H, Company I, Company AA, and Company D(Company EE) qualify to be included in this. However, a critical condition has to be met, as for now, none of these banks do market microfinance products. Given the regulatory aspects (see CIMA regulation mentioned here above), such products have to be created first, prior banks can be involved in distribution.

### B. DFIs

Given the nature of agriculture in Niger and the extreme poverty which characterizes the agricultural population in Niger, and given the CIMA regulations which are only allowing WII under micro-insurance systems, solutions have to be implemented at low scales so as to enable farmers to protect themselves against adverse weather hazards, which often result in vicious circles and poverty traps. In this aim, DFIs and microfinance, while providing credit services can increase both access to credit and to insurance. This is already the case in some countries such as India, Malawi, and Tanzania. Table 5-14 lists the ten main DFIs and their key financials. They all target the agricultural sector among other customers, although with some slight differences. Company E and Company F are the main credit providers, while Company HH and Company JJ are more specialized savings networks.

**Table 5-12: Statistics of some of the DFIs in Niger**

| S No. | DFIs | Own Funds | Outstanding savings volume | Outstanding credit volume | PAR (%) |
|---|---|---|---|---|---|
| 1 | Company E | 6,382,057 | 1,809,018 | 6,609,347 | 6 |
| 2 | Company F | 2,572,688 | 549,431 | 4,096,293 | 41 |
| 3 | Company FF | 280,609 | 705,459 | 3,323,850 | 6 |
| 4 | Company GG | 1 346 838 | 993 383 | 3,106,840 | 3 |
| 5 | Company HH | 1,586,282 | 1,634,773 | 2,109,423 | 1 |
| 6 | Company II | 134,772 | 2 852,778 | 1,957,608 | 8 |
| 7 | Company JJ | 999,500 | 2,382,260 | 1,880,054 | 12 |
| 8 | Company KK | 1,584,630 | 642,693 | 1,825,341 | 16 |
| 9 | Company LL | 644,706 | 1,702,600 | 1,379,279 | 4 |
| 10 | Company MM | 1,027,821 | 201,380 | 915,185 | 22 |
| | Total | 16,559,905 | 13,473,776 | 27,203,219 | |

Source: ARSM

### C. Input providers

Input providers are other major partners who can be involved regarding the agricultural sector as they also suffer from losses due to climatic risks. On the one hand, agricultural insurance in Niger will be efficient only if farmers can access seeds, fertilizers and other inputs, as it will allow them to reduce technical risks independent from weather hazards. On the other hand, it would be inefficient to offer agricultural insurance in rural areas where agriculture only consists in subsistence farming, and insurance has to be linked to input access (and/or credit as already mentioned).

For this reason, input providers matter in the process of offering agricultural insurance. Experiences are numerous where demand for agricultural insurance is high due to the integration of credit and inputs with insurance.

Further discussions shall include main stakeholders in this domain whose main advantage is a deep knowledge of the agricultural sector. These include public and private organizations such as Company WW, producers' organizations (Institution G, Institution H, etc.), Company XX, IARBIC project, and private seeds and fertilizers producers, etc.

### D. Other leading partners

Other leading players may include technical partners who could provide assistance to the insurance market with the aim of tackling agricultural insurance and insurance to the agricultural sector. i.e. extending traditional damage insurance to agricultural customers. Donors and international organizations such as World Bank or FAO have know-how regarding agricultural insurance in the region, and have offices and expertise in Niamey.

At the IFC and IBRD level with EC support, the Global Index Insurance Facility (GIIF) could play a support role to allow insurance companies in Niger to address the agricultural insurance issue while building skills or providing advisory services. The table below (Table 5-13) lists the distribution channel partners for WII product in Niger.

**Table 5-13: Distribution channel partners for WII product in Niger**

| Channel partners | Description and rationale | Potential solutions |
|---|---|---|
| **Insurers** | Insurers are not able to reach agricultural population<br>Existing network focused on urban and industrial locations. | Alternative channels (micro-insurance, credit, seed sellers, etc.) |
| **Brokers** | Brokers are not interested in WII due to high risks in the sector<br>There are leading brokers on the Nigerien market (Company YY,Company ZZ), but none expressed their interest about covering agricultural risks. Most of their turnover is made of industrial risks (mining, etc.). | The creation of a specialized broker is not an option, given the competition (and opposition) it will face and the process to implement it at the CIMA and national level. Alternative channels should be preferred. |
| **Banks** | Banks have a low penetration and network in the country and do not provide credit to agricultural sector.<br>They do not have yet micro-finance products that could meet the CIMA Code requirements that WII should be provided only through micro-insurance. | Develop micro-finance products at the banks' level.<br>Strengthen a few agricultural aggregators which could benefit from banking sector financing while aggregating small farmers. |
| **DFIs** | DFIs are best suited to distribute WII in order to make WII operational on the short term in Niger.<br>DFIs, though mainly focused on trade activities, are already financing agricultural activities. Based on the CIMA regulation, authorizing WII provided it is distributed through micro-insurance, DFIs are complying with this requirement. | Develop insurance and credit to farmers through bundle loans.<br>Develop other micro-finance products such as warrantage. |
| **Farmer's cooperatives** | Farmer's cooperatives have a deep knowledge and penetration of agricultural sector. The most structured cooperatives could be used in addition to the DFI to distribute insurance.<br>There are professional cooperatives in Niger and 4 federations of cooperatives, though some are weak, especially for some crop value chains (millet, etc.). Cooperatives represent groups of farmers and can easily target dozens of them while providing insurers and/or | Strengthen cooperatives through value chains national development strategies.<br>Use cooperatives to provide insurance with deduction at the source. |

| | | |
|---|---|---|
| | financial institutions a unique interlocutor. | |
| **Crop aggregators** | No entity in Niger is now playing the role of an aggregator and could thus be used to distribute insurance to the "aggregated" farmers. Company Y used to play this role on onion and potato productions but went almost bankrupt.<br>At present there is no aggregator as such in Niger which could distribute insurance. | Develop integration of agricultural activities (production, transportation, transformation, sale, etc.) to create aggregators that could be able to distribute insurance someday. |
| **Retailers and input providers** | Retailers and input providers are in touch with a tiny part of Niger's farmers as most of these farmers do not have access to credit for seeds or materials. However, they could play a role in the future in distributing insurance and being paid for that (material or seeds + insurance, etc.). | Develop credits and strengthen farmers' creditworthiness in order to allow a greater number of farmers to purchase inputs and material. |
| **Social safety nets programs** | Social safety nets programs could be used as proxy for distribution if some prerequisite are met.<br>Social safety net programs in benchmark countries are used to distribute insurance and reach agricultural population. In Niger there is a lack of coordination of safety nets programs between international donors and the government which prevent such mechanisms to be efficient if launch. | Strengthen the coordination of safety nets programs under a unique body (CCA for instance). |

### 5.3.5 Existing Insurance Products Covering Climate Risks

In Niger, climate risks are being covered presently through government relief and internal development agencies on a case by case basis, with the support of various donors. The insurance sector is very weak due to various reasons explained already and does not play any role for now in terms of climate risk coverage and/or transfer to the international reinsurance market. For the same reasons, presently there is no agriculture insurance product available in the country.

### 5.3.6 Constraints of Climate Risk Insurance Products in Agriculture Sector

Following are the major constraints in introducing crop insurance products in Niger:

i. Highly challenging environment for insurers
   - Insurers lack rural distribution channel networks, expertise in agriculture insurance, data
   - Technically complex to insure crops and livestock
   - Catastrophe risk exposures
   - High transaction and loss assessment costs

- More profitable opportunities exist in commercial and urban areas

ii. Market size
- Small size, geographically spread out
- Lack of insurance awareness among potential buyers
- Lack of financial capacity or willingness to pay premiums
- Lack of incentives to insure
- Lack of experience in launching and managing voluntary insurance products

iii. Inadequate data and infrastructure
- Poor statistical base (crop production, risks, losses)
- Poor rural services including credit
- Difficult to establish distribution channels and linkages.

# 6 Market Assessment of Agriculture Insurance Products in Niger

## 6.1 Typology of Potential User/Buyers of Agricultural Insurance

The potential users/buyers of agriculture insurance can be broadly divided into two categories, viz., individual farmers and commercial entities.

Niger has more than 10 million inhabitants engaged in agricultural activities as per RGAC data, representing 86.5% of the total estimated population during 2004. Maradi and Zinder hold almost half of the agricultural population, 20.9% and 20.7% of the total agricultural population in Niger, followed by Tahoua (18.4%), Tillabery (17.4%), and Dosso (13.4%). Table 6-1, shows the gender composition in the agricultural activities[32].

**Table 6-1: Distribution of agricultural households by region and gender**

| Region | Male headed HH | | Female headed HH | | Total | |
|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | Distribution (%) |
| **Agadez** | 38,703 | 87.6 | 5,473 | 12.4 | 44,176 | 2.7 |
| **Diffa** | 45,250 | 90 | 5,002 | 10 | 50,252 | 3.1 |
| **Dosso** | 181,712 | 96.3 | 725 | 3.7 | 182,437 | 11.6 |
| **Maradi** | 291,181 | 97 | 8,921 | 3 | 300,102 | 18.4 |
| **Tahoua** | 285,956 | 91.1 | 27,788 | 8.9 | 313,744 | 19.3 |
| **Tillabery** | 220,569 | 97.4 | 5,892 | 2.6 | 226,461 | 13.9 |
| **Zinder** | 38,793 | 90.4 | 41,126 | 9.6 | 79,919 | 26.3 |
| **Niamey** | 68,680 | 90.8 | 6,923 | 9.2 | 75,603 | 4.6 |
| **Total** | **1,519,144** | **93.4** | **108,150** | **6.6** | **1,627,294** | **100** |

As per the RGAC survey results, the Nigerian agricultural population is young: 53.4% are under 20 years. With almost equal distribution of numbers of both sexes, it is worth noting that the number of women exceeds the number of men in the age groups 15 to 34 years. This trend is more pronounced in Zinder, Maradi, and Tahoua. The immigration of young men from rural areas to urban areas has skewed the gender composition of the farming communities in the favor of females in this age group. Shocks like the recent food crisis and droughts in recent years have caused a large male population to move to cities for alternate employment. Therefore, the age pyramid of the agriculture community is loaded with a higher number of young females, children and the aged – both males and females, when compared with the overall population age pyramid.

Farmer's cooperatives are active in most parts of Niger and individual small, medium, and large holding farmers are organized through these cooperatives. In terms of potential users/buyers of agriculture insurance, it is important to approach cooperatives to reach the individual farmers.

[32] Republic of Niger, Ministry of Agricultural Development Ministry of Animal Resources, Project gcp/ner/041/ec, Census of Agriculture and Livestock (RGAC 2005/2007), volume viii, final results, Gender " sedentary", June 2008.

There are a few commercial agricultural firms in the crop production sector cultivating large farm holdings. Even though their number is very small, they will top the list of potential buyers of agriculture insurance.

As there are no products available in Niger at present, user satisfaction cannot be gauged. During our interactions with farmers and cooperatives, we gathered that farmers would be interested in availing agriculture insurance products if they were provided clarity on the terms and conditions. The very low literacy rate in the country would certainly stand as a major challenge while popularizing any agriculture insurance product.

The awareness and understanding of climate risk among individual farmers is therefore very low. The weak economic status of farmers coupled with their low awareness is unlikely to provide encouraging signs of regarding their willingness to pay for insurance product unless they see easy to understand benefits upfront. On the contrary, these factors might help them perceive insurance premium payouts as a tax. The options would be to ingeniously combine insurance products with farm inputs like seeds and fertilizers through agribusiness organizations, or with loans through financial organizations.

### 6.1.1 Willingness and Ability to Pay for WII

#### *6.1.1.1 Willingness to pay*

While exposure and its vulnerability to the hazards are paramount factors for the government to encourage the community to adopt risk-adaptation measures like agriculture insurance, it is important to assess the community's willingness and capacity to pay for the product before launching it in the country. Willingness to pay is influenced by the level of awareness on the risks and benefits of the product (in this case weather index based crop insurance product) in addition to their capacity to pay.

As per the farming communities survey, farmer's knowledge on crop sensitivity to water is reasonably good. Farmers responded that millet and sorghum are less sensitive to water deficits compared to other crops, which corroborates the vulnerability analysis (Figure 4-4 to Figure 4-7). The level of farmers' awareness on traditional insurance is high in Niamey (77%) and Maradi (66%) compared to other regions, which corroborates the penetration rate map of insurance in Niger. The level of availing insurance for vehicles, life, health, etc. is also high in Niamey (37%) and Maradi (34%) regions. It is low in the other regions, ranging between 10% and 14%. However, the level of awareness on knowledge of weather index crop insurance is very low in all the regions with farmers' responses in Tahoua (3%), Niamey (10%), and Zinder (10%). The farmers in all the regions showed less interest for insurance of livestock.

#### *6.1.1.2 Affordability*

The farmers who depend only on agriculture crops are economically weaker than those having a mix of agriculture and livestock. Almost 60% of the sample population, which depends on agriculture only, has an average annual income below USD 200. The choice of crops also determines the income of the farmers even though 70% of the farmers surveyed use most of their harvest for their own consumption. The remaining 30% farmers sell 30%-50% of their farm produce. The income distribution of farmers in the survey sample is provided in Table 6-2.

**Table 6-2: Annual average income distribution of farmers from agriculture and livestock**

| Region | USD 200 | USD 200-600 | USD 600-1000 | USD > 1000 |
|---|---|---|---|---|
| **Maradi** | 53.3 | 20.0 | 16.7 | 10.0 |

| | | | | |
|---|---|---|---|---|
| **Niamey** | 50.0 | 10.0 | 20.0 | 16.7 |
| **Tahoua** | 60.0 | 30.0 | 3.3 | 6.7 |
| **Zinder** | 70.0 | 20.0 | 6.7 | 3.3 |
| **Total** | **58.8** | **20.2** | **11.8** | **9.2** |

The average landholding size of rainfed farmers is bigger than those practicing irrigated crops. About 12% of the farmers surveyed, have landholding sizes of less than 0.5 ha, while 17% have landholding sizes of 2-5 ha. The small landholding farmers are mostly vegetable cultivators.

Considering the average yield per hectare and farm-gate price of crops, if a farmer is cultivating millet, sorghum, and cowpea in 1 ha of land under rainfed conditions, the present premium costs would be about 7%, 17%, and 22% respectively of the gross revenue from that crop. Analysis shows that premium cost of peanut is 76%, which is not viable and the crop is more sensitive to water deficit and larger yield fluctuations during rain-deficit years. The income per hectare of land, calculated premium, and percentage to income from major rainfed crops is provided in Table 6-3.

**Table 6-3: Income per hectare of land, premium calculated and percentage to total income from crop**

| Crop | Land size | Income from crop | | Premium (USD) | Percentage to income |
|---|---|---|---|---|---|
| | | FCFA | USD | | |
| **Millet** | 1 ha | 64,000 | 128 | 9 | 7% |
| **Sorghum** | 1 ha | 48,000 | 96 | 16 | 17% |
| **Cowpea** | 1 ha | 43,000 | 86 | 19 | 22% |
| **Peanut** | 1 ha | 35,500 | 71 | 54 | 76% |

Even though the percentage share of insurance premium to income for millet, sorghum, and cowpea is substantial compared (7% to 22%) to income, farmers have expressed their interest and willingness to pay for insurance product. However, premium cost for peanut is very high and is not viable. Farmers' associations are also of the opinion that farmers should be protected from weather risk through agriculture insurance to protect their livelihoods as well as to help them pay back loans availed for agriculture. More than 60% of the farmers have responded expressing their willingness to pay for a product worth USD 25 (FCFA 12,500) in Maradi and Niamey (Table 6-4).

**Table 6-4: Willingness to pay if the cost of insurance is USD 25 per hectare**

| Region | Yes (%) | No (%) |
|---|---|---|
| **Maradi** | 74 | 26 |
| **Niamey** | 62 | 38 |
| **Tahoua** | 17 | 83 |
| **Zinder** | 57 | 43 |

## 6.2 Review and Assess Drivers of Risk Transfer

The fundamental requirement for risk transfer in the agriculture sector in Niger is to ensure long-term food security and encourage climate resilient farming activities. Based on the findings of chapter 5 and 6, it is apparent that the agriculture sector across the country is highly vulnerable to climate change risk. The probability of occurrence of minor droughts in

many parts of the country (see section 4.1.3) is very high. The agriculture sector, specifically the majority of small landholding farmers in Niger, are mainly supported through government subsidies and external aid. Lack of technical knowledge on modern farming practices and access to such resources are their key constraints. Any crop failures can aggravate the vicious poverty cycle a majority of Nigerien farmers are suffering from.

The only insurance in the agriculture sector exists by way of farm equipment insurance under automobile insurance. However, although this is compulsory, only a small percentage of the farming community complies with this in more remote areas of the country.

## 6.3 Agricultural Insurance Product Characteristics

The primary characteristics of weather index based crop insurance products is that contracts are designed with reference to specific and single events or a combination of events (e.g., drought, flood, cold wave, heat wave, etc.) that show a high degree of correlation between the index value and crop or herd losses, depending on the type of contract. The index has to refer to a specific and predefined region or area, which is covered by the local weather station. Usually, farms that purchase the index based insurance to protect against one or more perils should be located within a 20-30 km distance from the local weather station as mentioned in section 4.1.2. The insurance product is sold in standard units (e.g. USD 10 or USD 100) with a standard contract for each unit purchased. The index serves as a proxy for the total losses within that district rather than measuring the individual losses of each policyholder. The index should be defined against events that are highly correlated with regional agricultural production or against the loss of key productive assets.

Once the index is constructed it starts to pay whenever its value falls below a defined threshold or strike value, with indemnity which is usually proportional to the difference between the index value and the strike. The maximum indemnity is paid when the index falls below the limit. The limit is a pre-specified value which is indicated in index contracts to define the border between catastrophic losses and insurable ones.

All buyers of an index contract or policy in the same region are offered the same contract terms per unit of insurance coverage. That is, they pay the same premium rate and, once an event has triggered a payment, they receive the same rate of payment. Their total payments and indemnities would be that rate multiplied by the total value of the insurance coverage purchased. Payouts for weather index insurance can be structured in a variety of ways, ranging from a simple zero/one contract (once the threshold is crossed, the payment rate is 100 percent), through a layered payment schedule (e.g., a one-third payment rate as different thresholds are crossed), to a proportional payment schedule. A simple weather index insurance contract design is given in Figure 6-1.

### 6.3.1 Advantages of Weather-Index Based Crop Insurance

Following are the main advantages of weather-index based crop insurance:

a) *Less moral hazard:* The indemnity does not depend on the individual producer's realized yield.
b) *Less adverse selection:* The indemnity is based on widely available information, so there are few informational asymmetries to be exploited.
c) *Lower administrative costs:* Does not require underwriting and inspection of individual farms.
d) *Standardized and transparent structure:* Uniform structure of contracts.
e) *Availability and negotiability:* Standardized and transparent, could be traded in secondary markets.
f) *Reinsurance function:* Index insurance can be used to more easily transfer the risk of widespread correlated agricultural production losses.

g) *Versatility:* Can be easily bundled with other financial services, facilitating management of basis risk.

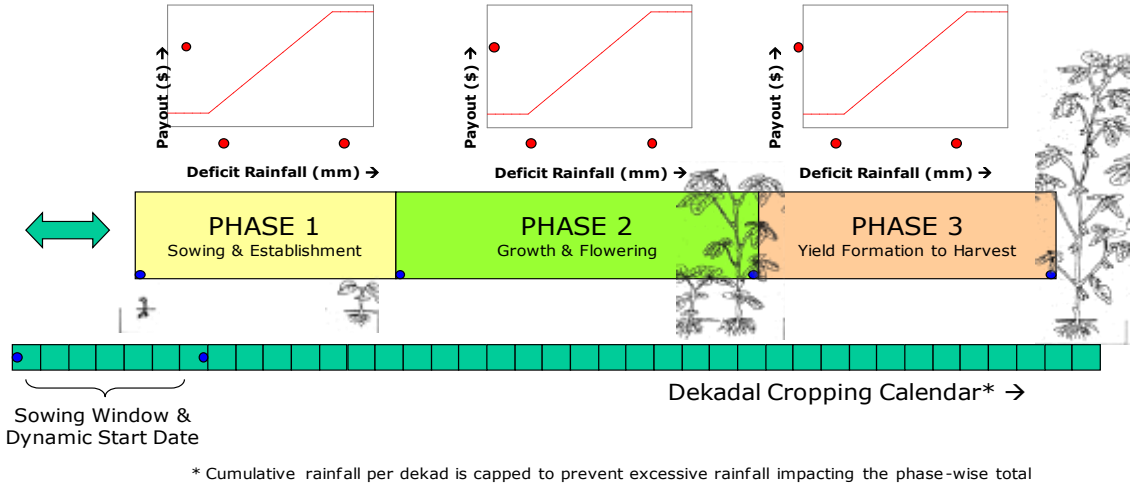


**Figure 6-1: Weather index insurance contract design**

### 6.3.2 Stakeholders in Crop Insurance

Crop insurance stakeholders have been summarized in Table 6-5:

**Table 6-5: Stakeholders in crop insurance**

| Category | Potential stakeholders | Role |
|---|---|---|
| **Insurers** | Insurance companies<br>Insurance association | Underwriting of the risk |
| **Reinsurers** | Reinsurance companies | Acceptance of transferred risks |
| **Delivery Channels** | Agricultural banks<br>Rural Service organizations<br>NGO's<br>MFI 's<br>Input suppliers | Distribution channel of insurance to farmers<br>Farmer education and extension |
| **Farmers** | Farmer Associations<br>Co-operatives | Representing farmers, as buyers and beneficiaries |
| **Government Departments** | Meteorological Service<br>Regulator of Insurance<br>Ministry of Finance<br>Ministry of Agriculture<br>Planning Ministries | Representation of government organizations at policy, research or operational level.<br>Possible subsidy and/or ongoing support to the program. |
| **Donors** | Technical assistance | Support (financial and/or consultancy) mainly during design and implementation phases |

# 7 Potential Insurance Business Model Options for Implementation in Niger

## 7.1 Potential Role of Public-Private Partnership (PPP) in Index-based Insurance

Based on the preceding sections, the issue of partnerships that have to be built to implement a potential index-based insurance model should be handled with care. While it could be inspired by foreign experiences, it has to take into account the limited potentials in Niger, according to the country's insurance and/or micro-finance market and its stakeholders' willingness and capacities to implement an insurance program.

This section tackles the possible roles of the main private stakeholders and the investment priorities to help build a sustainable insurance policy. Accordingly, the options for IFC to prioritize support to such players and the pros and cons for each choice will be detailed keeping in mind the need for commercial viability of the proposed products and partnerships. Each time potentialities to motivate these stakeholders to participate in a PPP will be determined as well as investments that could be required from them so as to enable quick effective implementation and practical next steps.

Main stakeholders that will be part of a PPP will include:

- Insurance companies
- Banks and/or micro-finance institutions
- Farmers' organizations and cooperative unions (or private companies)
- Input providers or other agricultural material providers

Apart from these private players, most PPPs rely on the following other stakeholders:

- The State usually provides a suitable regulatory framework, administrative infrastructure, and data collecting (meteorological or yields) infrastructure.
- Donors may provide grants, loans, trainings, or other development activities to these stakeholders according to their priorities and according to the needs identified by the leading players.

All of them have to be interested in providing insurance and none can be ignored in this process. Prioritization will depend as much on IFC's will as on the opportunities and stakeholders' willingness to embark on the project.

### 7.1.1 Insurance Companies Potentialities to Enter in PPP

As detailed in the report, the Nigerien environment to implement and develop index-based agricultural insurance products can be described as adverse due to the very limited technical and financial capacities of the insurers, the very high marketing costs, the limited potential in terms of contributions from the insured, etc.

However, there is willingness and interest from companies to address the agricultural insurance issue. Indeed, at least two of them, Company M and Company L, explicitly expressed their interest to venture into index-based agricultural insurance during our meetings in Niamey. This is an opportunity to seize as Company M belongs to Company N which is already engaged with the GIIF (and IFC) in other countries in West Africa.

#### 7.1.1.1 Preliminary steps

However, first and foremost, and prior to any question on the product's design, it must be underlined that some preliminary steps represent the top priorities to launch any insurance product in the future in Niger. As quoted by our interlocutors in Niamey, such as Stakeholder C, the question of raising awareness about agricultural insurance companies is a serious issue that needs to be tackled first.

#### 7.1.1.2 Raise awareness among insurers

A priority question is the question of the insurance penetration rate in Niger, especially in the agricultural sector. As explained in the course of this report above, insurers currently have too few clients in the agricultural sector to have a full understanding of potential insurance issues regarding agriculture. Almost no property insurance is sold to agricultural clients and farmers and herders; low levels of mechanization means that almost no tractors are insured, and only a very small number of farmers and herders own cars. Therefore, they are not covered by compulsory products. Besides, as explained by Stakeholder D, agricultural insurance lessons taught in this school only addressed regular damage insurance on agricultural goods and crops. As a result, awareness is very low among insurers on index-based insurance.

As the stake in Niger is to create and launch a new product, awareness and trainings on a different basis than general insurance are needed. If a general awareness workshop on the regulatory issue could be the starting point for Nigerien insurers, it has to be completed by other sessions. Costs could be shared with insurance companies or, more likely, reinsurers.

- We thus recommend that IFC engage in awareness raising actions for insurers (top priority) and possibly other players. The main stake is to give them a minimum understanding of index-based insurance principles and practices in contexts similar to Niger, in order to pave the way to launch a pilot project.
- We recommend these awareness raising sessions take the form of multiple actions: conferences or workshops first, then study trips to countries such as the ones we benchmarked in this report (Ethiopia, Malawi, Kenya, India, Mongolia, etc.). The business models of such events have, of course, to be shared between stakeholders. While IFC could provide dates, locations and administrative arrangements, insurers, reinsurers and other invited participants (farmers' organizations, Input providers, etc.) could pay a fee, possibly including trips.
- We also recommend IFC to send documentation to Nigerien insurers about current WII initiatives and to continue providing them information about WII. Dispatching in surface mail should be preferred to e-mails because of the poor connectivity of Nigerian insurers to emails.

Once these regulatory and awareness issues have been addressed, the environment would have been set to launch a WII product and address its development issues.

#### 7.1.1.3 Further steps to launch a pilot project

For the reasons detailed above, and in spite of the companies' willingness, it is difficult to envisage for now that these companies could offer commercially viable products, generating enough underwriting premiums to cover distribution costs, losses and management expenses, without being supported by public players. Another factor is that potential customers have very low contributive capacities to purchase such products. However, market-based and actuarially designed insurance, if offered to customers, would allow quantifying risk exposure and helping governments and farmers/herders to improve climate risk management.

Doing so, there are two possibilities in terms of products for insurance companies. They could focus either on weather index-based insurance or on traditional agricultural insurance. We recommend that they enhance their capacities on both issues. Reinsurers might be involved as well to address WII. Indeed, according to our knowledge and comprehension of Niger's opportunities, we believe that both types of insurance could be launched some day, provided there is sufficient stakeholders' awareness and willingness, and a sufficient market. Traditional agricultural insurance such as MPCI, named-peril, etc. mostly targets higher-yields production units such as cash crops. In contrast, WII mostly targets smallholder farmers and herders in wider areas for climate related risks. Obviously, the latter is best suited to address climate change issues.

Besides, as insurance companies have very low capacities, based on international benchmarks we recommend engaging in an insurance pool, as it appears to be the best opportunity to tackle the issue:

- Pooling risks through a public-private partnership allows sharing underwriting gains and losses based on the proportional share of premiums brought into the pool by each insurer. Regulation authorities could limit this joint market share in order to stop a single company from owning a majority market share for instance.
- Pooling risks following benchmark examples would allow implementation of best practices in Niger. Insurers will retain part of the risk together in the pool and excess loss will be transferred to the international reinsurance market and/or to government reinsurance.
- Pooling risks, while isolating agricultural insurance from other insurance businesses already underwritten by these insurance companies, is a strong motivation as it prevents this product from jeopardizing the insurers' other activities, which are an asset due to the insurers' limited resources.

Basically, the following few steps need to be taken before a pool is launched:

1) Risks to pool have to be identified. It mainly consists in new risks (such as agricultural risks, medical risks or catastrophic risks) which are usually not being covered by any of the insurance companies present in the market because of the companies' limited capacities. A serious limit to coinsurance pools is that the number of risks covered is usually limited as the pooling arrangement is usually based on the lowest common denominator between the companies. However, it allows a proportional share of the risks between co-insurers.
2) Management rules are elaborated and gathered in a co-insurance contract between stakeholders (leading company/co-insured, etc.). Deals are then contracted as regards the main technical characteristics with other players, such as reinsurers. Coinsurance pools offer a capacity to reduce reinsurance costs as risks are pooled and because the co-insurance pool will operate as a monopolistic entity. The same applies to possible deals with the State in the case of premium subsidies; subsidies are shared between co-insurers on a proportional basis.
3) The coinsurance pool's structures are then created. It consists of a single infrastructure for several companies sharing administrative and technical functions and thus allows reducing fixed costs such as actuarial follow-up, or staff dedicated to product commercialization, premium underwriting, or claim adjustment.

Therefore, a pool allows diversifying activities and portfolio while securing indemnities' payments and sharing gains and losses. It is also an undeniable advantage to improve expertise among insurers.

Thus, backing the sector capacities could include the financing of different actions, which all target their ability to seize the matter and shall lead to:

- Improve general insurance penetration rate in offering loans for activities' development and especially for agricultural insurance development (MPCI, named-peril, etc.) or for traditional products offered to the agricultural sector (damage, civil responsibility, etc.).
- Organize and set expertise transfer, in interesting main reinsurers of Nigerien companies in the process as well as installing data transfer process including all stakeholders (production, yields, meteorological data): national meteorology, agronomic research institutes, early warning systems, donors, etc.
- Plan further actuarial studies in order to calibrate premiums on weather index-based insurance when IFC would have decided which products shall be launched and in which areas.

However doing so would require counterparts from the insurance sector and investments:

- To confirm their interest in such products and willingness to go. Companies shall offer a list of incentives to foster climate change adaptation through agricultural insurance, for instance in selecting only drought-resilient crops (cf. risk-exposure models infra).
- To produce specifications and conditions linked to climate change (resilient seeds, needs in water, encouragement in shifting from water-intensive crops to resilient crops, etc.).
- Insurance companies could be interested in financing development of the meteorological network so as to get first hand data and set WII in regions where it sounds commercially viable and actuarially interesting.

Practically, if IFC decides to target insurance companies IFC could (in order of importance):

- Launch actuarial studies on particular WII products in particular areas.
- Offer loans to insurance companies willing to develop (increase) penetration rate of insurance products in rural areas (traditional damage insurance).
- Offer loans to insurers willing to invest in new products' development (agricultural insurance).
- Finance the setup of a pool of co-insurance and provide guarantees to interest potential reinsurers.
- Attract partners (The World Bank, etc.) to advocate for better control of compulsory insurance products in Niger in order to enhance the resources of Nigerien companies
- Co-finance (loans) to set up a larger meteorological network.

Nonetheless, the Achilles heel of the agricultural insurance pilot project's design issue is the distribution capacity of insurers. A prerequisite to any product development is that farmers and herders become actual targets for the insurers and clients, and real customers. To this end, banks and micro-finance institutions can contribute to the delivery of insurance to targeted individuals or organizations.

### 7.1.2 Roles of Banks and Microfinance Institutions to Enter PPP Investment Models

Financial institutions such as banks and microfinance institutions should also be involved in the process of developing index-insurance. As has been explained in the report, they are the main delivery channels of index-insurance in many countries, and the main agents of change as regards the climate change issue since they could condition loans to resilient practices. However, DFIs are best suited to distribute insurance based on the regulatory aspect mentioned earlier, as banks do not have yet microfinance products. Besides, as the Nigerien agricultural sector is mainly made of smallholder farmers, rather than agribusiness

companies, DFIs are more likely to be involved in the process, rather than banks, unless the latter improve rural finance services and micro-finance services in the near future.

Banks and DFIs should be envisaged as distribution channels and agents of adaptation to climate change and as entities capable of building the agricultural sector's financial capacities and in doing so reinforcing its solvency and ability to get insurance.

Backing banks and DFIs as main distribution channels for insurance products enables fostering climate change adaptation.

Main identified banks (Company C, Company G, Company H, Company I, Company AA and Company D) and DFIs (Company E, Company F, etc.) should be associated to any agricultural insurance product design.

As financial institutions, already having an agricultural clientele (at least DFIs), represent major distribution channels, they have a major interest in terms of delivery cost as insurers will not have to deploy agents in rural areas to underwrite premiums and could also rely on DFIs and banks to market the products.

As insurance improves farmers' creditworthiness, it will in turn strengthen banking sector penetration in the agricultural sector. This is the main reason why banks, to our mind, do not have to be prioritized at first. Before enhancing the capacities of banks, one of the main goals is to promote the emergence of a solvent agribusiness sector.

On the contrary, DFIs have to be targeted as they address small farmers and herders and already finance agricultural activities in greater proportions than banks. IFC could thus provide credit lines to main DFIs such as usual seasonal credits or drought-adaptation credits allowing recipients, while being bundle to insurance, to adopt climate change resilient measures such as shifting from non-resilient to resilient crops, using improved seeds, etc. Reducing the exposure of farmers to climate change would also provide incentives to join an insurance scheme.

One of the main possibilities to strengthen the sector's financial capacities is obviously to allow farmers and herders better access to credit and better penetration rate of DFIs. Alternative products such as warrantage, which is a system of credit where farmers instead of selling non-perishable harvests at once, use it as a collateral to reimburse a bank loan. This practice is growing significantly in Niger and improving the penetration of DFIs in the agricultural sector, as testified by Stakeholder B, Director of Institution A, during our meeting.

For this reason, IFC could help in identifying potential groups of farmers or herders along with DFIs, who are judged reliable as regards to the value chains they belong to, and to the climate change resilient techniques they are using, and provide grants to guarantee sufficient collateral to DFIs/banks, including mid-term loans.

Capacity building includes the ability and skills to analyze quantitative data (farmers' revenue, prices, and production data, etc.). Building a PPP in which insurers, reinsurers, State, experts and distribution channels that are DFIs are gathered will allow better expertise from all stakeholders. IFC could catalyze this expertise and organize training sessions on index-based insurance, its main stakes, delivery channels, process, etc.

Our preselected banks and DFIs to whom the project could be proposed are included in **Error! Reference source not found.**.

[Table 7-1 contains confidential information and has been removed.]

### 7.1.3 Role of Farmers' Organizations and Cooperative Unions

#### *7.1.3.1 Identifying interlocutors*

Farmers and their organizations, and cooperatives and companies represent the underlying basis structure of index-based insurance. To determine who will be the insured and if they are going to be individual farmers or organizations, the general organization of the agricultural sector in Niger must be briefly revisited:

- Most of the farmers in Niger are practicing subsistence agriculture outside the framework of professional organizations and cooperative unions
- In spite of promising niches for production of cash-crops (onion, rice, pepper, potato, gum Arabic, etc.), the Nigerien market is mainly based on cereals and livestock production. Even in these value chains, disorganization is high. Farmers supply themselves with inputs or sell their production through individual strategies, or numerous intermediaries, which do not favor organization and powerful positions in these markets. Only two value chains, rice and beans (niébé) currently have national development strategies, funded by Japanese cooperation and the PRODEX respectively. Other studies have been launched on certain value chains such as pepper, livestock, onion, etc.

However, professional organizations do exist in Niger and one particularity of Sahelian countries such as Niger, Mali or Burkina-Faso is to have dynamic civil society organizations. In Niger, there are four main umbrella organizations for the agricultural sector under which all agro-forest-pastoral productions and value chains are covered. This network is represented at the National network of agricultural chambers (RECA), which centralized agricultural development and main orientations and studies of value chains[33].

Consequently, we do not recommend launching a pilot based on individual memberships to agricultural insurance as farmers are usually financially too weak to afford insurance and would not allow the launch to be a sustainable business model.

We recommend, instead, associating the distribution of insurance to existing farmers' organizations and cooperative unions. There are many advantages in doing so:

- Professional organizations have a deep knowledge of the agricultural sector in Niger
- It would be easier for insurers to have interlocutors representing dozens of farmers than farmers themselves
- Professional organizations can manage with banks (if insurance is distributed through credit) or with insurance companies, how premiums will be paid (deduction at the source, payment, etc.)

We recommend IFC send EOIs to each umbrella organization to preselect potential partners able to implement a pilot project on particular value chains, pre-selected by IFC following this study. Professional umbrella organizations will identify member-organizations able to carry out such projects and be the insured by purchasing insurance to cover their potential losses due to weather events, while trying to minimize climate change related risks by using resilient techniques.

#### *7.1.3.2 Launching the pilot project*

The main role for Nigerien professional organizations in insurance distribution process will be to help insurance distribution and to make it affordable for their members.

[33] www.reca-niger.org

Due to the lack of financial resources, smallholder farmers do not always have the power to purchase insurance premiums, even through their own organizations. As a result, when index-insurance is offered they might not be able to get it without being helped. Therefore, various options are needed to help them afford insurance. For instance, farmers' organizations can provide insurance, while deducting the premium at the source on the farmers' income. In this case, farmers do not take money out of their pockets, but are rather being supported by their organizations and cooperative unions, which pay all or part of the premiums before being reimbursed by the farmers through levies at the source or reimbursement after sales.

In a country such as Niger, farmers are unlikely to purchase insurance themselves, without any support from their organizations or from supporting bodies. However, it must be observed than even in more mature markets such as the USA, EU countries, or India, states are subsidizing premiums and farmers do not purchase insurance only with their own resources. Only a few named peril insurances in these countries, such as hail insurance for instance, are underwritten in free markets without any support. In Niger, the country's profile aggravates this need to rely on farmers' organizations, as it is highly dependent on agriculture and is highly vulnerable to covariate risks such as drought.

As already explained, farmers' organizations and cooperatives may have the capacity and the urge to embark on partnerships in certain already identified value chains in which they would pre-pay part of the premiums to minimize farmer's risks in order to enhance global production and maximize gains.

Therefore, given the very nature of agriculture in Niger, we recommend a path where farmers' organizations are at the basis of the process. Farmers' organizations, cooperative unions, etc. have an in-depth knowledge of farmers and herders and could help convince them to embark on agricultural insurance, while reinforcing the products' credibility. Whether they directly pay insurers or pay for insurance through credit to banks, they are, if selected with care, reliable partners to engage with.

### 7.1.4 Trading Companies and Central Purchasing Bodies (aggregators)

Though they are not at the centre of the process, the potential role of trading companies and central purchasing bodies must be evoked since they are frequently associated to distribution in insurance processes. In Niger, a company like Company Ywas playing a role of aggregator of onion and potato productions and invested in modern conservation equipment, as they were buying more than half of the onion production, and could thus be entrusted with insurance distribution. Other companies such as Company NN for the milk production, etc. could play a similar role.

The idea is that, as there are many cash flows involved, and as these companies are purchasing crops from the farmers or from their organizations, they could help distributing insurance while being paid for it by insurers. They are well suited to deduct insurance premiums at the source and give back the collected premium to the insurers.

That is the reason why we recommend involving these stakeholders in order to facilitate insurance distribution, where it is hard to distribute it only through credit for instance. However, this should remain optional and depend on the will of these trading companies to enter the process. For now, they have not expressed any interest on the topics, as some of these firms declined to meet with us while in Niamey.

### 7.1.5 Roles of Input Providers or Other Agricultural Material Providers

Input providers could be involved instead of other players or in addition to their role. There are mainly two possibilities to involve them in the process. It sounds to us all the more important to include them since IFC's PPCR is focusing on irrigation supply and climate

resilience, and that input providers (seeds, fertilizers, irrigation) could provide resilient techniques and inputs.

- The first possibility is to involve them in the distribution of insurance. While providing resilient inputs (improved seeds, irrigation material) purchased on credit by banks and sold to farmers or farmers' organizations, insurance could be linked to the use of such materials. A guarantee that input suppliers will provide the needed material over a certain period would be a strong motivation for them to agree distributing insurance in the costs of inputs. Here these stakeholders would play a significant role in the insurance distribution process. In addition, it could be envisaged as an incentive to them that the insurances' payouts could cover at least (or be limited to) the cost of inputs, if the risk occurred during first phases of the plant's growth.
- The second possibility is to use them as collateral for insurers to guarantee the implementation of technical specifications as regards climate change resilient inputs, rather than as distributors. Involving them allows better trust for insurers to embark on the project and guarantee the technical itineraries for each concerned crop. This can minimize the cost of insurance premiums and maximize payouts at the same time.

We thus recommend involving input providers in all cases in a potential insurance scheme in Niger. However, the choice to associate them by assuring they will be the only providers of inputs or seeds for farmers willing to adopt index-insurance or to involve them in the distribution process will depend on actuarial studies that will financially assess the pros and the cons, according to the level of coverage needed for participating farmers.

Indeed, actuarial design of premium faces a dilemma. On the one hand it can cover (part of the) losses due to climate events (even though the insured event is climate, regardless of actual production losses). On the other hand, it can choose to cover inputs use. Covering input use aims at replacing inputs early in the agricultural season, in a situation where the climate event occurs in the first phase of the cropping cycle. With such a policy and in case the event occurs during the following phases, the payout is limited to the amount spent on inputs.

This choice relies first on the will of the parties and the contributive capacities of the insured. Pilot projects, if implemented in at least two different regions, could address the two roles envisaged for input providers and lead to further decisions at the same.

### 7.1.6 Government Role and State Support

The Government has a multiple role in index-insurance and its entities and administrative structures should be involved at different levels.

A major role of the Government is to act as the sponsor and leader of the project. None of the private partners is technically or financially strong enough to single-handedly take the burden of launching an index-based insurance project in the agricultural sector in Niger. It is, therefore, the State's role to make sure that such a project can be launched and facilitate other stakeholders to get involved take on the lead in a second step.

Government (Ministry of Finance) should provide the regulatory framework:

- To prompt insurance companies to launch WII products
- To then control, through the Directorate of Insurance, data availability and help them adjust index accordingly. To do so, it must strengthen its capacities to tackle agricultural insurance
- To organize and rationalize the agricultural insurance market through coherent and sustainable risk layering, transferring higher risks to reinsurers or by reinsuring catastrophic risks itself (for instance through contingent loans).

Government (National Meteorology under Ministry of Transport) provides the meteorological infrastructure and the Ministry of Agriculture and Ministry of Livestock provide the yield and production data:

- Government should allow better access for insurance companies to reliable weather and yield data so that these stakeholders can manage risks and develop products relying on accurate design and pricing.
- Government should invest in meteorological infrastructure (rain gauges, stations) to cover the country uniformly in order to provide accurate weather data, especially in regions suitable for index-insurance.
- Government is thus the best suited to choose pilot regions to test weather-based index insurance.

Government provides the research framework:

- Government should continue its efforts to foster drought-resilient crops and species and generalize their use.
- Government should encourage the commercialization of resilient seeds and other inputs and the adaptation of foreign species, when possible, to local varieties.
- Government should improve animal health practices and help implement best international practices to reduce risks among herders and to increase potential efficiency of an index-based insurance for livestock.

Government (The President and the Ministry of Agriculture) is responsible for land policy and the general orientation of agriculture:

- Land questions have to be handled by government as these provide strong incentives for insurance and the financial sector. Land certificates are the best guarantees an insurer or a lender can obtain.
- The 3N plan is a step forward in the process of designing a national strategy in Niger for agriculture. However, a Framework Law on Agriculture could provide more accurate prospects and targets for Nigerien agriculture, including agricultural insurance and the stakeholders to be involved, as well as particular focus regarding production potentialities per value chain per region.
- Consequently, government has to encourage, through mechanization, access to credit, etc. and promote the emergence of an actual agribusiness sector in Niger that would represent the main demand for agricultural insurance in Niger.

The question of government (Ministry of Finance / Ministry of agriculture) supporting index-insurance affordability by subsidizing insurance premiums or indemnities could also be explored. Indeed, another possible option to increase affordability and penetration of insurance is that the State subsidizes part of the insurance process, usually mainly insurance premiums or indemnities. In this case, farmers and their organizations will find themselves being supported by proactive state policies. Many countries confronted with agricultural risks such as frequent and severe droughts, as is the case in Niger, choose to invest in *ex ante* risk management measures such as insurance premium subsidy, rather than in *ex post* expensive programs. This enables mitigating the burden of post-disaster treatment and transfers the risk to insurance and reinsurance markets (India, Morocco, etc.). These ex-ante programs include subsidies to agricultural insurance.

### 7.1.7 Prospects and Potential PPPs to Implement

We propose below several solutions to implement a weather index-based insurance scheme in Niger (Figure 7-1):

**Option 1** is the easiest to implement. Insurers will be pooled into a co-insurance pool and excess losses will be transferred to the international market and to the government above a

ceiling that has to be detailed in excess loss treaties. Insurance will be underwritten by the pool through credit institutions (mainly DFIs, possibly banks), and purchased by associations of farmers (unions, cooperatives, companies, etc.). Input providers will provide resilient techniques that work as incentives to reduce, for instance, the cost of insurance. Government will provide the framework and specialized institutions will provide data (meteorological data, yields, etc.). Technical partners will assist in the design of insurance.

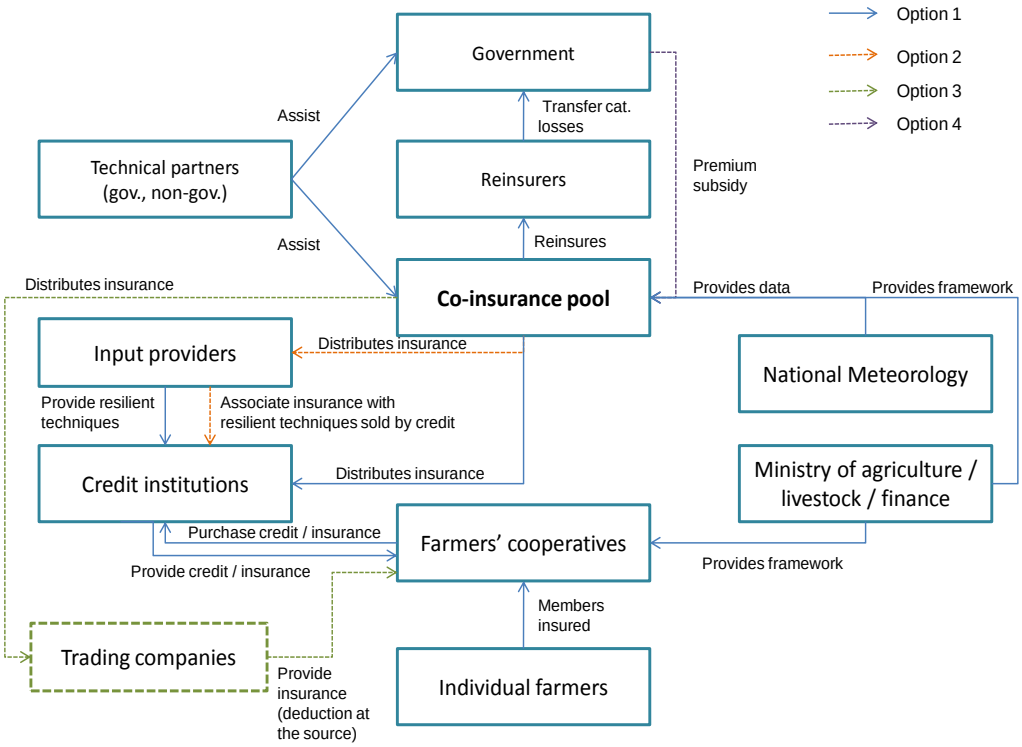


**Figure 7-1: Niger's proposed WII schemes**

Source: ACTUARIA

**Option 2** proposes a larger role for input providers. Indeed, they will be associated to the distribution of insurance, which will be priced with the cost of inputs, possibly sold through credits or directly to farmers' organizations. It will allow strictly limiting insurance payouts to the cost of inputs.

**Option 3** involves trading companies as channels of insurance distribution. These companies will purchase crops and productions to farmers / herders or their cooperatives / unions / companies. As financial flows will already be involved, it will allow direct deductions at the source, when crops are purchased or being sold.

**Option 4** implies greater State support through premium subsidies.

### 7.1.8 Economic of Investment of WII in Niger

The economics of investment for launching WII in Niger has been calculated based on vulnerability, and risk. Based on vulnerability, sorghum, peanut, cowpea and onion are the crops that respond to water deficit. Onion being an irrigation crop is not considered for WII. Even though millet is a drought resistant crop it needs risk mitigation measures as it is a subsistence crop of Niger. In addition, to this during the stakeholder consultation workshop, stakeholders also express common desire including millet for the WII. These crops occupy about 60% of Niger's present cultivated area and production. The Average Annual Loss (AAL) for these crops varies and for this reason, WII should be crop based. The Probable

Maximum Loss (PML) figures shows that there is a strong need for reinsurance also to be in Niger market (Table 7-1).

**Table 7-1: AAL and PML of selected crops based on 17 years of crop data**

| Crop | Millet | Sorghum | Cowpea | Peanut | Onion |
|---|---|---|---|---|---|
| **AAL (ton)** | 331,474 | 151,020 | 204,858 | 42,217 | 41,342 |
| **AAL (%)** | 12% | 20% | 26% | 17% | 12% |
| **PML (ton)** | 1,204,743 | 532,957 | 683,467 | 143,726 | 175,503 |
| **PML – AAL ratio** | 3.6 | 3.5 | 3.3 | 3.4 | 4.2 |

The investment cost estimated for launching WII in Niger is about USD 0.65 million (detailed break up provided in the subsequent section). Ideally pooling of insurers is preferred in the present context of Niger. Appropriate capacity building and resource mobilizing is required to set a good environment for the market. The premium considered per hectare is USD 25 (FCFA 12,500). This is a quick assessment figure which needs to be revised through actuarial studies and needs to be constantly revised based on additional data generated each year.

Internal Rate of Return (IRR) is calculated considering 10 years and is 112% with a payback period (recovery time) 6.5 years. The sensitivity analysis considering 100% claim on 3$^{rd}$ year (even though as per hazard assessment mild drought affected 30% of Niger every 3$^{rd}$ year) and 100% claim in the 6$^{th}$ year (moderate drought affect about 40% of Niger every 6$^{th}$ year) along with 10% claim in rest for the year (even good rainfall year) will have an IRR is 72%. In a scenario of 20% increase in the distribution cost with 30% and 60% claim for 3$^{rd}$ and 6$^{th}$ years along with 10% claim in rest for the year, still provide an IRR of 46%.

At this stage, the approach does not take into consideration the reinsurance issue. Nevertheless, the shape of the LEC suggests that reinsurance will be highly recommended to make the product feasible. The ratio of the PML to AAL is not high, meaning the reinsurance should be affordable.

IRR number shows promising results. For the economic analysis, conservative figures were considered. For arriving at the IRR, it is assumed that only 30% of the cultivated area (of selected crops) were considered and at least 10% claim happen each year even good rainfall years. Industry benchmark overhead costs considered for distribution and management. A very gradual growth (average 2%) of sale of product throughout ten years with higher growth in the 5$^{th}$ and 6$^{th}$ years when market attain maturity and further slow growth is considered.

### 7.1.9 Business Model for WII in Niger

#### *7.1.9.1 Potential customers and their profile*

1. Potential users are farmers who practice rain-fed agriculture
2. Crops considered for WII are millet, sorghum, cowpea, and peanut
3. An estimated 3.8 million farmers in Niger cultivate these crops considering the total crop area and per head capita holder size at 0.7 hectares. The millet and sorghum farm holdings are relatively bigger compared to cowpea and peanut farms. Taking into consideration the low awareness and poor infrastructure, the potential users considered are 30% of the total farmers cultivating these crops. Therefore, the present target users of WII would be about 1.1 million farmers.

4 The premium is calculated based on 17 years of crop data and comes to USD 25 per annum. This is pure premium+30% loading. Crop specific premium needs to be calculated, as there is a price difference for these crops. The premium for millet would be lowest, USD 9, sorghum USD 16, cowpea USD 19, and peanut USD 54 per annum.

5 Economic status of the potential users varies. Average annual income from 1 ha of land cultivating millet, sorghum, cowpea, and peanut is USD 128, 96, 86, and 71 respectively.

#### *7.1.9.2 Key partners to be involved*

WII needs the involvement of public institutions in facilitating a favorable environment for developing and continuing the insurance business in the country. The public institutions will provide the regulatory framework, administrative infrastructure, and data collection (meteorological or yields) infrastructure. Figure 7-2 shows the proposed key partners and their roles for WII in Niger.

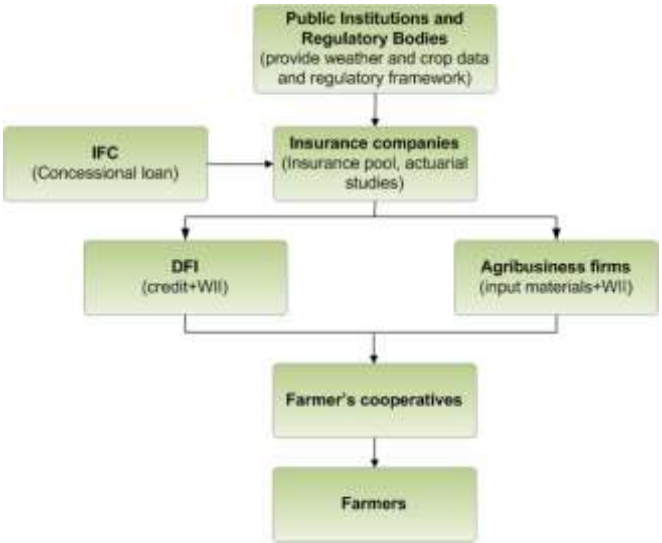


**Figure 7-2: Key proposed partners and their roles for WII in Niger**

#### *7.1.9.3 Operation model*

1 A 100% private business model with public institutions providing facilitation support is suggested
2 The investment amount required is USD 650,000 (detailed break up is provided in Table 7-2).
3 Considering the economic status of farmers, existing subsidies in the agriculture sector (30% subsidies for seed and fertilizers) and the concessional loans and grant money, insurance companies can provide a subsidized price for WII.
4 The subsidy can be implemented on a shared basis – with contributions from the government and insurance companies that are availing a concessional loan from IFC
5 The distribution of the WII product needs to be tied to agriculture credits (compulsory), and credits for seeds and fertilizers
6 Existing distribution channels should be used to reach the rural interiors so that there is minimal loading on the cost of the product. The channel partners should be given commission based on sales. This will encourage stakeholders in charge of distribution to put efforts in promoting the products.
7 The claims should be through channel partners and in the form of climate resilient seeds. If a balance amount is left, this can be provided in the form of grains rather

than as cash. This will help farmers to continue in agriculture and the climate resilient seeds will help reduce risk and improve yields. On an overall basis, these measures should improve the farmers' economic status and help them graduate from the WII subsidies.

**Table 7-2: Investments required to launch WII (first year) in Niger**

| Designation | Investment (USD) | Stakeholders |
|---|---|---|
| Feasibility studies | 100,000 | Insurers |
| Collection of own data and calibration | 50,000 | Insurers |
| Product conception and pricing | 100,000 | Insurers |
| Communication and marketing | 100,000 | Insurers |
| Reinsurance | 250,000 | Insurers |
| Training and capacity building and human resource | 50,000 | Insurers |
| Total investment cost of development of WII | 650,000 | |

#### *7.1.9.4 Risk sharing*

1 Regulation authorities could limit the joint market share in order to stop a single company from owning a majority market share.
2 Insurers will retain part of the risk together in a pool and excess loss will be transferred to the international reinsurance market and/or to government reinsurance.
3 IFC's concessional loan will help insurance companies to share risk with IFC in the investment.
4 To give impetus to the private sector, the public sector should provide free weather data for calculating claims for the first 10 years.

#### *7.1.9.5 Business model benefits*

This business model allows mapping all cash flows: the IFC loans and the premiums enter in the outturn account of the business model, and the outflows are made of commissions to distributors, management costs, claims, and IFC reimbursements (Table 7-3). Reinsurance and loss calculations need actuarial studies and periodic calibration and updating, which have to be taken into account.

1 If an insurer gets enough incentive to invest USD 250,000, the firm will be able to launch the WII product with the IFC loan
2 The firm will then have a cumulated income of USD 2,280 million over the next 10 years.
3 The insurer will reward distributors (agents, brokers, etc.) USD 456,069 over the same period
4 It will dedicate USD 46,000 to its internal costs and USD 462,000 to claims
5 It will keep USD 593,000, net of IFC reimbursements over the 10 years.

This is based on the assumption that IFC would provide a loan of USD 400,000 at the interest rate of 2% per annum over 10 years.

**Table 7-3: WII business model for Niger**

| P & L of the insurer(s) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Premium (assuming % growth as below WII product every year)** | 203,239 | 207,304 | 213,401 | 219,499 | 227,628 | 233,725 | 237,790 | 241,855 | 245,920 | 249,985 |
| **Based on product growth percentage** | 0% | 2% | 5% | 8% | 12% | 15% | 17% | 19% | 21% | 23% |
| **Investment costs** | **650,000** | | | | | | | | | |
| **Support from IFC (loan + repayment)** | 400,000 | -8,000 | -8,000 | -8,000 | -8,000 | -8,000 | -8,000 | -8,000 | 8,000 | 408,000 |
| **Distribution costs (20% of premium)** | -40,648 | -41,461 | -42,680 | -43,900 | -45,526 | -46,745 | -47,558 | -48,371 | -49,184 | -49,997 |
| **Management costs (10% of claims)** | -2,032 | -2,073 | -6,402 | -2,195 | -2,276 | -14,024 | -2,378 | -2,419 | -2,459 | -9,999 |
| **Risk or probable claim (based on risk)** | -20,324 | -20,730 | -64,020 | -21,950 | -22,763 | -140,235 | -23,779 | -24,185 | -24,592 | -99,994 |
| **- based on Loss ratio** | 10% | 10% | 30% | 10% | 10% | 60% | 10% | 10% | 10% | 40% |
| **Bottom line** | -109,765 | 135,040 | 92,299 | 143,454 | 149,063 | 24,722 | 156,075 | 158,880 | 161,685 | -318,006 |
| **Internal Rate of Return** | **112%** | | | | | **112%** | | | | |

## 7.2 Pilot Agriculture Insurance Program

The hazard analysis shows that Maradi and Zinder regions are highly vulnerable to drought and the probability of occurrence is high in these regions (Figure 9-1 to Figure 9-4). However, the number of farmers engaged in agriculture is high in Maradi compared to Zinder. More than 60% of Maradi region experiences severe drought (probability of occurrence 15 years). For these reason, it would be ideal to pilot the agriculture insurance program in Maradi.

Based on the analysis of exposure and vulnerability of crops, it is recommended to select sorghum, cowpea, peanut, and onion as test crops for launching the crop insurance product on a pilot basis. The selection of these crops is due to:

i. the high degree of crop vulnerability to drought, and
ii. high acreage of these crops in Niger.

Hence, Figure 4-3 to Figure 4-7 show that cowpea is the most vulnerable to water deficit followed by sorghum, peanut, and onion. Whereas millet is the least vulnerable to water deficit as this is a drought resistant crop. Regarding total crop acreage, after millet, cowpea covers the highest acreage followed by sorghum and peanut. Although acreage of onion is low this crop is currently the main cash crop for the farmers in Niger. This is the reason why onion has been recommended as one of the test crops for the pilot crop insurance product.

# 8 Summary Findings and Recommendations

## 8.1 Summary Findings

- Niger is highly vulnerable to climate change induced hazards. The recurring drought is affecting the agriculture sector, livelihoods and food security, in-turn curbing the country's development.
- Niger has reasonably good density of weather observation stations – 15 meteorological stations and 154 rain-gauge stations, mostly distributed in the inhabited southern part of the country. The data is available for the last 30 years and is sufficient to develop WII product.
- Satellite data (NOAA-AVHRR and METEOSAT) are available at different resolution since mid-80s for this region and could be used to develop a satellite based index insurance, to refine the meteorological data. Different index can be built based on satellite data (NDVI, EI, etc.).
- Crop data of major crops are available only since 1995 for the entire country with missing values in some years. As at least 20 years is usually required to build consistent index with minimum basis risk, the available crop data length is insufficient to generate robust vulnerability curves
- There is a lack of livestock mortality data in the country. Niger started organizing its statistics on fodder production only recently. The production statistics is not consolidated as most of the livestock produced in Niger is exported to neighboring markets (especially Nigeria) through unofficial trade networks. It needs in-depth survey to understand the mortality rate and cause to set the premium for livestock insurance.
- The country is highly vulnerable to drought hazard and most regions are likely to face minor drought conditions once in a 3 to 10 year period, and moderate drought conditions once in a 6 to 10 year period. Large parts of Maradi, Tahoua, and Tillaberi are likely to face severe drought conditions once in an 11 to 15 year period. Probability of severe drought affecting majority of Niger is once in 21 to 25 years and extreme drought once in 26 to 30 years. Severe and extreme droughts are covariate risks. Maradi and Zinder are more hit by droughts than other regions. However, Zinder is arid and Maradi more populated. For these reasons, it would be ideal to pilot the agriculture insurance program in Maradi or Zinder.
- The vulnerability analysis for key crops shows cowpea is the most vulnerable crop to water deficit followed by sorghum, peanut, and onion. Whereas millet is the least vulnerable to water deficit condition.
- The country's financial investment in the agriculture and livestock sector is very low, and accounts for only 1.13% of the GDP (and only 0.27% for the sole state budget) even though the sector, formal and informal, contributes around 15% of the nation's GDP. Financing the agriculture sector is not seen as a very lucrative proposition by the financial institution in the country. In addition, the lack of collateral and credit guarantees are the key reasons for the low penetration of banking in the agriculture sector. The solvency and credit access could be tackled on different levels to increase financing in the agricultural sector and allow a better penetration rate of insurance.

- Presently, there is no agricultural insurance product available in Niger. It needs adequate background work before launching of any products. As the main hazard in Niger is drought, WII should rely on an index measuring water availability/deficiency.
- The recent developments in Niger and West African region represent an opportunity to launch WII schemes in the entire CIMA region, which was forbidden until April 2012. Book n°7 of CIMA Code now provides a legal framework for WII in CIMA zone that it can be launched but has to remain a microinsurance product.
- There is only one life insurance company in Niger. There are four companies in Niger working mainly in the general insurance sector and relying on a captive market made of legally compulsory insurance products. These companies have low capacities at present to launch agricultural insurance but are potential players in the market. These insurers presently face issues like limited solvency, low credibility, high claim handling costs, absence of expertise in WII. Two of them, Company M and Company L, appear to be promising potential players.
- Although awareness among the farmers is low, farmers have heard about insurance mechanisms and are interested to avail it to protect from major losses due to drought. However, demand and financial capacity of farmers are low as per the survey. Maradi has shown highest interest (74% of surveyed farmers) agree to pay a $25 premium to get their losses covered (to an unknown level).
- Basis risk would be high due to the lack of adequate crop data and will in turn increase the price of insurance.
- The premium considered per hectare is USD 25 (FCFA 12,500). This is pure premium+30% loading. Crop specific premium needs to be calculated, as there is a price difference for these crops. The premium for millet would be lowest, USD 9, sorghum USD 16, cowpea USD 19, and peanut USD 54 per annum. Rough calculations (PML/AAL, etc.) show evidence there is a strong need for reinsurance to transfer excess loss that will not be able to be retained at insurers' level.
- As demand and financial capacities of farmers are low, the insured will not be able to afford insurance without incentives in spite of a certain willingness to pay they express. Any WII project in Niger will need consistent financing from government and/or donors agencies, whether in the form of subsidies to premium or for instance in the form of an excess-loss treaty based on foreign experiences (government/donors can be the reinsurer in last resort for losses up to a certain percentage of the average expected losses).

## 8.2 Recommendations

- To protect livelihood and food security in Niger, it is essential to device adaptation strategies for climate change induced risk for the agriculture sector. WII is an option towards this and it needs strengthening of the base country data for product development.
- Satellite data is a good proxy for meteorological data and can be used to build WII index. It is necessary to refine the satellite data with field data, which will confirm main findings from satellite imagery. However, AWS data is the most accurate one and 75 AWS are required to develop a reasonably good density of weather station across the country and will cost USD 900,000.
- Agronomic data prior to 1995 available in Niger should be collected in order to refine agronomic data and reduce basis risk.

- For livestock insurance, NDVI method explored in Kenya is an option that can be tried in Niger. However, it needs in-depth survey focusing on one or two districts to understand the mortality rate at households' level and causes to set the premium and pilot it at district level as the country lack production and mortality statistics.
- WII should pilot either in Maradi or Zinder based on hazard and vulnerability crops that can be included in the pilot would be sorghum, cowpea and peanut. A detailed actuarial study using long-term crop data to calibrate the premium must be launched. It will need constant revisions based on additional data obtained each year from the farmers' field.
- It is essential to develop awareness and training for insurance companies in Niger. Ideally, a coinsurance pool, gathering the most proactive insurers on WII, should be created to underwrite premiums, and share risks and benefits of insurance among the active players in the country. Pooling risks, while isolating agricultural insurance from other insurance businesses already underwritten by these insurance companies, is a strong motivation as it prevents this product from jeopardizing the insurers' other activities. Company L and Company M expressed their interest and have consistent technical partners (respectively Company O and Company N) to discuss the operational implementation of WII. These entities will be best suited to help them express their needs and handle the issues of WII. Company N Africa stakeholders for instance and Company M, which belongs to Company N has close ties with other Company N members in West Africa and should benefit from the Planet Guarantee experience based on Company N. It is also essential that insurers are trained, possibly through trainings in countries where WII is already implemented/piloted (Burkina-Faso, Ethiopia, Kenya, etc.).
- Reinsurers have to play a leading role on the market and provide the technical skills to launch WII. It is among the top five priorities to embark reinsurers already familiar with WII and possibly with the GIIF project on Niger WII project. IFC could select reinsurers it already knows and works within the region to foster WII's operational implementation.
- DFI can play a key role in the distribution of WII in the country taking into consideration of their network presence in the rural Niger. The recent regulation of the CIMA code explicitly associated WII with micro-insurance distribution. Company E and Company F, which are the two main DFIs in Niger, are believed to be the main willing institutions to distribute WII products. The bundle loans (credit and insurance) techniques have already been successful in benchmark countries.
- Alternative distribution channels include cooperatives, and aggregators. Strengthening of cooperatives through national development strategies and developing integrated approach in the sector (production, transportation, transformation, sale, etc.) will help in strengthening aggregators. Developing credit in order to allow a greater number of farmers to purchase inputs and material and use input providers as distributors for insurance is also a viable option.

# 9 Annexures

## 9.1 Annexure 1: Additional Support Information

### 9.1.1 Description of Study

The study diagnostic and the recommendations are summarized in the following matrix:

| Themes | Diagnosis | Recommendations |
|---|---|---|
| **Data** | **METEOROLOGICAL DATA**<br>- 15 meteorological stations and 154 rain-gauge stations, mostly distributed in the inhabited southern part of the country, every 28 kms for the rain-gauge and every 158 kms (average) for meteorological station.<br>- Data are available since 1982 and is sufficient to develop WII product. However, for hazards like pest, disease, wind and temperature stress additional 75 meteorological stations are required<br>**SATELLITE DATA**<br>- Satellite data (NOAA-AVHRR and METEOSAT) are available at different resolution since mid-80s.<br>**AGRONOMIC DATA**<br>- Available for major crops only since 1995 for the entire country. However there are missing values in some years.<br><br>**LIVESTOCK DATA**<br>Lack of mortality data and consolidated production statistics on livestock<br><br>Conclusion: Rainfall / satellite data are sufficient to build a rainfall-based index. Agronomic data are short which would increase the basis risk. | Satellite data is a good proxy for meteorological data and can be used to build the index. However, it is necessary to refine the satellite data with field data which will confirm main findings from satellite imagery.<br><br>However, AWS data is the most accurate one. Financial support of USD 900,000 is required to implement additional 75 AWS and can be implemented through insurers and/or governments and/or cooperatives.<br><br>We recommend IFC would take the lead on two tasks to soften the risk:<br>- Conduct a comprehensive field survey, once the target crops and areas are identified, to help calculate premiums through household data<br>- Support the Government of Niger to facilitate in collecting agronomic data prior to 1995 in order to refine agronomic data and reduce basis risk.<br>- Carry out indepth survey in one or two district to understand the mortality rate and its cause to assess the premium for livestock. |
| **Hazards** | **REGIONS**<br>Most regions are likely to face minor drought conditions once in a 3 to 10 year period, and moderate drought conditions once in a 6 to 10 year period.<br><br>Large parts of Maradi, Tahoua, and Tillaberi are likely to face severe drought conditions once in an 11 to 15 year period. Probability of severe drought affecting majority of Niger is | **REGIONS**<br>The choice of the best region for the pilot has to be discussed with Niger governments, in order to avoid the project being blocked when time would come to approve the product at a regulatory level even though in terms of hazard and vulnerability preferred location for piloting would be Maradi or Zinder.<br><br>**CROPS**<br>It is recommended to select millet, sorghum, and cowpea as test crops for launching the |

| Themes | Diagnosis | Recommendations |
|---|---|---|
| | once in 21 to 25 years and extreme drought once in 26 to 30 years. Severe and extreme droughts are covariate risks. Maradi and Zinder are more hit by droughts than other regions. However, Zinder is arid and Maradi more populated. For these reason, it would be ideal to pilot the agriculture insurance program in Maradi.<br><br>**CROPS**<br>Cowpea is the most vulnerable crop to water deficit followed by sorghum, peanut, and onion. Whereas millet is the least vulnerable to water deficit as this is a drought resistant crop. | crop insurance product on a pilot basis. The selection of these crops is due to:<br>iii. the high degree of crop vulnerability to drought<br>iv. high acreage of these crops in Niger<br>v. higher value added.<br><br>IFC should discuss with Government of Niger their political will to insure millet growers because of the "social importance" of millet compared to other crops.<br><br>It is also recommended that IFC would put condition on the farmers, who purchase WII product, to use drought tolerant varieties (e.g., climate resilient crop varieties) of these crops in the country. |
| **Basis risk** | Basis risk is high due to the lack of adequate crop data. | It is required IFC support the government in collecting historical agronomic data which are presently available in disaggregate form in the agriculture offices in districts and regions.<br>Also see recommendations above on data section. |
| **Index** | Due to the main hazard being drought, WII should rely on an index measuring water availability/deficiency.<br><br>Index has to be based on rainfall measurement/availability weather by satellite or by meteorological stations. | In the view of huge cost involved for setting up meteorological station to represent the rainfall over the farmers' plots where the information is needed most can explore the use of satellite data based rainfall indexing.<br>The skill of Aghrymet centre in Niger can be used to model an index with the support of the industry's scientists (especially reinsurers).<br>We recommend to use this expertise which would be cheaper than using for instance EARS, ILRI, or other specialized centres. |
| **Pricing** | Given our first results based on AAL/PML ratio based on 17 years of crop data, insurance costs could be quite high and premium calibrated on the cost of this risk as well.<br><br>The premium considered per hectare is USD 25 (FCFA 12,500). This is pure premium+30% loading. Crop specific premium needs to be calculated, as there is a price difference for these crops. The premium for millet would be lowest, USD 9, sorghum USD 16, cowpea USD 19, and peanut USD 54 per annum. | It is critical to carry out a detailed actuarial study using long term crop data to calibrate the premium and needs to be constantly revised based on additional data obtained each year from the farmers' field. We strongly recommend IFC to launch this study once crops and pilot areas are determined. |
| **Insurers** | The insurers in Niger has:<br>- Limited solvency<br>- Low credibility<br>- High claim handling costs<br>- Absence of expertise in WII | IFC should first of all use the good will expressed by the insurers to organize a round table gathering Company L and Company M insurers' technical partners/networks (respectively Company O |

| Themes | Diagnosis | Recommendations |
|---|---|---|
| | - Strong will to launch new products<br>- Momentum to open the market to new operators | and Company N, both) to discuss the operational implementation of WII. These entities will be best suited to help them express their needs and handle the issues of WII. The Company N Africa stakeholders for instance and Company M, which is belonging to Company N has close ties with other Company N members in West Africa and should benefit from the Planet Guarantee experience based on Company N.<br><br>The agenda of this round table is creation of a coinsurance pool, in order to share profits and risks and act as complementary in the market. Pooling risks, while isolating agricultural insurance from other insurance businesses already underwritten by these insurance companies, is a strong motivation as it prevents this product from jeopardizing the insurers' other activities.<br><br>In order to rapidly implement a WII pilot project, it is essential to sensitize and train insurers and organizing study trips to at least two countries where WII is running (for instance Kenya and Burkina Faso).<br><br>Additional efforts in advocating for the launch of new companies on the market such as Company PP (Company QQ), will improve competition and professionalization. |
| **Reinsurers** | Rough calculations (PML/AAL, etc.) show evidence there is a strong need for reinsurance to transfer excess loss that will not be able to be retained at insurers' level.<br><br>The 4 companies have reinsurers, with different capacities and technical skills regarding WII. | IFC should facilitate contact between the companies' reinsurers and these companies, as it already has a strong experience of the regional reinsurers' with the GIIF project. IFC could select reinsurers it already knows and works within the region to foster WII's operational implementation. These reinsurers should be invited to the round table with insurers and their network.<br><br>Reinsurers could then play a leading role on the market and provide the technical skills to launch WII. |
| **Role of the state** | Apart from the CIMA Code authorizing WII at regional level, every product must be approved in the market. There is no such experience for now and need to develop a regulatory framework.<br>Provide main meteorological and agronomic data.<br>Coordinate the catastrophic risks emergency response. | IFC, World Bank and other donor agencies along with the national insurance companies should work with the Government for approval of product in the market and organize and collect the meteorological and agronomic data.<br><br>Government should be involved in the risk layering of WII and act on two levels:<br>- Reinsuring catastrophic and covariate droughts in last resort |

| Themes | Diagnosis | Recommendations |
|---|---|---|
| | | - Provide subsidies on premium in order for WII to be available to the higher number of farmers<br><br>Government should also be associated to the choice of the pilot project (area, crop) in order to ensure no bottleneck arise from any state institution in the project. |
| **Willingness to Pay** | Although awareness is very low, there is understanding among surveyed famers of insurance mechanisms and interest from them to cover major losses due to drought.<br>However, demand and financial capacity are low as per the survey sample – about 59% of farmers earning less than $200 a year, 20% earns between $200 to $600, 12% between $600 and $1000 and 9.2% above $1000.<br><br>However, in Maradi area 74% of surveyed farmers agree to pay a $25 premium to get their losses covered (to an unknown level).<br><br>. | Demand being expressed is critical to successfully launch a WII product in Niger. It has to be encouraged and defined. Piloting the WII products will also help in generating awareness of the benefit of WII in the country. A post pilot willingness survey is required to ascertain the level of readiness of farmers in buying WII product.<br><br>Such a study should take place following the decision IFC and government will take to launch the pilot. It will create momentum to:<br>- raise awareness among farming communities and farmers' cooperatives on the benefit of WII products<br>- provide rebate in the premium price either through subsidies or rebate in the farm input price in the initial 4-5 years |
| **Distribution** | Due to CIMA code restrictions and as no commercial banks do sell microfinance product, the only ones able to distribute a micro-insurance product are DFIs. At least two of the numerous Nigerien DFIs expressed their willingness to distribute insurance (Company E and Company F).<br>Alternatively, there are numerous cooperatives which could be involved in the distribution, and collect the premium on behalf of insurers which also express their interest.<br>No real aggregators exist as such in Niger, since Company Y (potato and onion) went bankrupt. | We recommend using DFIs in order to bundle loans to insurance as benchmark examples succeeded and leverage the existing distribution network of DFIs. However, cooperatives could also be involved to increase value chains organizations.<br><br>IFC should meet these partners along with insurers and define with them the role they will play and the financial component they will get. |
| **Subsidy** | No subsidy on premium for any kind of insurance product currently.<br><br>However, huge amounts of money are spent in *ex post* (11% of risk management programs from 2010 to 2012) and *ex ante* risk management instruments (63.5% of these risk management programs). | Subsidies will help expand WII and to make it affordable. It has to be a State's choice to allocate part of the money previously dedicated to other ex-ante disaster intervention (for instance) into risk transfer instruments (insurance, i.e. premium subsidy).<br><br>This could not be decided before any actuarial calibration of the pure premium. Only when IFC would have done that, it will be able to say which part of it is going to be paid by farmers/by the State, according to the |

| Themes | Diagnosis | Recommendations |
|---|---|---|
| | | level of premium required.<br><br>Taking into consideration of the economic status of Niger farmers, it makes sense to provide rebate in the premium price either through subsidies or rebate in the farm input price in the initial 4-5 years. |

### 9.1.2 Details of Data Collected and its Source

**Table 9-1: Particulars of data collected**

| Variables | Main source | Other source | Remarks |
|---|---|---|---|
| **Crop data – area, production** | Department of Agriculture, agricultural statistics | Supplemented with data collected from INS, FAO publications | Agricultural data for the period 1995-2011 (17 years) |
| **Weather data** | Meteorological Department | None | Weather data (monthly level, temperature, rainfall, solar radiation, wind speed and relative humidity) were available for 29 years from 15 weather stations and rainfall data for 29 years from 154 rain gauge stations. |
| **Insurance statistics** | Directorate of Insurance Control – Ministry of Finance | Insurers' Committee Insurance companies | CIMA status were available from 2008 to 2010.<br>Annual reporting was available for 2010. |
| **Basic demographic data** | INS publication, National Institute of Statistics, Niger | Annual Statistical report 2006 – 2010 from INS | Data consists of region wise break up of number of males and females, rural males, rural females, urban males, urban females. |
| **Farming communities and farmers associations** | Federation of cooperatives (RECA, FCMN, MOORIBEN, AINOMA, FUCOPRI) and Department of Agriculture | | Information related to organization profile, strategies and plans |
| **Private players in Agri business** | Chamber of Commerce | | There are many private entities registered with the Chamber of Commerce. However, only a few are working. Information like size of the organization, product wise sales statistics, etc. were collected from some of the key players. |
| **Financial organization** | Ministry of Finance Directorate of Credit | Company C, Company G, Company E, Company F Institution A, Institution C website | ARSM report on micro-finance was available for 2012 but is still in progress<br>Banks and DFIs data were available from 2008 to 2010 |
| **Policy documents** | 3N High Commission | | 3N, PROMOVARE, PPP (yet to receive from the country focal point), seed policy (as it is not approved by the parliament so not available) |

| Variables | Main source | Other source | Remarks |
|---|---|---|---|
| **Livestock statistics** | Directorate of Statistics - Livestock | | Good quality region wise data available with the department on livestock was collected and compiled for the period 1970-2007 |

### 9.1.3 Spatial Distribution of Drought Hazard in Niger

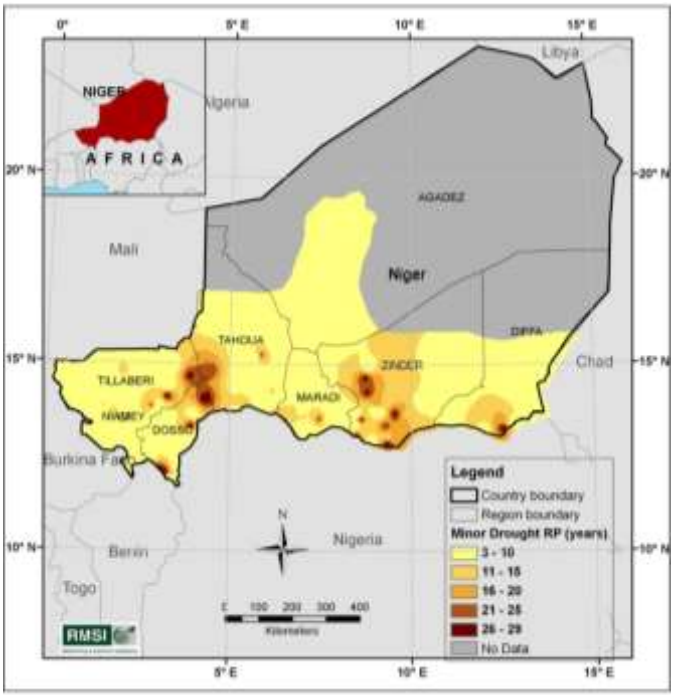


**Figure 9-1: Map showing spatial distribution pattern of minor drought event return periods, based on SPI values computed using historical rainfall data**

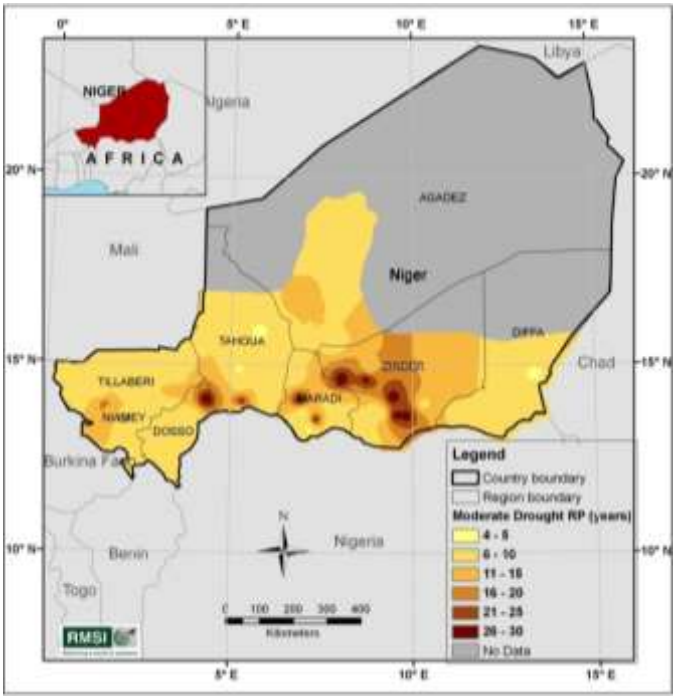

**Figure 9-2: Map showing spatial distribution pattern of moderate drought event return periods, based on SPI values computed using historical rainfall data**

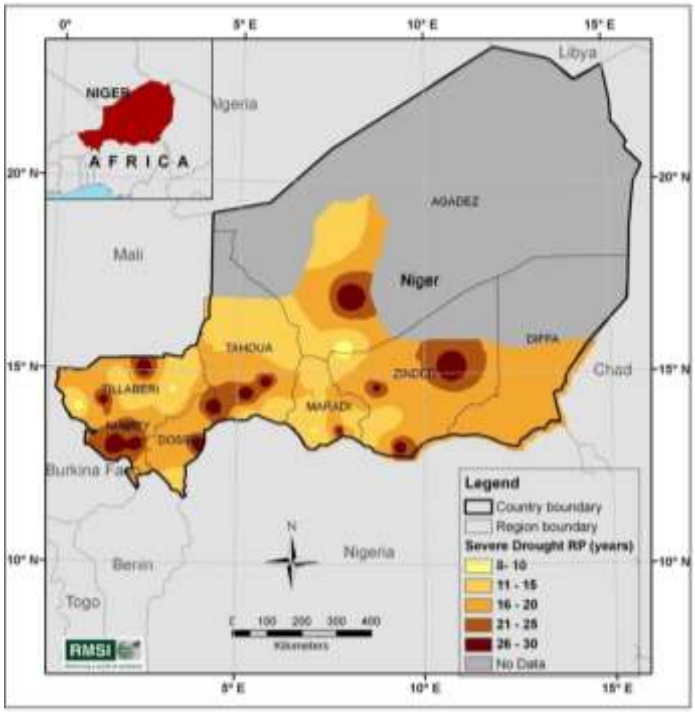


**Figure 9-3: Map showing spatial distribution pattern of severe drought event return periods, based on SPI values computed using historical rainfall data**

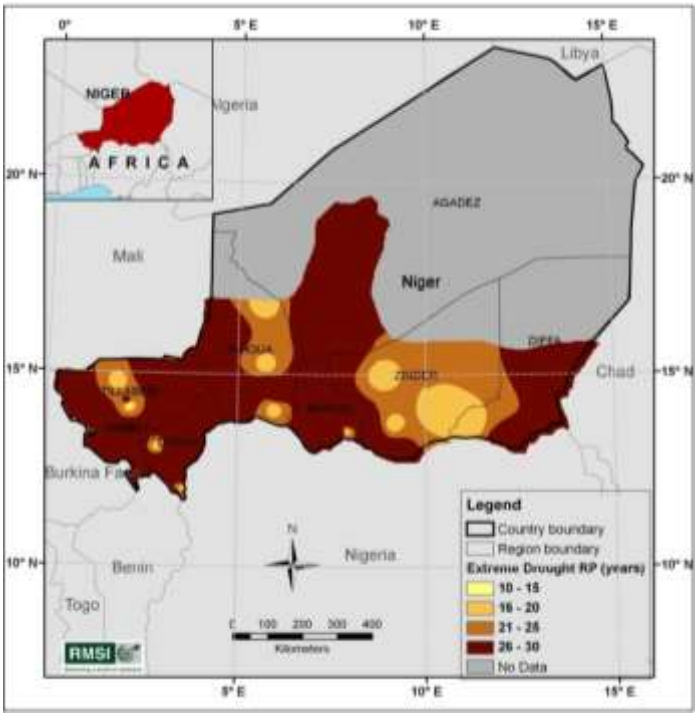

**Figure 9-4: Map showing spatial distribution pattern of extreme drought event return periods, based on SPI values computed using historical rainfall data**

### 9.1.4 Weather Index-based Insurance

The increasing popularity of WII can be explained by its undeniable advantages. These advantages are briefly assessed to see how it could be related to Niger's situation.

- **Less data-intensive**: One of the main advantages of index-based insurance is that the triggering threshold and indemnities management are not linked to actual crop losses data due to climatic events in environments where the information is often lacking. Indemnity, on the contrary, relies on a calibrated model, defined at early stages of the process, which accurately defines indemnities given to the insured according to the level of the index measured.
- **Reduction of expertise and transaction costs**: When it is not only a "trigger" but also the basis of indemnity, WII allows reducing the cost of expertise, as there is no need to assess actual loss value at the plot-level. The index embeds all the information needed to assess the indemnity.
- **Suppression of moral hazard and adverse selection**: With index-based insurance, the insured receives indemnity according to the index, whether the farmer has or has not suffered losses. Therefore, the farmer has no interest in creating a situation in which he would influence the damage's extent that triggers the insurance payouts. The farmer has even more interest in managing his crops well, considering that he could be reimbursed for the index occurrence, while still benefiting from his crops' income. Thus, the insured does not know more about his risks than the insurance company does: index-based insurance attracts both "good" and "bad" risks and "good" farmers do not pay for "bad" farmers.
- **Reduction in reinsurance costs**: As the threshold is triggered by an objective parameter and avoids any human intervention, index-based insurance is usually considered as being safer, more objective, and capable of avoiding the risks of drift, i.e. manipulation of yield or loss data. Reinsurance pricing is thus economically beneficial compared to traditional insurance.

#### *9.1.4.1 Indexes and main options*

There are mainly two kinds of WII, whether they are targeting the "causes" or the "yields". Both could potentially play an important role in climate change adaptation.

- Index-based insurance on causes specifically targets the parameter assumed to generate the risk (rainfall, temperature, wind, etc.) through the index.
- Index-based insurance on yields relies on indexes that represent aggregated average yields in a particular area - often reckoned through satellite imagery, and indemnify farmers according to this index, notwithstanding the actual yield of the insured.

##### 9.1.4.1.1 Index-based insurance on causes

**Principle:** Index-based insurance on causes aims at insuring phenomenon assumed to generate a risk, in areas where there is risk exposure to adverse climate events. For instance, in rainfed areas this takes into account the effects of drought, excessive rainfall, or strong winds on particular crops or on several crops at the same time. As soon as preliminary analysis finds sufficient correlation between rainfalls, strong winds, or low temperatures on the one side and production on the other, farmers or herders can

underwrite an insurance policy in which payouts are made each time these parameters fall below (or upon reaching) an agreed threshold.

Whatever the index, these policies that are currently offered in Nicaragua, India (rainfall), the Caribbean (winds), or Mongolia (low temperatures) have some common elements:

- Indemnity is triggered by the insurance policy: This trigger can be a rainfall threshold during a defined period or the number of cold or hot temperatures registered over a defined period (for instance, livestock insurance against cold temperatures in Mongolia is defined over January to May).
- Insurance is adapted to crops phasing: Adverse weather events may occur at any phase of the crops' growth. Index-based insurance usually makes a distinction between these phases as they could all be affected by climatic risks at different levels. The index can make a distinction depending on whether the adverse event occurs during seeding, sowing, growing, flowering, or harvesting.
- A limited range of action: The index can define thresholds upon (or under) which events cannot be characterized anymore as insurable adverse weather events, but as natural disasters (severe drought, hurricanes, etc.) in which insurance cannot intervene.
- A correction of data used to measure the index: Data used to build indexes have to be constantly reviewed due to changes in the occurrence and severity of triggering parameters assumed to generate losses. In the case of rainfall, for instance, rainfall above or below certain thresholds cannot be taken into account due to phenomenon such as evapotranspiration or the soil's water retention ability. For example in India, rainfall below a daily 2 mm or above 60 mm is not taken into account.

**Climate change appropriateness and opportunities in Niger**: Although the scientific community is still divided over the question of climate change in the Sahel and, whether it will result in long-term increased desertification or renewed greening, they usually agree[34] to the conclusion that the occurrence of extreme weather events has increased. Niger accounts for a huge part of the Sahel hotspots in which the rainy days in August have decreased as is evidenced by the past 10 droughts of the 20$^{th}$ century. The main indicator is drought and the occurrence of severe and extreme drought is mainly measured through rainfall indicators. In countries, such as the Caribbean, southern U.S. or countries located around the Indian Ocean, various events related to climate change induce losses and make it impossible for an index-insurance to be based only on rainfall. It has for instance to take into account winds, atmospheric pressure, evapotranspiration or other parameters.

Implementing weather Index-based insurance has the double goal of covering potential losses due to climatic events as well as encouraging change in behavior and improved resilience from climate change. In countries such as Niger, where there is strong yield variability and where the occurrence of extreme weather events has increased over the past decades, there is a need to pay continuous attention to climate change.

Weather index-based insurance is best suited to this concern, as it is often linked to distribution through credit policy and input supply integrating climate change concerns. Indeed credits, with which insurance can be linked, could target resilient crops (rather than crops, for instance, needing intensive watering) or resilient improved species of livestock. Resilient seeds as well or sustainable fertilizers may be part of the insurance package if it is distributed through input providers.

[34] Heinrigs Philipp, Incidences sécuritaires du changement climatique au Sahel : perspectives politiques, OECD, 2011

The main advantage of weather index-based insurance in Niger, while choosing only one index, would be to avoid complex calculations involving many parameters, and consequently to allow cost reductions and improved loss adjustments. As there is strong correlation in Niger between rainfall and crop yields, since decrease in rainfall is the main cause for yield decrease, a weather parameter based on rainfall sounds appropriate.

In a country where the quality of yield data is restricted to the last 15 to 18 years, which is too short to design an accurate yield index, historical meteorological data is better (especially rainfall) since it spans a longer period, and could thus lead to a more accurate design of premiums.

However, if climate change and the increasing occurrence of weather catastrophic events are to be loaded in the insurance premium that will be charged to the insured, further actuarial studies would be needed to assess potential costs of these loadings as it could result in excessively high-costs due to Niger's profile and exposure to climate change.

##### 9.1.4.1.2 Index-based insurance on yields

Index-based insurance may also be based on yield statistics rather than on weather parameters, and is independent of actual yields of an insured farmer or herder.

**Area-yield**: Area-yield insurance is widespread and based on an index aggregating the farmers' average yields on a defined area, usually at regional or district level. Indemnities are then paid based on losses at the regional level rather than at the farm level, according to the difference between observed yields and average yields, each time the yields do not reach expected thresholds.

A prerequisite of area-yield insurance is to pool a population large enough to avoid the risk of moral hazard and solid enough to avoid any localized variation in yield due solely to weather for instance. For this reason, it is aggregates yield data on a relatively vast area. . It is common that area-yield insurance requires a minimum size of cultivated land from the insured farmers. For this reason, it mainly targets large farms rather than smallholder farmers.

Another variable of area-yield is to take an income-index rather than a yield index, or an income-based index modeled with a "price" variable, which is able to take into account the income given the fluctuations in prices in the area covered. These income-based area-yield insurance policies then define coverage modalities, such as percentage of indemnity, etc.

Area-yield insurance was developed in the 1980's in the United-States, when MPCI was suffering from profitability problems due to the moral hazard and adverse selection as well as high transaction and underwriting costs. It offered the ability to avoid on-site loss assessment and cut transaction costs. However, area-yield insurance finds a higher level of implementation in high-income countries where agriculture and insurance premiums are heavily subsidized, such as the US.

**Climate change appropriateness and opportunities in Niger**: Area-yield insurance is indicated in the case of homogeneous productions areas, where farms have correlated yields. As one of the main obvious climate change impacts is likely to be on actual yield, yields represent a good target for index-insurance and could be appropriate in designing such indexes. Besides, using area-yield at district or department level as an index allows taking into account all categories of risks related to climate, regardless of which of these risks directly affects production and in what proportion.

Area-yield insurance is appropriate for tackling climate change issues in the sense that high yield variability is resulting from climate change on a wide scale. To lessen this variability at the area level and cover these systemic risks, area-yield insurance has to be linked to credit or other distribution means. Linking both practices would allow managing the basis risk

associated with index insurance, and may encourage farmers in adopting resilient varieties of seeds and crops.

However, area-yield insurance is obviously highly dependent on yield measurements. In this sense, climate change is challenging the actuarial model and data underlying the insurance product. As area-yield indexes rely on historical data for determined areas and as climate change may induce a shift in this historical data, the challenge is to keep the data valid enough to avoid any basis risk. Area-yield indexes will thus require constant adaptation from the insured and follow-up from the insurance companies that may have a cost associated to them.

For Niger, area-yield indexes are not recommended in the present context due to the limited historical data available at department/provinces level (less than 20 years), which would make the indexes unsuitable for taking into account long-term tendencies and climate change. Besides, as agricultural activities are often informal due to the large number of small farms and subsistence farming, which prevents systematic documentation of crop statistics at various administrative levels, area-yield index based insurance cannot be adopted.

**Satellite data based insurance**: Satellite data based insurance relies on satellite monitoring of weather events that are assumed to generate losses. These satellite observations trigger the indemnities by delivering reliable data observed through remote sensing. This technology provides information about vegetation status and pasture greenness (plant coverage through near-infrared observation binding moisture deficit to pasture yellowing, fields' sizes, etc.).

Indemnity is based on a Normalized Difference Vegetation Index (NDVI), which converts the detected images (visible light and near-infrared) through an algorithm to an index giving vegetation density. This observation of ground vegetation then allows assessing water resources available for livestock or expected yields of rainfed crops or fodder, and triggers the payouts in assessing potential losses (in livestock/crops) through the index. In the case of livestock, index-based insurance is expressed in terms of expected mortality rate, modeled through historical data.

This high-precision method, started in North America in the early 2000, is being used for insurance underwriting in pilot phases in some developing countries such as Kenya. The FAO compiles most data provided mainly by US satellites. In the future, other indexes may be used for index based agricultural insurance, such as the Enhanced Vegetation Index (EVI). This has a more precise range of action than NDVI, or the Chinese Water Supplying Vegetation Index (WSVI).

The key satellite data providers and their features are provided in the Table 9-2 below. Almost all data are available free of cost.

**Table 9-2 Key satellite data providers and product features**

| S. No. | Data product | Description | Data availability and quality |
|---|---|---|---|
| 1. | US NOAA-AVHRR | 1 km square resolution NDVI calculations available | Daily data available<br>Archives since at least 1978<br>Poor geometric quality of data |
| 2. | EU SPOT-VGT | 1 km square resolution NDVI calculations available | Daily data available<br>Archives since at least 1988<br>Good data quality both in geometry and radiometry |
| 3. | US TERRA-MODIS | 300 m square resolution NDVI calculation available | Daily data available<br>Archives since at least 2000<br>Good data quality both in geometry and radiometry |

| | | | |
|---|---|---|---|
| 4. | EU MERIS-ENVISat | 300 m square resolution NDVI calculation available | Daily data available<br>Archives since at least 2000<br>Good data quality both in geometry and radiometry |

All data needs to be processed before using for developing a reliable index-based solution product. Lately, some service providers, such as *eleaf*[35], have been offering solutions integrating satellite imagery to numerous field crop parameters such as temperature, wind speed, etc. resulting in complete information over pixels of 250 $m^2$. However, this kind of service remains scarce regarding sub-Saharan Africa where basic information is often lacking, and it is expensive compared to free satellite data.

**Climate change appropriateness and opportunities in Niger**: Whether rainfall excess or shortage is measured by meteorological stations or satellites where such stations are absent or too sparse, the aim is the same and the climate change issue could be tackled identically. Satellite data based index-insurance against drought is in use in countries like Kenya with index-based livestock insurance, in Spain, and in Canada (Alberta).

Satellite data based index insurance is well suited to climate change as it measures and registers pasture and greening cover in fine resolution (from 1 km square to 300 m), almost on a daily basis. In Niger, it could represent a viable alternative to WII, although yield data is needed to design the index, which depends on historical imagery related to predictable losses. The correlation has to be established between satellite imagery and real time data to quantify and predict crop yield and/or losses as well as livestock mortality, according to the field size, the crop status, etc.

Distribution means of such satellite data based index insurance could include banks and micro-finance institutions as well as input providers and back the use of climate resilient inputs or help shift from nonviable crops to sustainable crops resilient to climate change.

### 9.1.5 Government Relief for Climatic and Agricultural Risk Management in Niger

The State investment budget in agriculture and livestock is rather erratic and dependent on subsidies and loans received from donors. If the state investment budget in agriculture is increasingly growing, the budget dedicated to livestock is, on the other hand, decreasing. This is in spite of the sector's important contribution to the GDP (around 15% in 2011) and of the climatic risk consequences on livestock and fodder.

These tendencies shall not hide the fact that investment in agriculture and livestock is very low in Niger (USD 59.7M in 2011), as it represents only 1.13% of the GDP (and only 0.27% for the sole state budget). The realization rate ranges from 50% (2011) to 73% or more (2009).

Figure 9-5 shows the budget for agriculture and livestock for the year 2009 to 2011 through various sources.

[35] http://www.eleaf.com/

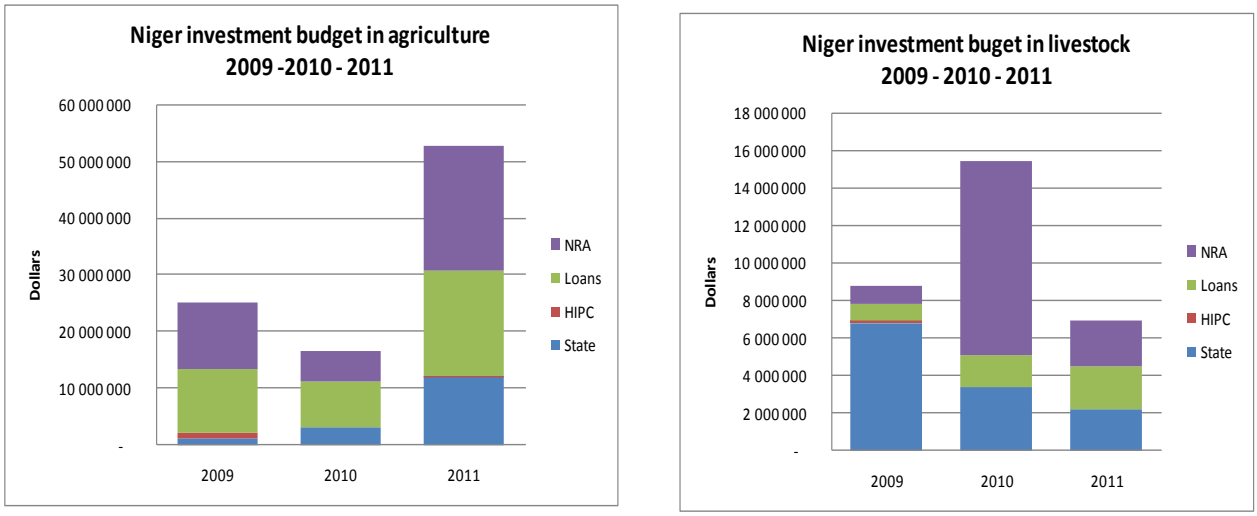


**Figure 9-5: Investment budget in agriculture and livestock, Niger**

Source: Financial Directorate – Ministry of Planning (NRA: not reimbursable aid)

Government support to agriculture is mainly taking two channels in Niger and climatic risks are tackled differently through these channels.

**An *ex ante* intervention** (programs focused on investment in risk mitigation and risk reduction techniques):

- The state investment budget includes agriculture and livestock investments. Donors heavily subsidize this investment budget though. In 2010, only 23% of the agriculture investment budget and 31% of the livestock investment budget consisted of State funds. Agricultural and Livestock ministries are managing these budgets, through various projects and programs.

Ex ante, intervention is rather erratic and quite dependent of the forecasted agricultural season. Risk reduction programs aim at decreasing the probability of a particular risk from occurring by targeting the risk's causes, mainly through large programs. Risk mitigation programs try to lessen the impact of a risk, if it occurs.

Consequently, risk reduction programs are budgeted during the prime agricultural seasons and include, for instance, research programs in improved seeds and species, capacity building programs for farmers' organizations, supporting the development of irrigated crops, etc.

During bad agricultural seasons, risk mitigation programs overcome traditional risk reduction programs and try to lessen expected risks for early-coming signs of forthcoming risks such as drought or locust invasion, through subsidies to fertilizers or pesticides against locust, etc. In case early warning comes too late or does not come, ex post interventions usually overshadow these programs.

Usual risk transfer programs that pertain to ex ante risk management, such as agricultural insurance or CAT bonds, do not exist in Niger.

**An *ex post* intervention** (programs focused on risk coping strategies and techniques):

- *Ex post* intervention is harder to quantify in Niger than *ex ante* interventions. Indeed, in case of emergencies due to climatic causes (drought, floods, etc.), many donors and agencies fund multiple programs. Generally, these agencies find it hard to coordinate emergency aid.

- Agencies and committees under the Prime Minister's supervision manage emergency relief and environmental questions:
  - The Food Crisis Cell (CCA - Cellule Crise Alimentaire) mainly manages donor funding in case of a food crisis,
  - The Early Warning System (SAP – Système d'alerte précoce) is dedicated to information about crisis risks and State warnings on drought, locust invasion, yields, etc.
  - The Nation Council on Environment for a Sustainable Development is in charge of implementing Rio+20 recommendations towards climate change (CNEDD).
- *Ex post* programs include financial and material aid in case a risk occurs, as well as technical, health, or sanitary intervention. In a country like Niger, which suffers from frequent droughts, food crisis, or market shocks, these ex post programs could be managed at the same time through the State's usual channels (local administration, etc.) as well as agencies like the WFP, the Red Crescent, etc.
- There is no doubt that ex post intervention can act as a disincentive for agricultural insurance, as farmers could rely on aid, rather than investing in risk management techniques. Besides, ex post intervention, though mainly funded by donors, is a burden for the State, which makes it necessary to look for an optimum allocation of resources.

However many other institutions are playing a role in government relief to agricultural and climatic risks, both in the form of *ex post* or *ex ante* interventions:

- The 3N High Commission, under the presidency, has been leading the Nigerien strategy towards agriculture and climate change since 2011.
- Various other departments and institutions also play an important role, though they not necessarily rely on the budgets of the agricultural or livestock ministries. These institutions include INRAN (National Agronomic Research Institute), the DMN (National Directorate of Meteorology, under Transport Ministry, etc.), the Aghrymet centre (under the CILSS – Interstate committee of Struggle against drought in Sahel), ONAHA (irrigation and water resources management), CAIMA (State subsidies to fertilizers and seed), and Agricultural Bank of Niger (BAGRI), etc.

### 9.1.6 Main Government Relief Programs

A great part of the State's intervention towards climatic risk management belongs to the title IV and V of the national budget, where Title IV consists of subsidies and common transfers and Title V of projects and programs (and administrative investments)[36]. These two titles of the national budget accounted for 30% of the whole investment budget in 2011.

According to our assessment of the approved budgets over the last 3 years, the greatest parts constitute ex ante risk management activities, with strong differences over the years. Ex post risk management only represents 11% of all the programs (Figure 9-6). However, it has to be taken into account that 2010 and 2011 were rather favorable years, following the 2009 drought. Investments in agriculture though have been shy during these two years. Moreover, many investments in risk mitigation programs were planned for 2012, after early signs of forthcoming drought have been observed during agricultural campaigns.

[36] We could not get access to the Livestock ministry's detailed budget during our assignment in Niamey. As for the ministry of agriculture, we were given access to 2010, 2011 and 2012 approved budgets.

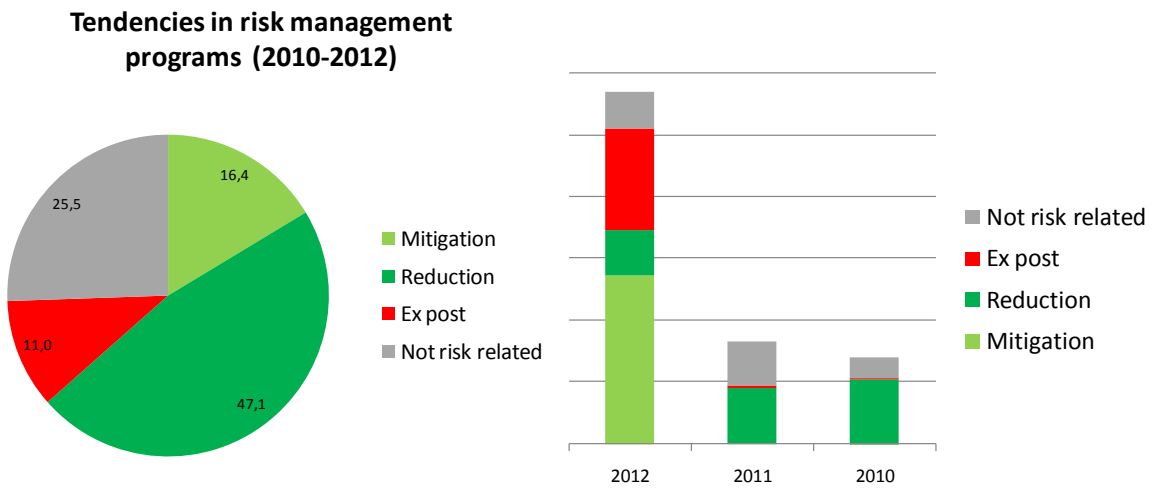


**Figure 9-6: Tendencies in risk management programs (2010-2012)**

Source: National budget (titles IV, V) – Financial Resources Directorate, Ministry of Agriculture

Indeed, a detailed insight on the main risk management programs planned and implemented by the Ministry of Agriculture acknowledges this rather erratic planning. Most of the programs (Figure 9-7) have small budgets of less than USD 500,000 over the three considered years, while those representing more than USD 1 million over the 3 years are mainly composed of subsidies to ONAHA and INRAN, and to the 2012 risk mitigation and risk reduction programs, following fears of drought. These programs mainly focus on irrigation, and inputs and subsidies to production. Drought, which is the main agricultural risk in Niger, is thus only tackled through the question of irrigation and input access, especially in 2012, i.e. when the risk is the highest. Programs dealing with locust invasion account for a small part of the ministry's activities, and have seen a surge in funding in 2012 as the first swarms of desert locust were localized north of the country.

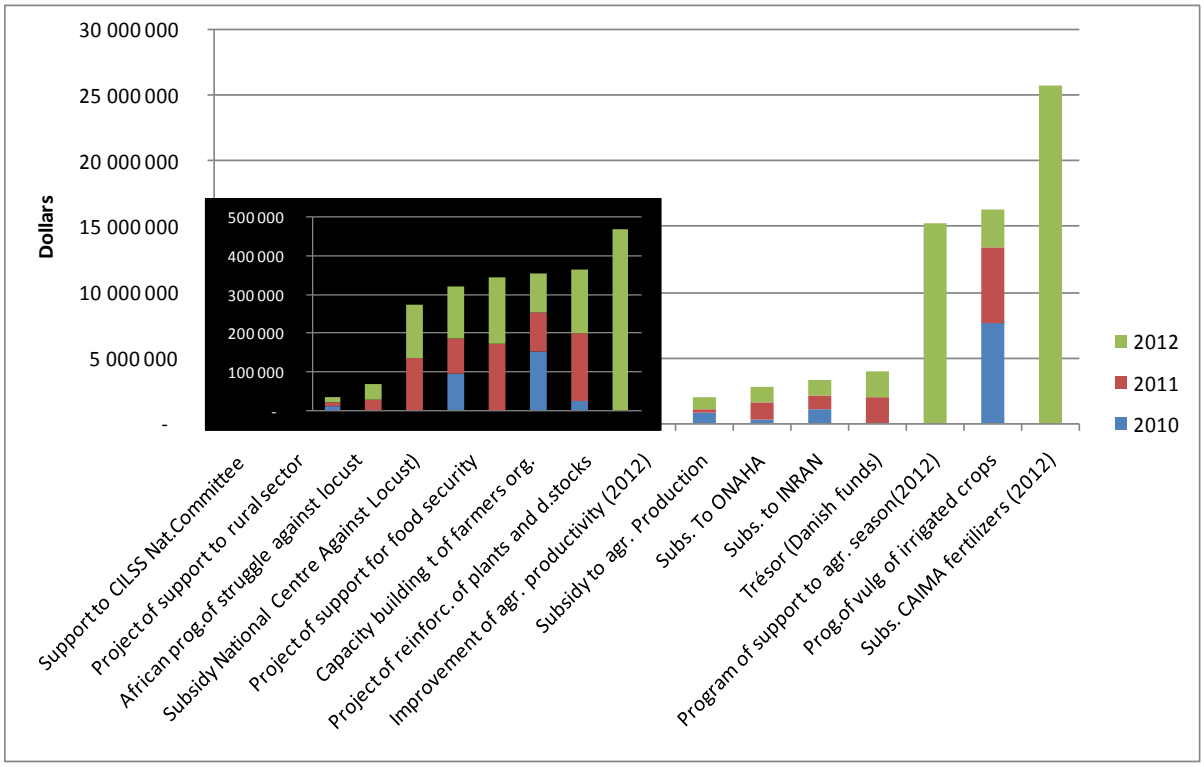


**Figure 9-7: Risk management programs implemented by ministry of Agriculture in Niger (2010-2012)**

Source: National budget (titles IV, V) – Financial Resources Directorate, Ministry of Agriculture

These programs represent around 1/3 of the national investment budget in agriculture, and a large part of *ex ante* risk management measures. The rest of it is mainly composed of *ex post* programs funded by donors (a majority) and some programs and projects of importance relying on several stakeholders, such as the Prodex.

### *9.1.6.1 Programs outside the ministry of agriculture's budget*

**Other Ex ante projects:** Even outside this ministry's budget, the lack of risk transfer program is patent. PRODEX[37], one of the main Nigerien projects for agriculture relying on PPPs (State, World Bank, farmers), illustrates these choices well. The program comprises of four components:

a. Improving coordination of supply chain and marketing agricultural products, which aims at interlinking the stakeholders of main selected value chains (onion, cowpea, tigernut, sesame, gum Arabic, livestock, and leather and skins) through better coordination of supply chains, strengthening of high potential players, and support to commercialization.
b. Creating financing instruments for SMEs, and cooperatives and private sector, in order to set up sustainable financing models, donations models, and improve access to credit in the targeted value chains.
c. Securing the irrigation potentialities of onion production and connecting the production areas to market places while building and rehabilitating production places, promoting access to markets, and making an environmental follow-up.

[37] Project of Development of exports and agro-forestry-pastoral markets

d. A coordination unit.

All these components target the same stakeholders: agricultural producers, herders, exporters, collectors, service providers, and transforming industries.

The component b of this program, dedicated to instruments of financing has mobilized around USD 6 million from December 2010 to May 2012 (Figure 9-8) and supported 2,600 projects. It is mainly focused on three main productions: onion, cowpea, and livestock/meat. Farmers, producers, and groups eager to invest in production, transformation or commercialization activities are being financed, provided they bring part of the initial amount of money to be invested.

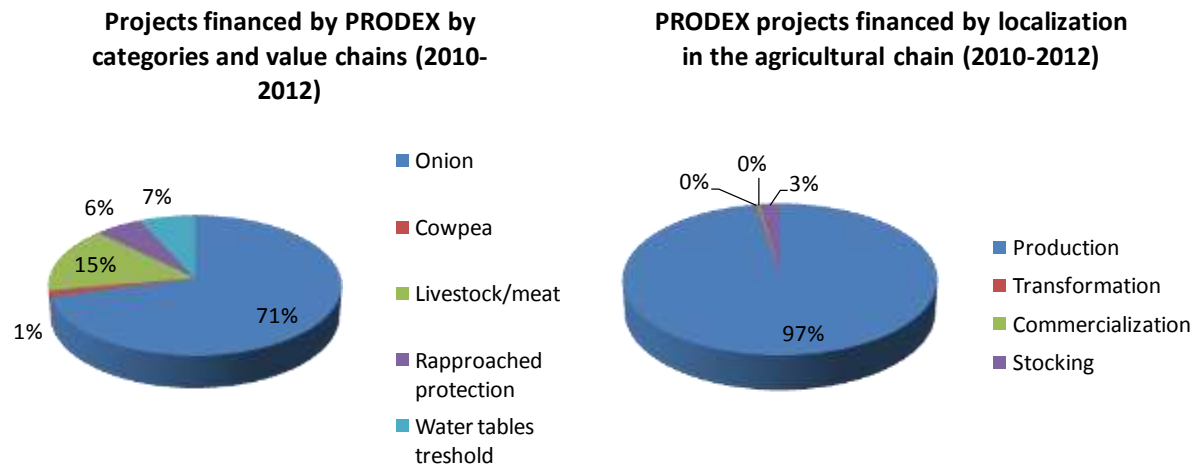


**Figure 9-8: Projects financed by Prodex**

Source: Prodex, May 2012

For now, these investments have been targeting the production part of each of the three value chains concerned, rather than downstream and upstream activities. Analyzing investments in production through a risk typology (Table 9-3) confirms that although PRODEX measures and instruments are all dedicated to *ex ante* risk management techniques, none of these projects are dedicated to risk transfer mechanisms.

**Table 9-3: Prodex activities by categories of risk**

| Category | Amount (USD) | Activities | Percentage among PRODEX financing |
|---|---|---|---|
| **Risk mitigation** | 176,000 | Production of improved cowpea seeds | 2.9% |
| **Risk transfer** | 0 | | 0% |
| **Risk reduction** | 5,804,518 | Irrigation systems for onion prod. Stocking and "fodder banks" | 97.1% |

Source: Prodex, May 2012

The kind of financing PRODEX provides, depends on the targets:

- For farmers organizations, which are being supported at different levels in onion, cowpea, livestock/meat, and leather and skins' activities, subsidies are provided at various rates according to the nature of the project and the amount of the financing. A preferential rate reaching 90% of subsidies is granted on priority to youth and women initiatives. All financing passes through DFIs.
- For agribusinesses, input providers, and commercialization activities (SMEs), PRODEX is providing a maximum subsidy of 50% for business plan development,

and a 25% other subsidy dedicated to the implementation phase. Complementary financing of the business plan relies on SMEs, whether on their own funds or through commercial banks partnering with PRODEX, for which PRODEX is offering a partial portfolio guarantee.

It has to be added, as its coordinator explained to us, that PRODEX is trying to help developing and structuring some agro-forestry value chains such as cowpea and livestock/meat/skins on priority, as well as tigernut, gum Arabic, and sesame somewhat marginally. It already has some partners and beneficiaries. According to Stakeholder E, this part of PRODEX activities could include a climate change component in the near future.

Other projects implemented outside the ministry's direct action include, for instance, the Company XX three funds program. Launched in 2011, Company XX is a public bank aiming at improving the financing of agriculture and offering credit solutions to farmers and agricultural sector stakeholders, for structuring investments (land development, rural infrastructures, and equipment, etc.) or inputs, commercialization, etc. Company XX is under UMOA regulation and like any commercial bank is held to laws on prudential ratio, etc. The bank is covering 5 regions out of 8 in Niger.

Company XX is supposed to host three funds dedicated to the agricultural sector. These funds have been created by Presidential Ordinance, are supposed to be managed by ad hoc Committees, and include:

- A Guarantee Fund for agricultural activities dedicated to rainfed crops (65%) and irrigated crops (35%)
- An Interest Subsidy Fund aiming at subsidizing the market's rates for farmers, in bearing an agreed percentage of these interest rates
- A Calamity Fund, which aims to help producers recover their production capacities following consequences of natural disasters or calamities such as drought, locust invasion, etc.

However, at the beginning of 2012, these funds had yet to start their activities, as the State had not provided the initial amounts expected as working capital. The calamity fund for instance, mainly dedicated to agricultural risk management was supposed to operate on a first envelope of USD 3.8 million.

Besides, out of a whole credit portfolio of USD 24 million by the end of 2011, only 30% of it was directly involving the agricultural sector and some refinancing credit conventions signed, for instance, with DFIs were still awaiting definitive approval. Company XX has been strongly criticized for not fulfilling its assignments towards the agricultural sector and for focusing more on the development of a commercial network competing with commercial banks.

It is unclear for now, what Company XX has or has not achieved in terms of risk management measures. However, most of its action towards climatic and agricultural risks aims at favoring *ex ante* intervention and risk reduction measures, while transferring the cost of it to private players through the funds. It should thus be encouraged and controlled as it has undoubtedly a forefront role to play. Company XX is the only potential risk transfer instrument specifically targeting agriculture Niger has implemented and could relieve the State's budget, if opened to private partners.

**Ex post projects:** Although ex ante programs are more documented, *ex post* intervention still represents the largest part of the State's intervention. They prevail each year when climatic and natural disasters occur. This has been the case over the last decade in 2001, 2004 or 2009 for instance, and it will probably be the case in 2012, in spite of the surge in *ex ante* risk reduction programs. Since most of the ex post intervention projects are under the President, the Prime Minister, and other agencies (CCA, CILSS, etc.) rather than technical

departments such as the Ministries of livestock or agriculture, the overall budgets for ex post intervention during the past years could not assessed[38].

The recent rationalization of the State's action in agricultural risk management shall be continued and focused in priority on programs based on risk anticipation and *ex ante* measures. In this aim, risk transfer tools could allow the State to strengthen these programs focusing on anticipation, and to overcome the problem of the financial burden the State's action is often representing, especially as regards the unexpected *ex post* measures. Risk transfer techniques are not a priority today although they could provide long term benefits through a risk management policy that is able to relieve the State's investments and transfer it to partners such as insurance companies, DFIs, etc.

In 2012, components of the budgeted State's action were less balanced in favor of *ex post* programs, while this budget almost doubled compared to the preceding years. The question is to find out whether these recent orientations will lead to sustainable changes or represent a one shot attempt to find a better equilibrium between the components of the Ministry of Agriculture's budget in 2012. Obviously, using a range of tools including *ex post* and *ex ante* risk management measures will help coordinate the State's action and climatic risk management in the country.

The 3N strategy is now trying to organize and rationalize the State's action towards agriculture, as Niger does not have for now, like Mali or Senegal in the region, a framework law on agriculture. This 3N program is focusing on five strategic axis:

ii. increase and diversify agro-forestry-pastoral and fishery productions,
iii. constant supply to rural and urban markets of agricultural and agribusiness products,
iv. resilience improvement of population against climate change and catastrophic crisis,
v. improvement of nutritional status of Nigeriens,
vi. animation, coordination of the 3N and impulse of reforms. Each axis is relying on diversified sources of funding, and shall lead to increased PPPs and improved State investments.

### 9.1.7 Credit Protection Program

#### *9.1.7.1 Banks and credit protection programs*

As in the whole UEMOA and ECOWAS area, banks in Niger contribute very insignificantly to agriculture financing. In Niger, 10 approved banks and 1 financial establishment are in operation (**Error! Reference source not found.**). They have 5.3% of the regional market share, with 78 offices (4.6% of the distribution network) and managed 232,491 bank accounts in 2010 (4.1% of the regional portfolio). This means the penetration rate of the banking sector in Niger is 2%.

[Figure 9-9 has been deleted because it contains confidential information.]

Out of those eleven institutions, two are specialized in habitat and microfinance, and the sole financial establishment approved is only offering loans to its customers (Figure 9-9). In 2010, none were specialized in agriculture. The Company XX, which is a public bank, started its activities in 2011 and is not taken into account here. At the regional level, the whole portfolio of agricultural banks hardly rose to 3% of the market in 2010.

[38] According to Stakeholder F, "3N initiative" is trying to coordinate the State's action towards agriculture.

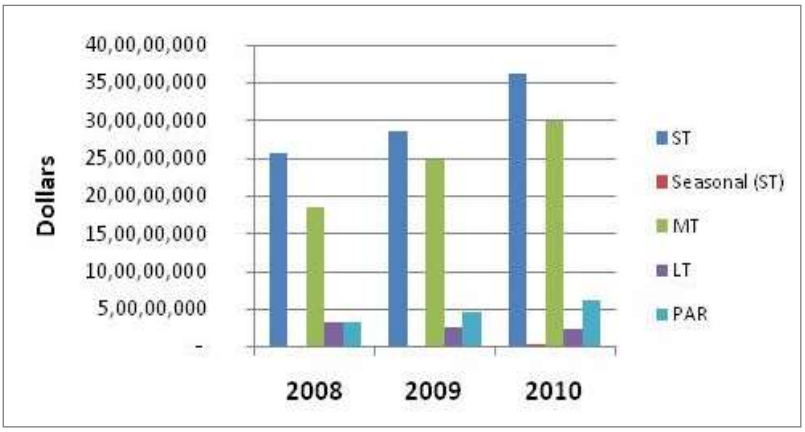


**Figure 9-9: Credit practices evolution in Niger from 2008 to 2010**

Source: UMOA Banking Commission – Annual report 2010

Indeed, agriculture accounts for a tiny part of the short-term credits, as the number of seasonal credits granted would testify (Table 9-4). Short term credits benefit commerce and tourism (hotels, restaurants, etc.) as well as industry and services first. More than 50% of mid-term credits in the region are held by Senegalese and Ivorian banks, though Nigerien banks try to increase their number. Long-term credits have been decreasing on the contrary since 2008 and only accounts for a small part of the whole credit portfolio. Unpaid debts are growing slightly as well in Niger.

**Table 9-4: Use of declared credit at the risk management central**

| Sector | Dec.2007 | Dec.2008 | Dec.2009 | Dec.2010 |
|---|---|---|---|---|
| **Agriculture, forestry, fishing** | 3% | 7% | 3% | 2% |
| **Extractive industries** | 1% | 1% | 1% | 2% |
| **Manufacturing industries** | 20% | 18% | 18% | 19% |
| **Electricity, gas, water** | 4% | 3% | 3% | 3% |
| **Building and construction** | 5% | 4% | 5% | 6% |
| **Commerce and tourism** | 37% | 33% | 33% | 32% |
| **Transport, communication** | 12% | 12% | 13% | 14% |
| **Insurance, real estate, private services** | 5% | 5% | 6% | 5% |
| **Public services** | 13% | 17% | 17% | 17% |
| **TOTAL** | **100%** | **100%** | **100%** | **100%** |

Source: Annual report 2010 – Banking Commission UMOA

**Banks do not have enough guarantees to finance agriculture in its actual state in Niger:** Agricultural clients of main Nigerien banks are the same "happy-few" already present in some value chains such as livestock, milk (Niger-lait, Sona-lait, etc.) production, onion and other gardening products (Agro-Niger, etc.) or rice cooperatives. However, those stakeholders seldom finance their production activities through bank credits, and prefer to use these credits for commerce and transformation activities, which offer better guarantees.

Solvency is obviously at stake as very few stakeholders in the agricultural sector can be considered as creditworthy companies or cooperatives. Even among the agribusiness leaders mentioned above, solvent demand is a cause of disagreement and some of them do have significant debts in Nigerien banks. This emphasizes the limits of the Nigerien kind of "agribusiness" model, eventually dependent on exogenous shocks such as adverse climate or market. It also brings to question the profitability of what is financed in the agricultural sector.

Common practices in terms of guarantees include fixed-term deposits (from USD 10,000 to USD 30,000) for SMEs being granted small short term credits, in addition to the credit cost which is already around 14%. However, for agricultural activities banks frequently require a land ownership certificate, or at least mortgage registrations (land, house, warehouse, etc.). Life insurances are only required for private individuals whose number is insignificant in agriculture and a potential agricultural insurance is not considered, for now, as a potential guarantee.

**Increasing solvency and credit access may include insurance:** According to banks, solvency could be tackled from different levels to increase financing in the agricultural sector and allow a better penetration rate of insurance. The first level is obviously the value-chains development: livestock, onion, cowpea, sesame, rice, tigernut, gum Arabic, pepper, potato, etc. Many value chains could be developed through State and PPP support and become solvent. Development activities should include development of exports activities and institutionalization and formalization of export companies', improve BAGRI credit policy, develop technical assistance (information on the use of pesticides, and other inputs that will be requested if agricultural insurance is launched), develop market studies, etc.

Second, when asked what would be needed in terms of requirements to finance agriculture, banks quote the fiscal pressure on agriculture which is preventing agricultural companies or cooperatives to insure imported machines and even dissuading stakeholders to formalize their activities[39], especially in regions close to the Nigerian border where commercial exchanges are numerous, which are also agricultural regions. This question is a dilemma for Nigerien authorities as Niger has already a narrow tax base and at the same time agriculture accounts for 48% of GDP. A priority should be to help reduce informal activities in the agricultural sector[40].

Credit policy is finally both the main issue regarding the involvement of banks and the easiest way to respond to exogenous shocks inducing production variability. The agricultural risks bank perceive are for too important to invest in agricultural financing. Therefore, techniques to manage risks at the banks' level could back their capacities to meet demand for agricultural credit. The more commercially orientated the production is and the more higher-yield crops are targeted, the more credit is needed to invest in inputs such as fertilizers, improved seeds, irrigation techniques etc. Thus, the less agriculture remains solely a subsistence farming activity, the better chances it has to be financed by commercial banks.

Credit and insurance are tightly linked. The State subsidies to credit and/or insurance programs could, for instance, offer an incentive to make agricultural insurance mandatory, as it is the case for numerous agricultural insurance schemes. Insurance can facilitate access to credit, and credit can help distribution of insurance and reduction of transaction costs. In spite of the defiant attitude of Nigerien banks towards agricultural insurance, agricultural insurance can increase the creditworthiness of farmers, producers, and other stakeholders. Indeed, while contributing to stabilize production and income instability due to climatic and market shocks at the production level of the value chain, it may reduce credit risks as well on upstream or downstream levels of each value chain. Besides, agricultural insurance allow

[39] Interviews with Company C and Company G on May 21th and 22th, 2012.

[40] Taxation of agriculture in Niger is a tricky issue. Informal activities represent the large majority of agricultural activities and globally escape to the radars of tax administration. Formal activities are thus taxed and represent one of the main sources of income for the State. As a result, and as the level of tax in Niger is considered as relatively low in the region (UEMOA's recommendations is 17% of the GDP, whereas it was around 11,5% in Niger in 2010), there is no debate for now regarding VAT on import of agricultural goods and materials, etc. whereas it could represent a solution to improve productivity.

banks (and/or DFIs) to transfer the credit risks to insurance companies, instead of retaining and pricing it (as they are actually doing) and potentially unbalancing their financial results.

**Micro-Credit Protection programs:** The Decentralized Finance Institutions sector in Niger has been changing structurally since 2007. Following a period of growth, the number of DFI stabilized or decreased and stakeholders consolidated their positions in the market. In December 2011, 81 DFI in Niger offered an outstanding credit volume reaching USD 30.3 million, 90% of which was provided by the first 10 institutions (which also provided 80% of the savings volume). The savings volume reached USD 17.6 million (Figure 9-10).

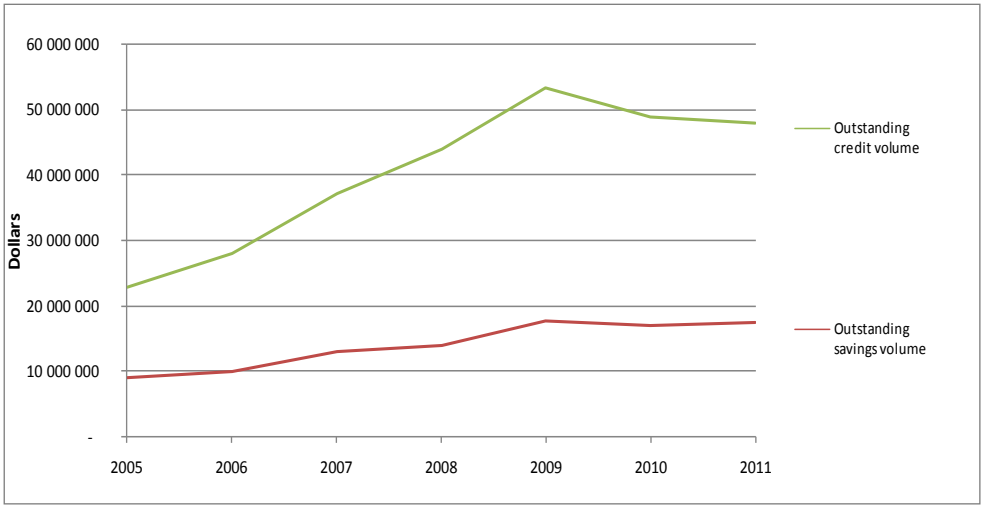


**Figure 9-10: Evolution of credit volume and savings volume of the DFI sector in Niger (2005-2011)**

Source: ARSM, Aperçu sur le secteur de la micro finance au Niger, 2010/Company E.

Two institutions (Company E and Company F) have a total credit volume of USD 10.6 million (1/3 of the entire outstanding credit volume) and are thus the only Nigerien DFIs controlled by the UMOA banking commission. Indeed, since 2010 (Law no. 2010-04 of January 21), DFIs having an outstanding credit and savings volume of more than USD 3.8 million (FCFA 2 billion) are under the jurisdiction of UMOA banking commission as any other financial institution of the banking sector. Most DFIs in Niger are usually considered as credit unions. Two networks operate in Niger, representing most of the important DFIs. These are the "Union des Mutuelles" supported by "Company CC" and Company JJ.

However, in terms of coverage (Figure 9-11), DFIs have a limited impact, as the 4% penetration rate in Niger is the weakest in UEMOA zone, where the average penetration rate is 15%, with a maximum of 35% in neighboring Benin. DFIs are concentrated around urban areas in most populated regions. By late 2011, only 129,128 customers (mostly groups) were offered services by DFIs.

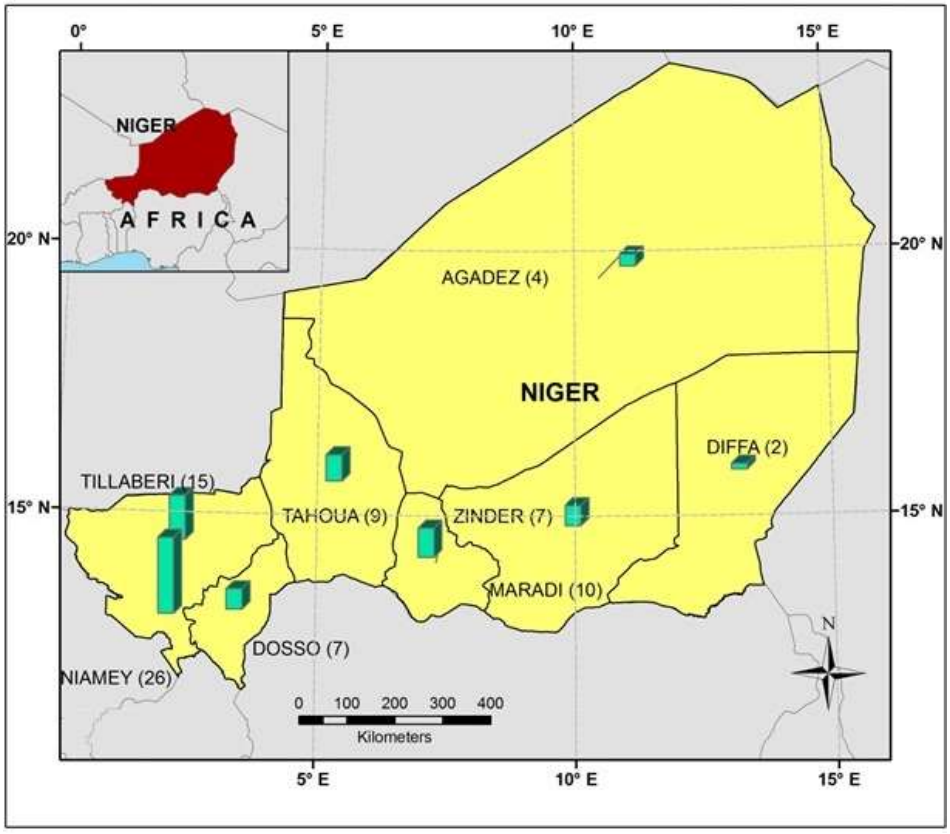


**Figure 9-11: Regional establishment of DFIs (2010)**

Source: Agence de Régulation du secteur de la micro-finance (ARSM)

However, a distribution network, of more than 190 distribution desks, though more localized in cities than in remote areas, backs these offices. This figure remains very low in a country, which counts more than 15 million inhabitants.

*1) Agriculture and financial services*

Financial services offered by DFIs in Niger to the agricultural sector are rather under-developed as many rural areas are extremely poor and cannot afford financial services. Services usually offered by DFIs aim at financing livestock feeding, short-term seasonal loans, loans for agricultural machines, warrantage, etc. In 2010, agriculture was representing 43% (about USD 12.1 million) of the financial services provided by DFIs (Figure 9-12).

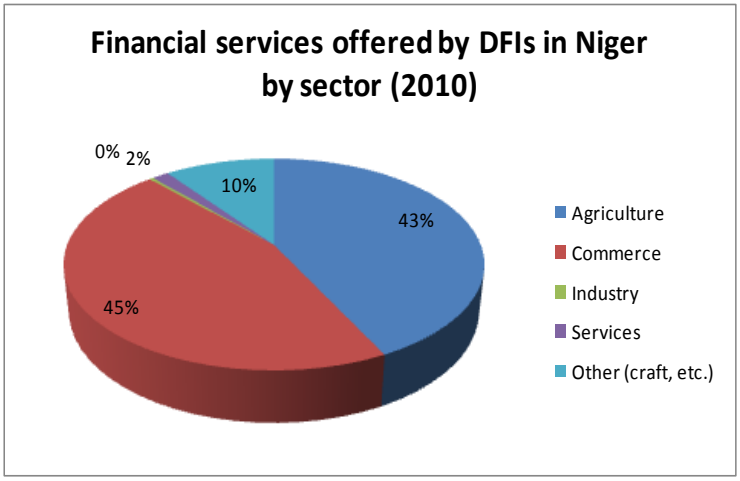


**Figure 9-12: Financial services offered by DFIs (2010)**

Source: Agence de Régulation du secteur de la micro-finance (ARSM)

For both Company F and Company E, livestock feeding is one of the main credit lines given to customers. However, other agricultural activities generally account for less than 10% of the volume of credit and commerce and income-generating activities represent the biggest part of credit volume (Figure 9-13). The average credit in both institutions comprised of between USD 250 and USD 300 on a short-term basis (less than 3 months), while credit's monthly interest rates in the micro-finance sector are usually 2% to 2.5% and the wear rate is legally fixed to 24% per year.

Company F Company E

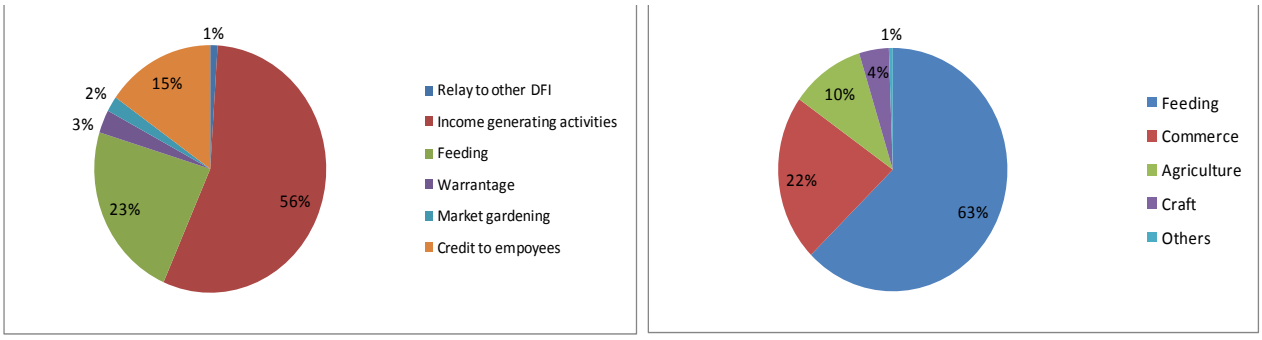


**Figure 9-13: Outstanding credit volumes of Company E and Company F**

Sources: annual reporting, Company E(2011), Company F(2010)

Some value chains are concentrating most credits in rural areas: pepper in Diffa, onions in Tahoua, millet and sorghum in Maradi, potato in Agadez, gum Arabic in Zinder and Tillabery, livestock in all regions from Agadez and Tahoua. Most of these activities still represent higher risks for DFIs than non-agricultural activities, because of the market shocks, which make them vulnerable. This has recently been noticed in onion and livestock productions.

*2) Credit guarantees and insurance aspects*

Credit guarantees in Niger are low in the agricultural sector, what is often discouraging DFI to finance agriculture, and on short and middle term preventing the development of agricultural insurance.

It is a common practice that debtors have to deposit around 10% (agriculture) to 30% (commerce) of the loan and to pay another 3% of administrative fee. In addition to this

deposit, DFIs require tangible security, such as property (movables, real estate, and cattle) or land ownership certificates. Warrantage, which is rapidly developing, draws a new perspective on guarantees for DFIs, as assets (made of non-perishable crops and productions) are pledged.

In the agricultural sector, however, these guarantees cannot be obtained most of the time, contrary to employees for instance who deposit their income at the DFIs. This lack of guarantees also explains the low rate of credit granted to farmers. That is the reason why DFIs have developed moral guarantee systems through traditional authorities in rural areas. In this case, every loan granted to groups (rather than individuals) are signed under the supervision of a traditional authority (village chief, etc.). Social control is thus on one hand supposed to prevent payment default risks, and on the other hand is supposed to use traditionally recognized land property to secure land dispute settlement process and avoid costly procedures within the State's jurisdictions. Indeed, when feasible, the administrative cost of a land certificate procedure is nearly USD 3,800, which is out of range for most farmers, groups, and cooperatives in this country.

Portfolio at risk (more than 3 months delay) reached 23.7% of the whole outstanding credit volume in 2011, with strong differences between the first ten institutions (11.7%) and the whole market. In an institution like Company Fthis rate reached 40% in 2010 due to the lack of diversification of financial services offered and overrepresentation of feeding credit, which suffered from a decrease in livestock prices since 2009 and an exchange rate naira/FCFA dissuading Nigerian operators to import livestock and meat from Niger.

Consequently, DFIs have developed refinancing operations with banks and credit guarantee funds. Risky operations are thus shared between DFIs and guarantee funds (50%-50%). Usually these refinancing operations and guarantee funds take the form of mid-term loans from USD 300,000 to USD 1,000,000, with interest rates from 5% to 10% per year. Company H, Company G, Company Cor Company AA are frequent contributors to these guarantee funds as well as foreign donors and cooperatives. The Company XX as well, which is supposed to manage a calamity fund of USD 3.8 million (FCFA 2 billion) funded by the State, is yet to start guarantee funding operations and has been severely criticized by DFIs and commercial banks for not fulfilling its initial assignment.

As in the banking sector formal insurance is only required for loans over a certain amount of money. For example, Company E is requesting life insurance for loans over USD 28,700 (FCFA 15 million). Besides, most DFIs offering mid-term loans are offering subscription in case of death or disability. They cannot call it "insurance" as they are not habilitated to conduct insurance operations, but in practice, it has more to do with insurance than credit. These death and disability products depend on the age of the beneficiary and span over a range of rates between 0.25% and 1% of the loan and act as a guarantee fund to cover the loan reimbursement.

*3) Conclusions on DFIs and credit guarantee*

- In terms of credit protection programs available to the agricultural sector, DFIs represent an opportunity as the only financial sector, which is really tackling agricultural issues and willing to finance farmers, groups, and cooperatives. Therefore, DFIs – and especially the top 10 in Niger - are front-line players in a potential strategy for insurance development at the farmer's level, as their distribution network is, most of the time, wider than banks and insurance companies. Affordability of insurance delivery costs can be improved using financial services provided by DFIs such as credit, which could also get state support to facilitate delivery.
- The Sate's effort to clean up the business has to be encouraged. While cleaning DFIs' sector and consolidating the positions of the most solid stakeholders, those players might be able to pass under Law n°2010-04 of January 21, 2010. It would be

an opportunity for them, while being controlled by UMOA's banking commission to adopt standardized governance rules and professional standards.

- However, in spite of their will to finance agriculture, even at this micro-finance level, DFIs find it hard to get enough guarantees to embark on such projects and therefore, with an agricultural population mobilizing 85% of the country's workforce, the penetration rate of micro-finance remains very low.
- The guarantee systems, as well as the training of DFIs staff, or the financial resources availability are at stake. Members' savings do not always allow DFIs to finance agricultural activities, especially through mid-term loans, as the guarantee systems have some difficulties in taking into account income specificities of agricultural households. Besides, DFIs sometimes have a strong dependence on donors and lack their own funds, which prevent them from using savings to improve their credit portfolio. Supporting DFI to strengthen their own funds is thus necessary.
- Building competencies and skills to analyze reimbursement capacities of farmers and herders, in changing environments where external shocks such as market prices may interfere, should be encouraged. This is particularly true in a Nigerien context where there is frequent asymmetry of information between DFIs and producers.
- Obviously, securing agricultural household incomes through market risk management is necessary to avoid default payment risks. Reducing these risks will then help stabilize agricultural incomes and the producers' financial capacities.
- This can only be achieved by strengthening value-chains organization as well. Organizing coherent value-chains by uniting producers together with upstream and downstream stakeholders (input providers, agribusinesses, traders, etc.) will help reduce market risks and secure incomes.
- Finally, the land issue must be tackled, as this is the strongest agricultural guarantee for DFIs or other financial institutions. In a process where value chains will help develop agricultural production while integrating farmers' activities with cooperatives or agribusiness, investments to secure land ownership are necessary. These can be done through both State and traditional authorities.

### 9.1.8 Agricultural Index Insurance Case Studies

Three experiences of interest to Niger are detailed here. They are all implemented by African countries though their origins could be found abroad. Malawi first, inspired by the Indian index insurance scheme, developed a Weather Based Index Insurance against drought. Ethiopia then, whose context is not that far from Niger's, and whose HARITA program has been described earlier, will be also detailed further. Kenya and Mongolia, who developed two index insurance schemes to cover livestock, are also of key relevance to the livestock activity in Niger.

#### *9.1.8.1 Malawi, small scale index-insurance*

Malawi, though located in Southern Africa, presents some similarities with Niger:

- Given the scientific findings of the last decade, droughts are said to have become more frequent and severe in Malawi due to global climate change, and have increased the volatility in rainfall patterns.
- Agriculture, as in Niger, is one of the main activities occupying close to 80% of the population, which is mainly made up of small farmers.
- In rural areas, 90% of the population depends on rain fed subsistence crops.
- Subsistence farming prevents farmers to plant high-value added crops and from being considered as solvent by financial institutions.

#### *9.1.8.1.1 Malawi benefited from India's experience*

Malawi was one of the first African countries to benefit from the Indian experience through World Bank support and developed its own weather based crop insurance, which is covering small farmers.

India has developed weather based index insurance scheme since 2003, after having pioneered other agricultural insurance schemes (damage insurance, area-yield, etc.) since the late 1970's. The Weather Based Crop Insurance Scheme covers around 40 different crops and is based on an index linking adverse climatic events (rainfall, temperature, humidity, frost) to yields. It has been distributed on a mandatory basis with credit through banks and DFIs and on a voluntary basis by brokers, while premiums are being subsidized by the State. At first only one company, AIC, was marketing the product before the market was opened to private insurers such as ICICI-Lombard in 2007 in order to allow free competition and increase the penetration rate of insurance, without subsidies and especially on high added-value crops.

Consequently and in order to benefit from this kind of insurance to implement commercially viable products aiming at reaching small farmers, a partnership was established between ICICI-Lombard and its reinsurer (Swiss Re), BASIX, a DFI which is distributing the product, and the World Bank to set up a rainfall based insurance product, under WBCIS. Though it has seen some difficulties while covering small producers, it explicitly targeted them through its strategy to target several crops. Besides, its index, which relied only on rainfall, was easier to understand than the WBCIS index. The BASIX product was rather profitable since it started, even though it was limited to a small fringe of customers and suffered from competition from subsidized insurance schemes and the limited potentialities due to an insufficient meteorological network and lack of data[41]. This same experience was then duplicated in Malawi.

#### *9.1.8.1.2 From groundnut coverage to cash-crops in Malawi*

Malawi's own weather based crop insurance scheme started in 2005 on a pilot basis. It intended, as in India, to target smallholder groundnut farmers first, prior to any extension to other crops and cover drought and excess water. This choice was firstly due to the vulnerability of the groundnut crops to drought first and secondly by its growth potential in Malawi[42].

Groundnut farmers were not keen on accessing credit and investing in materials, seeds, and other inputs to develop groundnut crops before the launch of the index insurance scheme. Insuring them allowed better access to credits that could then be used to invest in production techniques and inputs. This was one of the goals of National Association of Small Farmers (NASFAM) as it depicted major Malawian agricultural problems, the lack of access to credit, and the lack of inputs' quality. This professional organization then partnered with other stakeholders (World Bank, insurers, etc.) to provide agricultural insurance to farmers and helped its distribution in four pilot regions, located near meteorological stations, i.e. in areas where rainfall data could be reliable, and where NAFSAM had farmer's club interested in the project.

Weather insurance was thus linked to credit. As NAFSAM was interesting both in upgrading agricultural technologies and in providing resilient inputs (not only to climate adverse events but also to pests and diseases) in order to maximize farmers' outputs, it developed a

[41] GRET, BIM Paper n°25, « L'assurance agricole indicielle en Inde : NAIS, WBCIS, BASIX, une grande variété d'index et une couverture nationale », May 2010

[42] Mahul Olivier and Stutley Charles J. Government Support to Agricultural Insurance, challenges and options for developing countries, The World Bank, 2010.

mechanism along with a pool of insurers, banks and the World Bank to provide improved seeds to farmers. Weather index-based insurance was sold through the credits given to farmers to invest in improved groundnut seeds, as two banks agreed to embark on financing agricultural activities due to the fact that improved seeds lessen the risks of lending.

The insurance pilot was then extended in 2008 to high-value cash crops because of the lack of organization of the groundnut supply chain, the difficulties to recover loans, and the poor seed quality. It thus ceased operations on groundnut and started covering the tobacco sector, often associated with maize, and is further planned to be extended to paprika, tea, coffee, and cotton[43] . As a cash-crop, the tobacco value chain is relatively well organized as there is a huge demand for credits due to the inputs' needed and given the fact that banks recover loans at the source, i.e. before the farmers are paid for their production which is sold through auction at a central sales point. Banks have thus enough collateral to lend money while lessening the default risk. As a result, the weather-based index insurance on tobacco crops developed well in areas located in a 30 km radius from participating meteorological stations.

Nine companies gathered in a co-insurance pool coordinated by the Insurance Association of Malawi (IAM) and reinsured on the international risk market to underwrite these policies, which are distributed by banks with the support of trading companies (Figure 9-14). In 2009, some companies were authorized to expand these policies at individual farmer level, rather than at group levels. From less than 1,000 groundnut farmers covered in 2006, it reached around 3,000 mainly tobacco producers in late 2009 and collected more than USD 2.5 million premiums while still under the pilot phase.

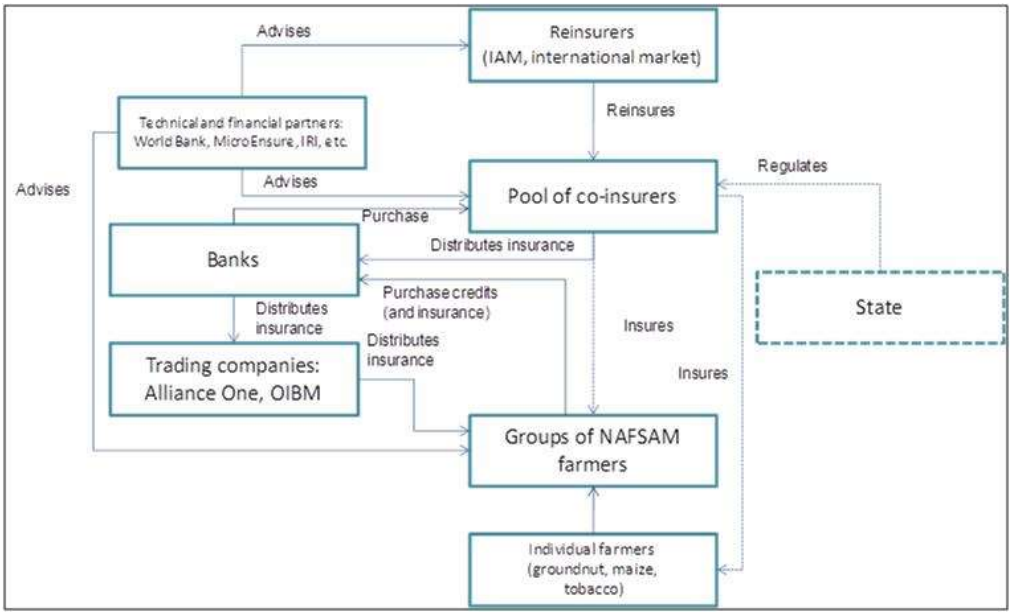


**Figure 9-14: Weather Based Crop Insurance Scheme in Malawi**

Source: ACTUARIA

[43] Hellmuth Molly, Osgood Daniel, et alii, Index Insurance and Climate Risk: prospects for development and disaster management, IRI, 2009

#### *9.1.8.1.3 Index design and climate change issue*

The Malawi weather based crop insurance scheme was mainly design with the support of the World Bank. Bundled loan and insurance contracts on groundnuts were offered in four pilot regions potentially affected by drought, and insurance on tobacco was then offered in two additional regions.

Both rely on the same trigger with rainfall deficiency as a proxy for peril. The trigger is the quantity of rainfall observed at reference weather stations, during the three phases of crop growth (establishment and vegetative growth stage, flowering stage, and maturity phase). Payouts are made when the index crosses a specified rainfall threshold at the end of the contract period, and for a maximum payout equal to the loan given by the bank.

Prior to the agricultural season, farmers sign a contract granting the "bundled loan"[44] in which the insurance premium is specified according to the assessment of historical rainfall data and the probability of a payout. When the season is good and that rainfall is sufficient, farmers owe banks the cost of inputs and insurance premium plus interest and taxes, whereas if insurance policy is triggered by rainfall deficiency, the insurance company pays (all or part of) the loan to the bank[45].

The question of climate change predictions and weather index insurance adaptation was raised in relation to the El Nino Southern Oscillation (ENSO), which increased drought probabilities from 19% to 40% during the years ENSO was observed[46]. The World Bank along with NAFSAM tested the level of awareness of farmers on climate change and climate predictions and concluded that they were aware enough to incorporate options linking the index to the actual climate change phenomenon.

According to Daniel Osgood, several methods have been envisaged, two years after the program started, spanning from a premium increase to contemplate climate change due to ENSO, to the adjustment of the size of individual loans and the inputs used. The results of this study found that pricing the cost of El Nino has to be related to the size of inputs granted through the loans, otherwise in similar conditions the impact would be negligible. In forecasted drought years, the number of inputs given through loans has to be increased in order to allow larger areas to be planted so as to adjust to the expected losses.

Finally, index adjustment was not found being solely able to prove beneficial regarding climate change, contrary to bundled-loans which can be used, if correctly designed and associated with variable inputs' amounts, as risk reduction mechanisms both for farmers and insurers. Although this study was not followed by actual changes in index or bundled-loans, it emphasized the need to address climate change not only through its cost on insurance premiums but also through related risk mitigation and risk reduction measures. An option seemed to adjust both insurance premium and loan size as a function of ENSO's impact on mid and long-term climate variability.

#### *9.1.8.1.4 Key lessons learned from Malawi's experience*

Several lessons might be learned from the Malawi weather based index insurance scheme. It has undeniable advantages:

[44] A bundled loan is the packaging of a loan for agricultural inputs associated with a rainfall index-based insurance policy.

[45] Osgood Daniel E. et alii, Integrating Seasonal Forecasts and Insurance for Adaptation among Subsistence Farmers: The Case of Malawi, Policy research working paper 4061, The World Bank, 2008

[46] Ibid.

- First, the concept of bundled loan insurance involves risk mitigation measures, which provide incentives for production while lessening drought risk.
- Second, index insurance reduced moral hazard in Malawi and reduced transaction costs in providing cheaper products not depending on farmers' practices.
- Loan-bundled insurance has allowed farmers to improve their credit worthiness and consequently their access to credit in securing collaterals needed by banks, through the direct link between the bank and insurers.
- A simple index based on cumulative rainfall over the growing period with different triggers given the stages of the crop's growth is easier to understand for farmers than complex indices. However, there is a demand for incorporating climate change aspects in the mechanism as droughts are becoming more frequent and more severe in Malawi.
- The project has been given strong support for index design from the technical partner, which is a prerequisite in such environments affected by frequent weather hazards to interest financial partners and reinsurers.

However, the WBCIS program in Malawi showed some serious limitations, as it remains for almost 6 years in the pilot phase and as there is patent lack of weather stations to increase the number of insured on the targeted crops.

- Investments in meteorological stations, as it was already the case in India, is needed in Malawi to upgrade to a wider insurance scheme based on reliable data covering more than a few hundreds of farmers. These investments are also required as regards the inputs or technical skills. Understanding of weather based index insurance is essential for farmers to be able to know the products and its limits in order to avoid disappointment, which could lead to abandoning such schemes.
- The groundnut experience has been limited due to the lack of formal organization of the stakeholders in the value chain. For this reason, the experience on groundnut was abandoned and replaced by tobacco and maize. To extend WBCIS to other crops, attention should be focused on (cash) crops with most organized value chains. Inputs' supply and availability is also a major concern for a weather based index insurance to succeed. In Niger, the level of organization of stakeholders in most of the value chains is quite low as well, making it necessary at first to strengthen this organization, for instance through supply of inputs, prior to the choice of such or such value chain.
- The regulatory framework has also been a major concern to scale up Malawian insurance to a nation-wide insurance. Companies were authorized to underwrite premium as long as the product was constrained to a pilot phase, but a legal environment, regulating weather based index insurance, is required for further development.

#### *9.1.8.2 Ethiopia's index insurance programs*

Ethiopia has received strong international attention since the 1984-1985 food crises following war and successive droughts, the latter causing around 1 million deaths. As in Niger, Ethiopia's economy is highly reliant on agriculture and livestock and 85% of the population is dependent on rainfed subsistence farming activities. Ethiopia has faced other rainfall related risks (shortages or excesses) in recent years, and farmers and herders have been confronted with soils degradation, falling crop yields, and livestock losses. At the same time, cereal prices increased and livestock prices decreased, which in turn heightened the agricultural population's vulnerability.

Consequently, attention focused on Ethiopia in the late 90's to launch pilot phases of different agricultural insurance programs to settle risk transfer instruments and to lessen the

drought and other weather related perils' effects on farmers and herders. Ethiopia's "track record" includes different phases.

- Ethiopia was the first, and only, developing country to launch a traditional Multi-Peril Crop Insurance (MPCI) to insure against rainfall, fire, and transit related risks, mainly targeting the few players in the Ethiopian agri-business. Selection to access the MPCI program is difficult in Ethiopia, as both insurance experts and staff of the Ministry of Agriculture assess the capacities of demanders to join the scheme.
- Ethiopia then launched in 2006, a World Food Program's backed "disaster index insurance pilot". Its aim was to prevent major drought risks by targeting people who could rely on themselves in normal years but were undergoing food insecurity during drought years. Axa Re reinsured the program, while USAID subsidized the WFP's premium. The WFP had previously embarked on a contractual insurance policy with Axa Re on the behalf of the State for a USD 930,000 premium and a maximum payout of USD 7.1 million[47]. The insurance relied on historical rainfall data used to design a drought index (EADI). A feature of that index is that it is strongly correlated to the level of international food aid. During the crop cycle, this index was double-checked by satellite observations and found accurate.
- For this reason, as early as 2007, the insurance scaled up to a comprehensive program including more stakeholders, such as the World Bank, the FAO and the UK cooperation body; DFID to design more accurate indices, to be able to integrate a real-time indicator of "livelihood stress index" of vulnerable populations in particular areas located close to weather stations, and to double check these by satellite data. The project framework was named Livelihood, Early Assessment, Protection (LEAP) and placed under a multi-year Productive Safety Net Program. This program is still under development and to our knowledge did not "trigger" as a risk transfer insurance tool for now, as no disaster drought risk was observed.

However, these index insurance experiences have been designed to target macro-level climate risks. The vast majority of smallholder farmers could not be covered by a traditional insurance scheme due to the lack of yields data at farmers' level, the distribution of agricultural population over the territory, and the small size of land plots, which would result in important loss assessment costs. Small scale index-based insurance thus represents a solution to these issues as it reduces the transaction costs while eliminating ex-post assessments and limits the need for meteorological and yield data at regional or area levels.

##### *9.1.8.2.1 An innovative insurance model and two different pilots*

Contrary to Malawi, what sounds as a classic weather based index insurance product is actually an innovation since the Ethiopian model is not focusing on cash-crops and solvent farmers (though insurance can increase the farmer's creditworthiness), but basically on subsistence cereals and crops. Besides, the Ethiopian approach is based on imbrications of multiple stakeholders with the aim of implementing holistic projects to address risk transfer and risk mitigation programs as well as creditworthiness improvement at the same time.

Insurance is offered by the Ethiopian insurer Nyala Insurance Share Company (NISCO), which is the only micro-insurance company in Ethiopia, and which is reinsured by Swiss Re. It is designed to target different crops such as beans or teff, in dividing the crop's growth cycle into 3 phases (1. germination and vegetative, 2. flowering, 3. ripening), and each

[47] Balzer Niels and Hess Ulrich, Climate Change and weather risk management: evidence from index-based insurance schemes in China and Ethiopia, WFP, 2010

phase into ten-day periods called dekads[48]. These periods are the reference periods for which rainfall is estimated through a model of yield reduction function, which includes the ratio of actual seasonal evapo-transpiration to the seasonal crop water requirement. Deficits are then consolidated and potentially trigger the payout at the end of the crop's cycle, up to the contractual limit agreed in the insurance policy.

The policy was developed by NISCO and Swiss Re in partnership with many other stakeholders:

- The Ministry of Agriculture and Rural Development established the legal framework and mobilized its administration in pilot regions
- The National Meteorology Authority provided the basic rainfall data needed to calculate correlations and model index. It also organized information sessions for the insured along with the insurers. The pilot project relied on farmers of cooperative union, located in perimeters of 20 km around weather stations so as to minimize basis risk.
- The beneficiaries from Lume Adama Farmers' Cooperative Union (the insured) in a *woreda* (administrative sub regional entity) of Eastern Ethiopia were consulted and expressed their interest and awareness. The cooperative was all the more interested that it was already related to NISCO, since prior to the new index insurance products it had already purchased NISCO's MPCI products to cover its members.
- A credit institution which is supporting the Union while pre-financing part of the premiums (which would have been too expensive for the insured otherwise), is giving cheap credits to union members.
- The WFP is providing technical assistance.

An index-based insurance policy was thus designed, and triggered in the first year of its implementation (in 2009) due to bad rainfall conditions. It basically, established the cost of production for each crop including inputs and labor costs. These production costs served to measure the impact of drought (rainfall data over 30 years) per ha compared to total production expenses which in turn was used to calculate the premium per ha. The maximum payout was thus expressed in percentage of the total sum insured. Figure 9-15 shows the flow chart of mechanism for Weather Index Crop Insurance (WICI) in Ethiopia.

[48] Meherette Eyob, Innovations in insuring the poor, providing weather index and indemnity insurance in Ethiopia, Focus 17, Brief 8, Dec. 2009.

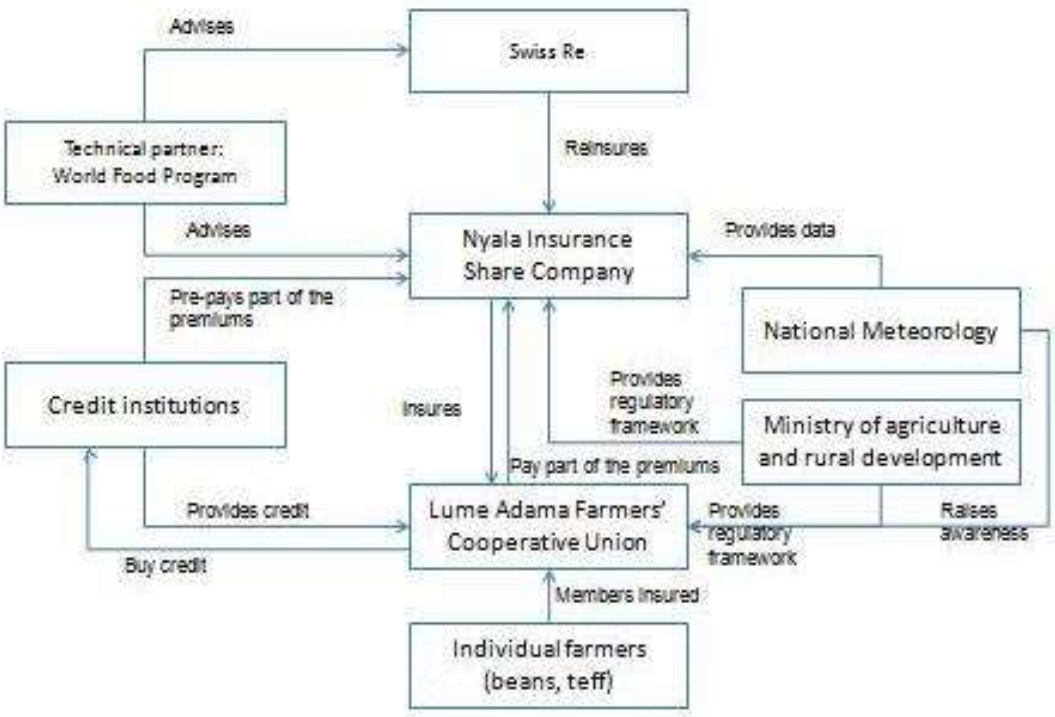


**Figure 9-15: Weather Index Crop Insurance (WICI) scheme in Ethiopia**

Source: ACTUARIA

In Northern Ethiopia (Tigray), a similar weather index based insurance has been designed and implemented through different partnerships on the same basis with the support of Oxfam America: the HARITA (*Horn of Africa Transfer for Adaptation)* (Figure 9-16). Unlike the first model, it specifically targets climate change trends in Ethiopia.

As stated above, the HARITA project includes three components:

- Conservation activities (risk reduction) to decrease farmers' vulnerability to climate shocks in improving water-resource management, adapting management practices to climate change trends, making and using compost and planting trees to improve soil quality, preparing seeds before sowing etc. It also includes food-for-work and cash-for-work transfer in case a food crisis is predicted, under a government program the PSNP (Protection Safety Net Program)
- Insurance (risk transfer) provided by NISCO which is detailed below
- Credits (prudent risk taking) to diversify income by investing in secondary activities (honey, cash crops such as horticulture, spices, etc.) or in high quality inputs (improved seeds). Insurance serves as a collateral to reduce the credit's interest rates, being a partial guarantee for banks. Access to credit is said to favor implementation of climate change resilience strategies among farmers[49] – and/or risk reduction activities - which would allow them to gain even during bad years.

A similar micro-insurance model, similar to the weather index crop insurance scheme described above, has been implemented in Tigray. However, slight differences apply to the policies:

[49] Oxfam, Harita Quarterly Report, Jan-March 2011

- Farmers have the option to pay their insurance with extra work under PSNP. They therefore work extra days, in addition to those worked to benefit from usual PSNP transfers, and are given an insurance certificate if they choose this option rather than food or cash. Doing so, they choose to perform disaster risk reduction work in their communities after planting. The insurance will be triggered if deficit rainfall is observed at participating weather stations and confirmed by satellite observations.
- Farmers who do not participate in PSNP but who are located in the areas covered can buy insurance directly from NISCO.
- Premiums of the insurance-for-work program are being funded by Oxfam America and will be soon funded by other donors following the recent developments of the program. From 200 insured farmers in 2009 in one location, it moved to 1,300 farmers in four different regions in 2010 and more in 2011.
- Besides, from the first index insurance covering teff, it extends to wheat, barley and sorghum, and proposed two different options along with technical partners (IRI and Swiss Re): a dry scenario index-insurance option (more frequent payouts, but more expensive option) and a very dry index-insurance option for extreme events. A large majority of the insured prefer to purchase the dry option.
- In 2011, additional research conducted by IRI and REST[50], designed two different additional indexes for short-cycle (teff, beans, barley) and long-cycle (sorghum, maize, millet, wheat) crops to insure them against late or early rainfall during each of the 3 phases for each crop. It covered around 40 villages[51], with the possible options for farmers to purchase both index insurance for crops vulnerable to early and late rainfalls such as sorghum, maize, wheat and barley. Average payouts were expected for the latter once in three years, contrary to once in five years for more resistant crops such as teff.

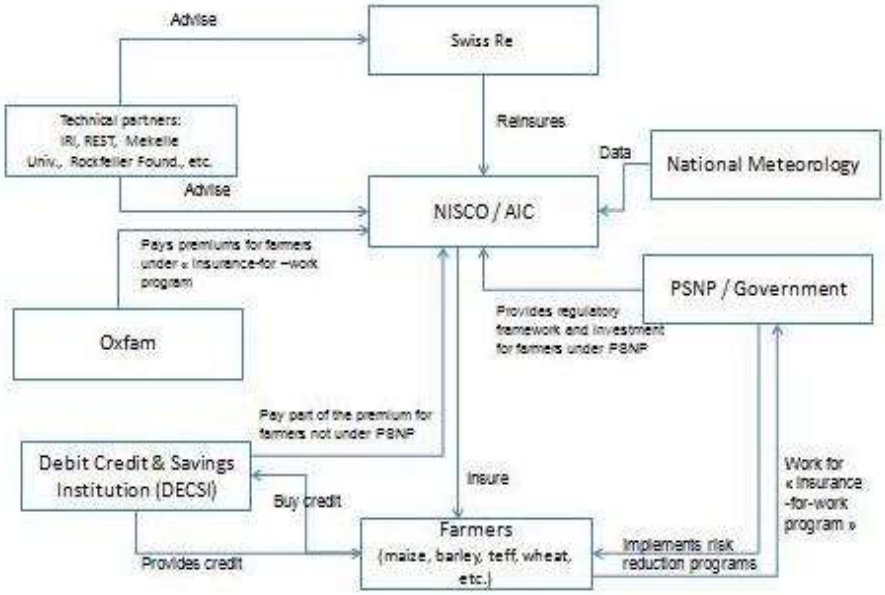


**Figure 9-16: HARITA's "insurance-for-work" scheme in Ethiopia**

Source: ACTUARIA

[50] REST: Relief Society of Tigray

[51] A second insurance company, African Insurance Company, was supposed to underwrite the policy.

#### *9.1.8.2.2 Key lessons learned from Ethiopia's experience*

Ethiopia's various insurance schemes offered to small farmers are for now successful experiences that are still expanding to other regions in Ethiopia.

- The basic product developed with Lume Adama Farmers' Cooperative Union scaled up in Ethiopia with the HARITA's experience, as it confirmed their capacity to avoid moral hazard and adverse selection, and reduce administrative costs.
- The main interest of these index-insurance products is that they remain affordable for small farmers through original methods of paying for the insurance premiums and efficient partnerships in a country where there is limited opportunity to sell insurance products to farmers otherwise. The use of cooperatives is essential, as they are the only ones able to make farmers aware of insurance and get them interested in such programs.
- With the HARITA's experience, the same amount of donors' money spent can be used for two different purposes at the same time: to purchase weather index insurance or hire labor force to perform (climate change related) risk reduction measures. It is thus invested at the same time both in risk transfer and risk reduction mechanisms.
- Even though these programs are highly subsidized by donors, it aims to seek a long-term impact on awareness towards insurance potentialities and sustainability, in order to anchor insurance in farmers' behaviors. This interest is heightened as farmers see their bankability improved by insurance and provide them better access to credit.

However, Ethiopia's weather-based index insurance products point to some needs that have to be addressed to strengthen the original insurance model.

- The scale-up capacity is limited by infrastructure availability in Ethiopia. According to Meherette (2009)[52], only 140 weather stations out of 900 in the country have the required historical data needed to design and price index-insurance. Out of this 140, only a small part collects data automatically. Others collect data manually and then send it to National Meteorology. However, satellite data could be used to strengthen data collected at weather stations.
- The main drawback results from the fact that not all the farmers' needs and expectations are met. Awareness and understanding of insurance needs to be improved, but index insurance could also be implemented in the same areas for livestock as the vast majority of farmers are involved in both farming and livestock activities.
- The Ethiopian model is quite complex as different models coexist. Different donors, different indices, different channels of distribution (credit / insurance-for-work / traditional distribution channels) and farmers and cooperative unions seldom have clear understanding of the weather-based index insurances.
- The regulatory framework in Ethiopia's was also, as in Malawi, one of the main concerns. The need for index-insurance regulation at the State level was high, as was the need for micro-insurance regulation.

[52] Meherette Eyob, Innovations in insuring the poor, providing weather index and indemnity insurance in Ethiopia, Focus 17, Brief 8, Dec. 2009.

- Finally, donors were also criticized by NISCO[53] for not being competent enough in insurance and reluctant to engage in multi-year programs rather than year-to-year programs.
- In Niger, the idea of providing such an insurance-for-work program could be envisaged as cooperatives and farmers' organizations would surely be interested, as for instance some of them already experienced water harvesting techniques funded by EC and Wahara[54]. However, the main obstacle to such a program being implemented in Niger is less the farmers' will or the financial resources that could be generated by donors' investment, than the existence of an insurer able to provide such a product and who can carry the project both on its technical and financial sides in the long term.

#### *9.1.8.3 Livestock index-based insurance in Kenya and Mongolia*

If index-based crop insurance is still at its early stage on the global scale, livestock index-based insurance has also still to find its feet, as it is implemented only in a few countries, and often only at a pilot stage. Given the size of the market in Niger and its weight in the national economy, livestock production is obviously a priority in Niger. Furthermore, livestock production is strongly affected by adverse climate events, whether climatic shocks such as drought increase livestock mortality or whether livestock is used by herders to adjust to climatic shocks and sell when there is a cash crunch, thus impacting the households' incomes.

Kenya and Mongolia are two countries which implemented index-based livestock mortality insurances. In Mongolia, which suffered heavy losses from 2000 to 2002 (11 million animals) due to extreme weather events and very low temperatures, there is currently an insurance scheme against livestock mortality due to low temperatures running on the national scale. In Kenya also there is an insurance product tested at the pilot phase against livestock mortality due to drought. As in Niger, Kenya and Mongolia have a livestock sector accounting for an important part of agricultural GDP, and have a part of pastoralist population, often nomadic, mostly relying on livestock production and jeopardized by climate shocks such as drought (Kenya) or low temperatures (Mongolia).

These two experiences could help design livestock index-based insurance in Niger, if Nigerien authorities choose to set up such an insurance scheme.

##### *9.1.8.3.1 Data, a (non-necessary) prerequisite to set-up a livestock insurance*

Mongolia launched its policy in 2006, following studies made by the World Bank after the Mongolian Government expressed its interest in insurance. It met its audience from the first year, as initially around 10% of the pilot regions' herders purchased insurance[55].

The Mongolian IBLI model, which was the first livestock index-based insurance, led the path to other insurances designed on the same pattern, with risk transfer mechanisms including herders, insurers, and government and/or reinsurers (Figure 9-17). It was then duplicated elsewhere, as it is often cited as an international best practice.

[53] N.S Araya, New Directions for Smallholder agriculture, IFAD http://www.slideshare.net/ifad/ethiopian-6626924

[54] See for instance: http://www.wahara.eu/index.php/water-harvesting

[55] Mahul Olivier and Skees Jerry, Managing Agricultural Risk at the Country Level: The Case of Index-Based Livestock Insurance in Mongolia, Policy Research Paper, The World Bank, August 2007

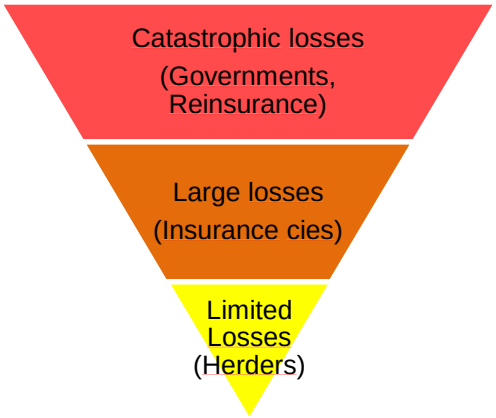


**Figure 9-17: Livestock insurance risk transfer structure in Mongolia**

Source: ACTUARIA

A prerequisite of any index-based livestock insurance is data. Mongolia records mortality rates per district (areas named *soum*) through an annual census since the 1920's for all major domestic species. Losses observed can then be related to climate events in years during which extreme events occur. This data informs stakeholders about the losses and the financial capacity of inner insurance markets or governments to cope with losses due to climatic events. In bad years, risk transfer to the international market is often the only solution, as events may prove catastrophic.

In Kenya, there was no such census, which could have facilitated the design of index insurance. In a context where accurate livestock mortality data is lacking (or in which official data is too partial due to it being an informal sector), the envisaged solution relied on satellite data. The insurance launched in 2010 and tested during previous years is thus relying on NDVI observed during 10-days periods through satellite since 1981[56]. However, the designed index includes livestock mortality data at household level collected by the Kenyan administration and interpolated at various points of the pilot region since 2000. One of the Kenyan WII's success, as it was the first time it has been done, was to design an index not only relying on historical and real-time satellite observations of the vegetal cover but also taking into account in the models the impact on households (Figure 9-18).

Contrary to Mongolia where there is data available in each *soum* for each species, Kenyan divisions in which the pilot product was implemented had to be divided into sub-divisions consisting of homogenous areas regarding NDVI observations, and predicted livestock mortality. Even though the basic process is the same with a certain rate of insurance payment given the level of index triggering the insurance policy, the index levels and premiums calibrated on these levels are different and are based on the vegetal cover observed in sub-divisions.

[56] Chantarat Sommarat et alii, Designing index based livestock insurance for managing asset risk in northern Kenya, 2009.

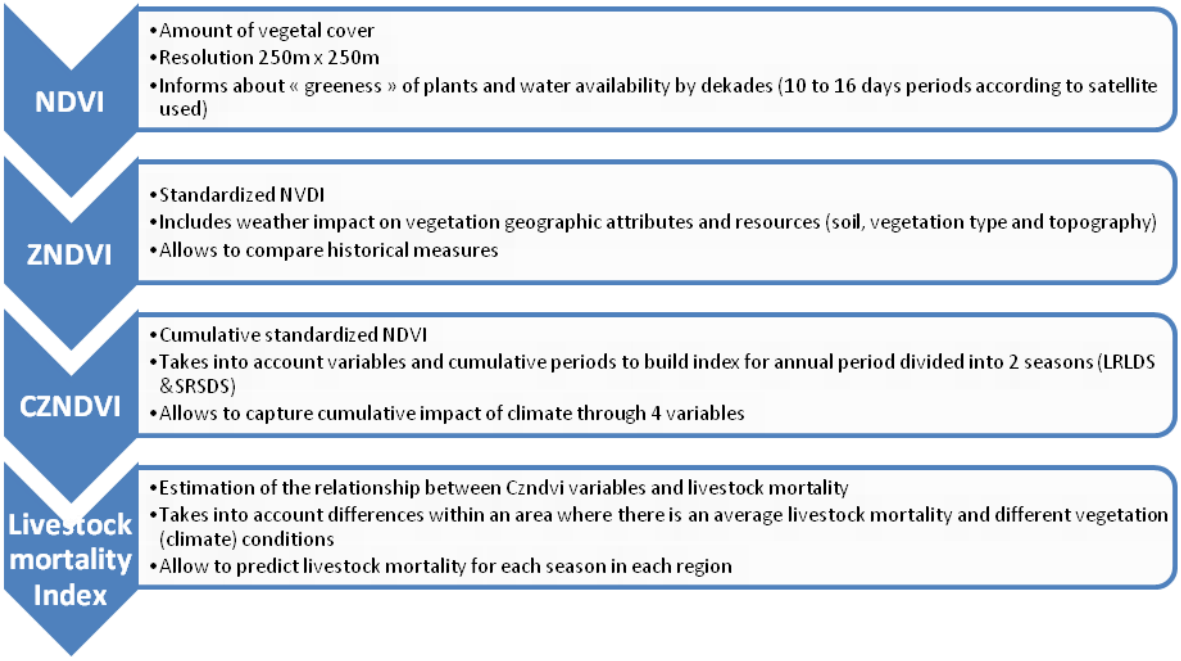


**Figure 9-18: Modeling livestock mortality index with NDVI in Kenya: successive steps**

Source: ACTUARIA with "Derive Predicted Livestock Mortality Index" (May 2012)[57]

Compared to the above, livestock data in Niger is available only for a recent period. The Kenyan model would thus certainly be closer to the Nigerien context than the Mongolian one.

#### *9.1.8.3.2 Calibration of the policies*

In Mongolia as well as in Kenya policies are calibrated in order to provoke payouts, if need be, at the end of seasonal activities. Whereas in Mongolia winter runs from January to May, in Kenya different indexes have been calibrated for long rain long dry season (LRLDS: from March to September) and short rain short dry season (SRSDS: October-February). Payouts are made following each season.

However, climate change related practices are not addressed *per se* in these policies. In Mongolia, which is suffering from many climate change related effects (more frequent harsh winters, progress of the Gobi desert, invasions of insects, etc.), the index design is only tackled through historical data use, which includes livestock census. In Kenya, where the project is still at its pilot phase, climate change related issues have not been addressed yet.

#### *9.1.8.3.3 Mongolia, both commercial and social instruments*

In Mongolia, two mechanisms co-exist based on the severity of the livestock losses. Index based livestock insurance is triggered when losses exceed 6% of livestock. Losses beyond 30% are managed by a catastrophic risk response mechanism by the Government of Mongolia and the World Bank. To avoid adverse selection, premiums are underwritten from March to June, before any sign of the impending winter's harshness. Payments are made after winter from July to August, as mortality rates are assessed from May to June per *soum* and per species.

[57] Online information available at http://livestockinsurance.wordpress.com/ a website gathering key finding of ILRI (International Livestock Research Institute), BASIS, AIMA, Cornell University and Maxwell School.

Offered commercially to individual herders by private insurance companies gathered in a pool of co-insurance for losses comprised between 6% and 30%, herders choose the sum they want to insure according to the value of their herd in the targeted *soum* (proposed choices usually range around 30% of this value but they can insure from 25% to 100% of the estimated value). To benefit from the disaster risk product, they must insure at least 50% of the herd's value and add an additional specific fee – rather than premium[58].

#### *9.1.8.3.4 Kenya, IBLI based on Tropical Livestock Unit*

In Kenya, payouts are made when the insurance policy is triggered by index above 15% of livestock mortality, whether it is LRLDS or SRSDS. In the Kenyan model, the sum insured has been rationalized and harmonized, contrary to the Mongolian experience. Instead of insuring the animal's value directly, the number of insured livestock is calculated using *Tropical Livestock Unit* (TLU), where each species is assigned a particular TLU value taking into account not only its financial value but also its resilience capacity to drought (1 for cattle, 1.4 for camel, 0.1 for goat, etc.).

Insured value and premiums are based on this TLU calculation. One TLU is assigned a monetary counterpart value, making it easy to define the insured value as the total TLU insured multiplied by the monetary value of a TLU. The premium is expressed as a percentage of this operation, according to the level of premium assigned to each region, given their vulnerability to drought and the drought frequencies and severity. Indemnities are then paid if the index is triggered for each of the two rainy/dry seasons, given predicted LRLD and SRSD announced respectively in September and February.

#### *9.1.8.3.5 Underwriters*

Kenya and Mongolia have set different underwriting strategies and have known a variety of fortunes. In Mongolia a co-insurance pool is underwriting the insurance policies, whereas in Kenya only one underwriter is currently included in the process in partnership, but with multiple stakeholders involved, including main players such as a bank and ILRI (International Livestock Research Institute) which initiated the product.

#### *9.1.8.3.6 LIIP Pool in Mongolia*

Because of the limited capacity of the Mongolian market and the potentially high exposure that would result from livestock losses due to climatic events, it has been decided in Mongolia that a co-insurance pool would underwrite index-based livestock insurance, in order to pool risks and establish layers of risk financing[59].

The 'Livestock Indemnity Insurance Pool' consists in a public-private partnership:

- The co-insurance pool made mostly of Mongolian companies retains part of the shared risks (Figure 9-19). Premiums are collected by the pool, placed into the pool and indemnities are paid from these funds, in order to avoid endangering the other branches of these companies due to livestock insurance. Gains and losses are shared according to the global premium each company has collected.
- Reinsurance is supposed to be provided by (and paid to) international market (commercial layers) and government (catastrophic layers). However during the policy's first years a government reinsurance reserve covered larger losses through a

[58] Hellmuth Molly, Osgood Daniel, et alii, Index Insurance and Climate Risk: prospects for development and disaster management, IRI, 2009

[59] Ibid

stop-loss treaty with the LIIP (commercial layer), while a loan from the World Bank covered catastrophic losses (social layer)[60].

- From its first year (2006) to 2010, the number of insured herders increased to more than 5,000, and has proved to be sustainable. Besides, companies and herders were protected against bankrupt risks of one or several companies, as the latter were required to deposit capital at risk into a LIIP account, which was managed by the government, and which guaranteed indemnities' payments.

As regards the regulatory aspects in Mongolia, the law had to be changed before index based livestock insurance could be introduced, as the law did not explicitly authorize it before the scheme was launched. As the whole sector was interested in pushing for a change in law, it was authorized rather rapidly.

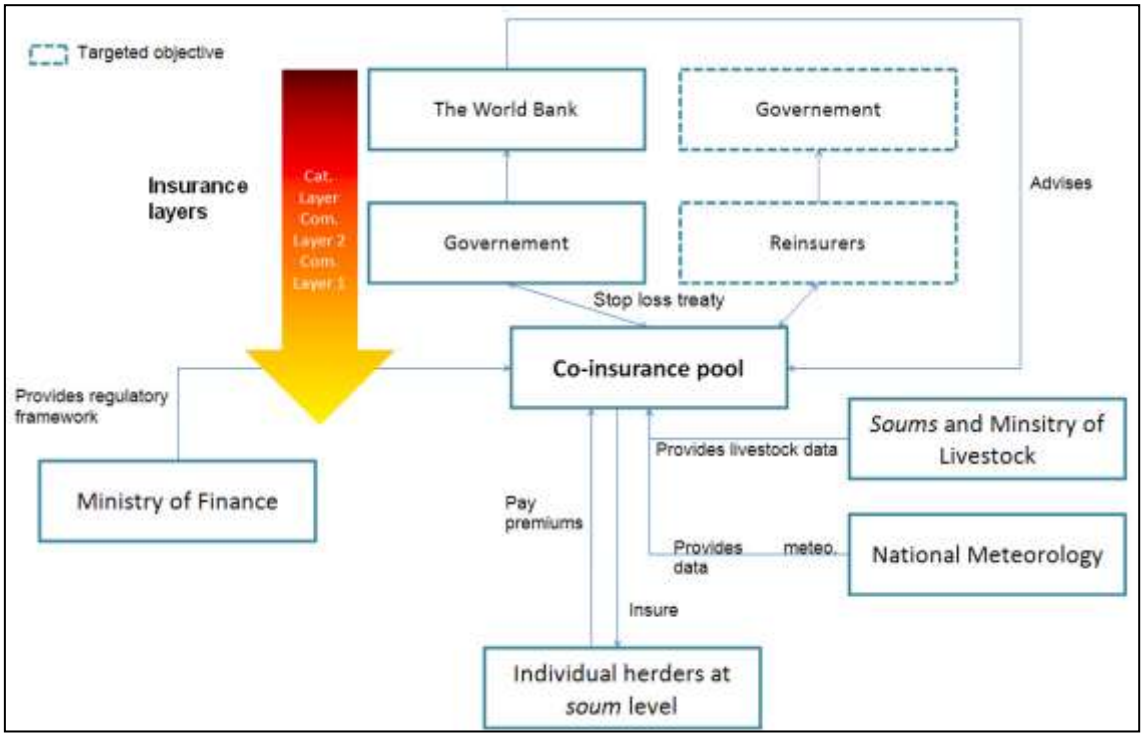


**Figure 9-19: Mongolia's livestock index-based insurance scheme**

**Source: ACTUARIA**

#### *9.1.8.3.7 A single underwriter in Kenya but multiple stakeholders*

In Kenya, index-based livestock insurance is underwritten by a single insurer , UAP, at the pilot phase, which is already underwriting MPCI crop insurance and livestock damage insurance against losses due to accidents, diseases, etc., and which is reinsured by Swiss Re (Figure 9-20).

Many other stakeholders play a role in the IBLI process (AGRA, ILRI, 2011). These are:

- Equity Insurance Agency (EIA), another insurer already into weather index-based crop insurance, provides agency services: extension, publicity and sales.
- ILRI and other research centers (Maxwell School, Cornell University, BASIS Centre, etc.) provide technical support and assessment studies for implementation. Indeed,

[60] Mahul Olivier and Stutley Charles J., Government Support to Agricultural Insurance, challenges and options for developing countries, The World Bank, 2010

to launch such a program required communication, as nomadic herders were not aware of insurance practices. ILRI set up numerous training games and awareness sessions along with partners in the pilot regions.

- As UAP and EIA have small networks and have agents particularly in the locations where pilot projects are implemented, the distribution uses a social safety net program (the HSNP: Hunger Safety Net Program), funded by DFID (UK cooperation) and Rockefeller Foundation, which delivers cash transfers to thousands of households in the targeted regions.
- Part of this program aims at improving distribution channels of financial services to rural households through a "Financial Sector Deepening Trust" (FSD), in association with Kenya's Equity Bank which belongs to the same group as EIA. Equity Bank was entrusted with the task to create points of sale in order to provide HSNP cash transfers in remote areas using ICTs (mobile phones, computers, tablets, etc.). It is thus planned that in the near future, EIA will use these distribution channels to underwrite IBLI policies, as the software was not ready for the last campaign and the underwriting process had to be done manually (AGRA, ILRI, 2011).
- Traditional authorities were not only associated to the launch of the program in the pilot region but also at the national level as the SG of the Supreme Council of Kenyan Muslims was mobilized since most of the herders in this region are Muslims.
- USAID contributed by providing data from former projects it funded, which helped estimate NDVI correlation with livestock mortality and reduced basis risk.
- The Insurance Regulatory Authority agreed to launch a pilot in spite of questions regarding the actual verification of declared livestock (see below).

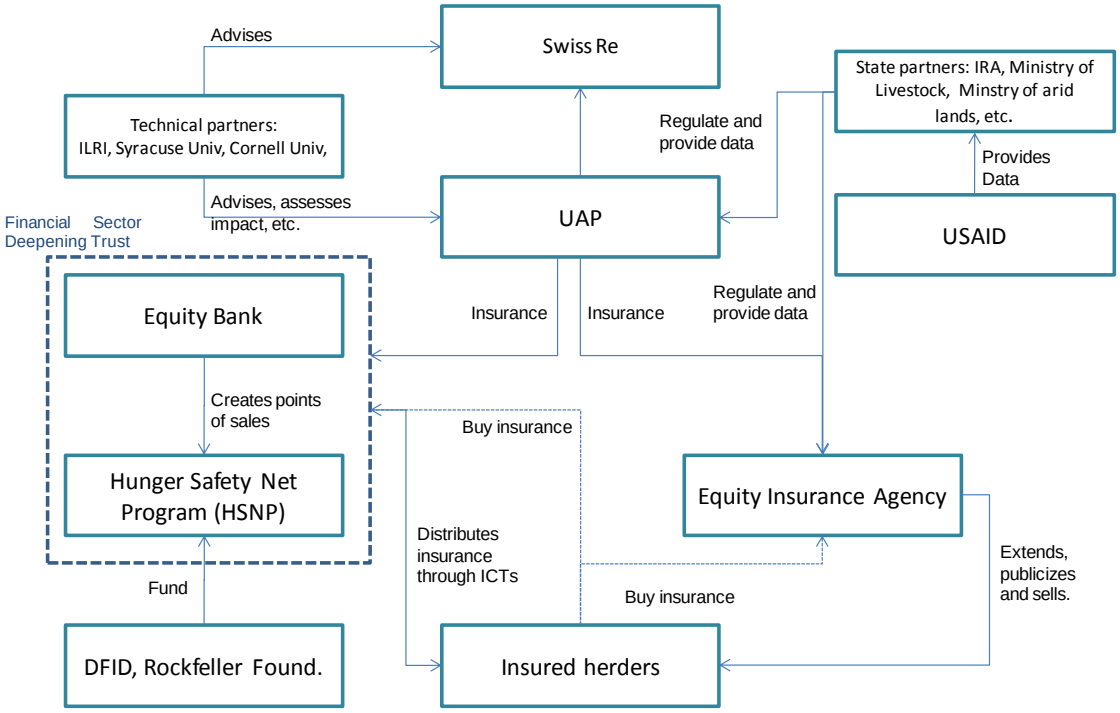


**Figure 9-20: Kenya's index-based livestock insurance scheme**

**Source: ACTUARIA**

#### *9.1.8.3.8 Key lessons learned from Mongolia's and Kenya's experiences*

Some of the key lessons learnt from index-based livestock insurance schemes set up in Mongolia and Kenya are:

Index-based insurance and pools allow policies to stay affordable:

- As is the case in Malawi for index-based crop insurance, the Mongolian pool of co-insurance allowed strengthening insurers' capacities to underwrite such livestock insurance for which they did not have the capacities alone. They were thus able to pool climate risks, secure defaults on payments risks, and share financial results.
- Besides, had the risks been priced outside PPPs or by the sole market with traditional general insurance products, they would have been far too expensive for herders. Index-based insurance avoids loss assessment costs and reduces delivery costs, while PPPs such as in Mongolia or Kenya introduce a risk layering able to transfer catastrophic events to the international market and/or governments.

Adverse selection increases where people see no interest and where no climate event is observed:

- Whereas in Mongolia the number of insured has increased since 2006 from 10% to 15% of the herders in the targeted areas, in Kenya, following the first two years the policy was sold and due to the absence of drought and tangible interest (no payouts made), adverse selection was high. From around 2,000 policies sold in 2009 and 2010, the figure decreased to only 500 policies which were actually sold in 2011[61].
- Another limit of the Kenyan model was the high expectations farmers and underwriters put in the software system, which was supposed to allow underwriting the first policies. As already stated, this software was not ready on time, policies were sold manually and at high costs as agents went from one location to another in a large area. This technical default hampered the insurance from the start. However, this was tempered by the high level of commitment of traditional authorities and community leaders who supported the IBLI project.
- In Kenya, a lowering in the trigger threshold from 15% to 10% predicted losses is envisaged in order to be more attractive. However, one of the main successes of this policy for now is that it is the first one to have been actuarially designed through large recordings of household data (revenue, losses due to drought, livestock mortality, etc.).

Index-based livestock insurance has still to find ways to improve delivery and reduce costs in areas where there is insufficient access for insurers:

- Contrary to crop weather index-based insurance, livestock index-based insurance in both Mongolia and Kenya is not linked to loans for herders. However, plans are being made in both countries to integrate lenders in the process of insurance delivery in order to reduce costs and improve access to credits.

As any index-based insurance, livestock index-based insurance requires regulation allowing it:

- Mongolia changed the law to allow livestock index-based insurance, while Kenya decided to tackle the issue later as a major problem, which is that there is actually no way to check livestock declared by the insured is actually owned.
- However, at the pilot stage there was no need to modify the law.

[61] Reuters AlertNet, Nov.30th, 2011 http://www.trust.org/alertnet/news/insurance-aims-to-help-herders-avoid-downward-spiral-from-drought

## 9.2 Annexure 2: Questionnaire for farming community and guiding questions

**Questionnaire number**:
(First two letters of the district name and number in ascending order. Example: Niamey questionnaire number 1 will be NI01)
**Name of the surveyor and date**:

**A. GENERAL DETAILS:**

1. District Name: 1a. Village name:

2. Farming community (use ✓ in the choice below):

| Group farming | Individual farming |
|---|---|
| | |

3. Type of farming (use ✓ in the choice below):

| Subsistence | Commercial |
|---|---|
| | |

4. Name of the farming community or head of family and contact phone number:

5. Size of the farming community or household (number of members in case of group farming or household size in case of individual farming):

6. Name of principal crops raised:

| # | Crops | Area (hectares) | Latest production (kg) | Irrigated (yes/no) | Source of irrigation (wells/canal/ bore well/ others) | Type of irrigation (flooding/ border/ furrow/drip/ sprinkler/ subsurface | Cropping season (Sowing date) | Cropping season (Harvesting date) | Rainfed (yes/ no) | Input cost (CFA franc) | Income (annual in CFA franc) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a | | | | | | | | | | | |
| b | | | | | | | | | | | |
| c | | | | | | | | | | | |
| d | | | | | | | | | | | |
| e | | | | | | | | | | | |
| f | | | | | | | | | | | |

7. Name of livestock raised:

| # | Livestock | Number | Meat production (kg) | Native or hybrid (yes/no) | Input cost (CFA franc) | Income (annual in CFA franc) |
|---|---|---|---|---|---|---|
| a | | | | | | |
| b | | | | | | |
| c | | | | | | |
| d | | | | | | |
| e | | | | | | |

8. Availability of loan/financing:

| # | Item | Loan | If availed loan specify source | Pledge any against security for loan? | Amount of loan (CFA franc) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| a | Seed | | | | |
| b | Fertilizers | | | | |
| c | Irrigation | | | | |
| d | Livestock | | | | |
| e | Insurance | | | | |

9. Availability of subsidy:

| # | Item | Subsidy | If availed subsidy specify source | Amount of subsidy (CFA franc) |
|---|---|---|---|---|
| a | Seed | | | |
| b | Fertilizers | | | |
| c | Irrigation | | | |
| d | Livestock | | | |
| e | Insurance | | | |

10. Did you experience any crop yield loss due to drought, flood and pest in the last 10 years:

| # | Extreme weather events | Frequency | Production loss (kg) |
|---|---|---|---|
| a | Drought | | |
| b | Flood | | |
| c | Pest | | |

11. Have you observed any changes in the rainfall and temperature over the past 10 years? Y/N

12. Is there any change in the cropping pattern you adopted due to change in weather pattern? Y/N
    If yes:

| # | Previous cropping pattern | Changed cropping pattern | Type of seed under changed cropping pattern (local/HYV/climate resilient) |
|---|---|---|---|
| a | | | |
| b | | | |
| c | | | |

13. Ideally, how often do you think you need to irrigate to obtain good production?

| # | Crop | Irrigation scheduling |
|---|---|---|
| a | | |
| b | | |
| c | | |
| d | | |
| e | | |

14. Knowledge on modern agriculture (improved irrigation system and climate resilient seed) (use ✓ in the choice below)?

| Type | Not aware | Fully aware | Partially aware |
|---|---|---|---|
| Improved irrigation systems (MI) | | | |
| Climate resilient seed | | | |

15. Do you get technical and managerial support and training regarding the modern agriculture (use ✓ in the choice below)?

| Type | Yes | No |
|---|---|---|
| Improved irrigation systems (MI) | | |
| Climate resilient seed | | |

If yes then what is the source?

| # | Sources | Improved irrigation systems (Y/N) | Climate resilient seed (Y/N) |
|---|---|---|---|
| a | Agricultural universities | | |
| b | Extension workers | | |
| c | Newspapers | | |
| d | Private sector | | |
| e | NGO | | |
| f | Agri-cooperative | | |
| g | Agri-material supplier | | |
| h | Others specify | | |

16. Are there any awareness camps/road shows conducted for awareness on modern agriculture? Y/N

If yes then

| Type | How frequent | And by whom |
|---|---|---|
| Improved irrigation systems (MI) | | |
| Climate resilient seed | | |

17. From where do you get financial support for the purchase and maintenance of improved irrigation system and climate resilient seed?

| # | Sources | Improved irrigation systems (Y/N) | Climate resilient seed (Y/N) |
|---|---|---|---|
| a | Government | | |
| b | Agri-cooperative | | |
| c | Bank | | |
| d | Agri-material supplier | | |
| e | NGO | | |
| f | Others specify | | |

18. Maintenance of irrigation system in your farm?

| # | Sources | Y/N |
|---|---|---|
| A | Availability of spare parts | |
| b | Availability of technical experts for installation and repairing | |
| c | Availability of power (electricity, diesel) | |
| d | Anti clogging mechanism | |

19. What is the technical risk in adopting improved irrigation system?

| # | Risk | Y/N |
|---|---|---|
| a | Clogging | |
| b | Technical expertise for | |

| | | |
|---|---|---|
| | maintenance | |
| c | Availability of spare parts | |
| d | Availability of power (electricity, diesel) | |
| e | Operational skill | |
| f | Availability of insurance | |
| g | Others if any specify | |

20. What is the technical risk in adopting climate resilient seed?

| # | Risk | Y/N |
|---|---|---|
| a | Availability | |
| b | Technical expertise | |
| c | Quality | |
| d | Crop failure | |
| f | Availability of crop insurance | |
| g | Others if any specify | |

21. What are the benefits of improved irrigation system?

| # | Benefits | Improved irrigation systems | Climate resilient seed |
|---|---|---|---|
| A | Production (kg/ha) | | |
| B | Water saving (cc/ha) | | |
| C | Fertilizer saving (kg/ha) | | |
| D | Grain quality (superior/inferior) | | |
| E | Others | | |

22. What types of seeds do you use?

| # | Crop | Local | | | Hybrid | | | Climate resilient | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Source | Cost | Yield | Source | Cost | Yield | Source | Cost | Yield |
| a | | | | | | | | | | |
| b | | | | | | | | | | |
| c | | | | | | | | | | |
| d | | | | | | | | | | |
| e | | | | | | | | | | |

23. What kind of obstacles do you face with regards to procuring good quality seeds (Y/N)?

| Financial | Technical | Others |
|---|---|---|
| | | |

24. How do you procure seeds?

| Distribution network | Government | Cooperatives | Dealers come and deliver | Middleman | Others |
|---|---|---|---|---|---|
| | | | | | |

25. How do you purchase your seeds?

| Cash | Cash + credit | Credit | Embedded charges | Others |
|---|---|---|---|---|
| | | | | |

## 9.3 Annexure 3: Weather and Crop Data Status in Niger

### Table 9-5: Status of available maximum temperature data

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | BILMA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | BIRNI N'KONNI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | DIFFA | 1986-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | DOSSO | 1999-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | GAYA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | GOURE | 1983-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | MAGARIA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | MAINE SOROA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | MARADI AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | N'GUIGMI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | NIAMEY AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | TAHOUA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | TILLABERY | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | ZINDER AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### Table 9-6: Status of available minimum temperature data

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | BILMA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | BIRNI N'KONNI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | DIFFA | 1986-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | DOSSO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | GAYA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | GOURE | 1983-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | MAGARIA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | MAINE SOROA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | MARADI AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | N'GUIGMI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | NIAMEY AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | TAHOUA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | TILLABERY | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | ZINDER AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### Table 9-7: Status of available rainfall data from meteorological station

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | BILMA | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | BIRNI N'KONNI | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | DIFFA | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | DOSSO | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | GAYA | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | GOURE | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | MAGARIA | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | MAINE SOROA | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | MARADI AERO | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | N'GUIGMI | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | NIAMEY AERO | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | TAHOUA | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | TILLABERY | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | ZINDER AERO | 1982-2011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### Table 9-8: Status of available maximum relative humidity data

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | BILMA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | BIRNI N'KONNI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | DIFFA | 1985-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | DOSSO | 1999-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | GAYA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | GOURE | 1983-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | MAGARIA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | MAINE SOROA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | MARADI AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | N'GUIGMI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | NIAMEY AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | TAHOUA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | TILLABERY | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | ZINDER AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### Table 9-9: Status of available minimum relative humidity data

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | BILMA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | BIRNI N'KONNI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | DIFFA | 1984-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | DOSSO | 1999-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | GAYA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | GOURE | 1983-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | MAGARIA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | MAINE SOROA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | MARADI AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | N'GUIGMI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | NIAMEY AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | TAHOUA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | TILLABERY | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | ZINDER AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### Table 9-10: Status of available sunshine hour data

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | BILMA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | BIRNI N'KONNI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | DIFFA | - | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | DOSSO | 2002-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | GAYA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | GOURE | 1983-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | MAGARIA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | MAINE SOROA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | MARADI AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | N'GUIGMI | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | NIAMEY AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | TAHOUA | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | TILLABERY | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | ZINDER AERO | 1982-2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 9-11: Status of available wind speed data**

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AGADEZ | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 2 | BILMA | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 3 | BIRNI N'KONNI | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 4 | DIFFA | 1986-2010 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 5 | DOSSO | 1999-2010 | | | | | | | | | | | | | | | | | | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 6 | GAYA | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7 | GOURE | 1983-2010 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 8 | MAGARIA | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 9 | MAINE SOROA | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 10 | MARADI AERO | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 11 | N'GUIGMI | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 12 | NIAMEY AERO | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 13 | TAHOUA | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 14 | TILLABERY | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| 15 | ZINDER AERO | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

### Table 9-12: Status of available rainfall data from rain-gauge station

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ABALA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 2 | ABALAK | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 3 | ADERBISSINAT | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 4 | AGUIE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 5 | ANOU ARAREN | 1982-2005 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ | □ | □ |
| 6 | ARLIT | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7 | AYOROU | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 8 | BAGAROUA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 9 | BAKIN BIRGI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 10 | BALLEYARA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 11 | BANIBANGOU | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 12 | BANKILARE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 13 | BELBEDJI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 14 | BENGOU | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 15 | BEYLANDE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 16 | BIRNI N'GAOURE PTT | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 17 | BOSSO | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 18 | BOUZA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 19 | CHADAKORI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 20 | CHETIMARI | 1983-2011 | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 21 | DAKORO | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 22 | DAMAGARAM TAKAYA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 23 | DAMANA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 24 | DAN BARTO | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 25 | DAN ISSA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 26 | DARGOL | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 27 | DIOUNDIOU | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 28 | DOGO | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ |
| 29 | DOGONDOUTCHI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 30 | DOGONKIRIA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 31 | DUNGASS | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 32 | FADAMA (TIBIRI DOUTCHI) | 1999-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 33 | FALMEYE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 34 | FALOUEL | 1983-2011 | □ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 35 | FANDOU MAYAKI | 1982-2011 | ■ | □ | □ | □ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 36 | FILINGUE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 37 | GALMI | 1987-2011 | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 38 | GANGARA | 1986-2011 | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 39 | GAZAOUA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 40 | GOTHEYE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 41 | GOUDOUMARIA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 42 | GUIDAN IDDER | 1982-2011 | ■ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 43 | GUIDAN ROUMDJI | 1982-2011 | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 44 | GUIDIGUIR | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 45 | GUIDIMOUNI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 46 | HARIKANASSOU | 1991-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 47 | IBECETANE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | □ | ■ | □ | □ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 48 | IBOHAMANE | 1982-2011 | ■ | □ | □ | □ | □ | □ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 49 | IFEROUANE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 50 | ILLELA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 51 | INGALL | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 52 | ISSARI | 1984-2011 | □ | □ | ■ | ■ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | □ | □ | ■ | □ | ■ | □ | ■ | □ | ■ | □ | ■ | ■ | ■ | ■ |
| 53 | ISSAWAN | 1986-2010 | □ | □ | □ | □ | ■ | ■ | ■ | □ | □ | ■ | ■ | □ | □ | □ | □ | □ | □ | ■ | ■ | □ | ■ | □ | ■ | □ | ■ | □ | ■ | ■ | ■ | □ |
| 54 | KABELAWA | 1985-2011 | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | □ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ |
| 55 | KAKASSI | 1994-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

Table 10-8 continued…

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56 | KALFOU | 1991-2011 | | | | | | | | | | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 57 | KANEMBAKATCHE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 58 | KANTCHE | 1984-2011 | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 59 | KAO | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 60 | KARA KARA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 61 | KARGUI BANGOU | 1995-2011 | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 62 | KARMA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| 63 | KAROFANE | 1982-2011 | ■ | | ■ | ■ | | | ■ | ■ | | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 64 | KASSAMA | 1995-2011 | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 65 | KAWARI (MATAMEYE) | 1997-2011 | | | | | | | | | | | | | | | | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | | | | | ■ |
| 66 | KEITA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 67 | KIECHE | 1993-2011 | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 68 | KILAKAM | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 69 | KIOTA | 1988-2011 | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 70 | KOLO | 1985-2011 | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 71 | KONA | 1982-2011 | ■ | | ■ | | | | | | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 72 | KORAHANE (DAKORO) | 2000-2010 | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | ■ | | ■ | ■ | | ■ | ■ | |
| 73 | KORE MAIROUA | 1985-2011 | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 74 | KORNAKA | 1982-2010 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 75 | KOTAKI | 1999-2011 | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 76 | KOUKA | 1989-2011 | | | | | | | | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 77 | KOULIKOIRA | 1994-2011 | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 78 | KOUNDOUMAOUA | 1995-2011 | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 79 | KOYGOLO | 1984-2011 | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 80 | LOGA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 81 | LONTIABERI | 1994-2011 | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 82 | MADAOUA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 83 | MADAROUNFA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 84 | MAGARIA MAKERA | 1988-2011 | | | | | | | ■ | ■ | | | | | | | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| 85 | MAGARIA.MADAOUA | 1985-2006 | | | | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | |
| 86 | MAIJIRGUI | 1996-2011 | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 87 | MALBAZA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 88 | MALLAOUA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 89 | MANGAIZE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 90 | MATAMEYE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 91 | MATANKARI | 1985-2011 | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 92 | MAYAHI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 93 | MOKKO | 1994-2011 | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 94 | MOUSSADEYE | 1994-2011 | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 95 | MYRRIAH | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 96 | N'GOURTI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 97 | N'WALA | 1984-2011 | | | ■ | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 98 | NAKI KARFI | 1995-2011 | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 99 | NIAMEY BANIFANDOU I | 1994-2011 | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 100 | NIAMEY COM.I | 1998-2010 | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 101 | NIAMEY COM.II | 1998-2010 | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | |
| 102 | NIAMEY VILLE | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 103 | OUALLAM | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 104 | OUNA | 1983-2011 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 105 | RAFFA | 1982-2006 | ■ | ■ | ■ | ■ | ■ | | | | | | | | ■ | | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ | | | | | |
| 106 | SABON GUIDA | 1987-2011 | | | | | | ■ | ■ | ■ | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 107 | SABONKAFI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 108 | SAE SABOUA | 1984-2011 | | | ■ | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 109 | SAFO | 1994-2011 | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ |
| 110 | SAKOIRA | 1991-2011 | | | | | | | | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

Table10-8 continued…

| Sr. No. | Station Name | Available data length | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 111 | SANAM | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 112 | SANSANE HAOUSSA | 1982-2011 | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 113 | SAOUNI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 114 | SARKIN YAMMA | 1984-2011 | □ | □ | ■ | ■ | ■ | ■ | □ | □ | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 115 | SASSOUMBROUM | 1982-2011 | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 116 | SAY | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 117 | SAYAM.CM.I | 1982-2009 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ | ■ | □ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ |
| 118 | SIA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 119 | SIMIRI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 120 | SOKORBE | 1985-2011 | □ | □ | □ | ■ | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 121 | SOUBDOU | 1995-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ |
| 122 | SOULOULOU | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 123 | TAKANAMATT | 1996-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 124 | TAKIETA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 125 | TAMASKE | 1982-2011 | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 126 | TANOUT | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 127 | TASSAOU | 1997-2010 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | □ | ■ | ■ | □ |
| 128 | TASSARA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 129 | TAZA | 1991-2009 | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | □ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ |
| 130 | TCHADAOUA | 1984-2011 | □ | □ | ■ | □ | ■ | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 131 | TCHINTABARADEN | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 132 | TCHIROZERINE | 1991-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 133 | TEBARAM | 1982-2011 | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 134 | TERA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 135 | TESKER | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 136 | TESSAOUA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 137 | TIBIRI DOUTCHI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 138 | TIBIRI MARADI .PA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 139 | TILLIA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 140 | TINKIM | 1982-2007 | ■ | □ | ■ | □ | □ | ■ | ■ | ■ | ■ | □ | □ | ■ | □ | □ | ■ | ■ | □ | □ | □ | □ | ■ | ■ | ■ | □ | ■ | ■ | □ | □ | □ | □ |
| 141 | TIRMINI | 1993-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 142 | TOGONE | 1995-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 143 | TONDIKIWINDI (OUALLAM) | 1999-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | □ | ■ | ■ | ■ | ■ |
| 144 | TORODI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 145 | TOUKOUNOUS | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 146 | TOUMNIA | 1982-2010 | ■ | □ | ■ | ■ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ |
| 147 | TSERNAOUA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 148 | WACHA | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 149 | YAOURI | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 150 | YAYA | 1990-2010 | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ |
| 151 | YEKOUA | 1998-2011 | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 152 | YELOU | 1982-2011 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 153 | YENI | 1982-2007 | ■ | □ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ |
| 154 | ZINDER VILLE | 1985-2011 | □ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

■ Data available
□ Data not available

**Table 9-13: Distance between two nearest meteorological stations**

| Sr. No. | Meteorological station name | Longitude | Latitude | Nearest meteorological station name | Distance between two nearest stations (km) |
|---|---|---|---|---|---|
| 1 | AGADEZ | 7.98 | 16.97 | ZINDER AERO | 368 |
| 2 | BILMA | 12.92 | 18.68 | N'GUIGMI | 492 |
| 3 | BIRNI N'KONNI | 5.28 | 13.80 | TAHOUA | 122 |
| 4 | DIFFA | 12.78 | 13.42 | MAINE SOROA | 89 |
| 5 | DOSSO | 3.18 | 13.02 | NIAMEY AERO | 122 |
| 6 | GAYA | 3.45 | 11.88 | DOSSO | 129 |
| 7 | GOURE | 10.30 | 13.98 | ZINDER AERO | 144 |
| 8 | MAGARIA | 8.93 | 12.98 | ZINDER AERO | 89 |
| 9 | MAINE SOROA | 11.98 | 13.23 | DIFFA | 89 |
| 10 | MARADI AERO | 7.08 | 13.47 | BIRNI N'KONNI | 198 |
| 11 | N'GUIGMI | 13.12 | 14.25 | DIFFA | 99 |
| 12 | NIAMEY AERO | 2.17 | 13.48 | TILLABERY | 112 |
| 13 | TAHOUA | 5.25 | 14.90 | BIRNI N'KONNI | 122 |
| 14 | TILLABERY | 1.45 | 14.20 | NIAMEY AERO | 112 |
| 15 | ZINDER AERO | 8.98 | 13.78 | MAGARIA | 89 |

**Table 9-14: Distance between two nearest rain-gauge stations**

| Sr. No. | Rain gauge station name | Longitude | Latitude | Nearest rain gauge station name | Distance between two nearest stations (km) |
|---|---|---|---|---|---|
| 1 | ABALA | 3.43 | 14.95 | TOUKOUNOUS | 53 |
| 2 | ABALAK | 6.25 | 15.47 | IBECETANE | 49 |
| 3 | ADERBISSINAT | 7.85 | 15.62 | BELBEDJI | 109 |
| 4 | AGUIE | 7.77 | 13.50 | GAZAOUA | 16 |
| 5 | ANOU ARAREN | 7.90 | 17.28 | TCHIROZERINE | 10 |
| 6 | ARLIT | 7.33 | 18.50 | IFEROUANE | 128 |
| 7 | AYOROU | 1.85 | 14.75 | MANGAIZE | 21 |
| 8 | BAGAROUA | 3.30 | 14.12 | KARGUI BANGOU | 24 |
| 9 | BAKIN BIRGI | 8.78 | 14.27 | GANGARA | 33 |
| 10 | BALLEYARA | 2.97 | 13.77 | FANDOU MAYAKI | 13 |
| 11 | BANIBANGOU | 2.50 | 15.05 | MANGAIZE | 58 |
| 12 | BANKILARE | 0.72 | 14.57 | TERA | 61 |
| 13 | BELBEDJI | 8.07 | 14.65 | GANGARA | 56 |
| 14 | BENGOU | 3.57 | 11.98 | YELOU | 30 |
| 15 | BEYLANDE | 2.87 | 12.75 | FALMEYE | 24 |
| 16 | BIRNI N'GAOURE PTT | 2.90 | 13.08 | HARIKANASSOU | 13 |
| 17 | BOSSO | 13.32 | 14.72 | N'GOURTI | 66 |
| 18 | BOUZA | 6.05 | 14.42 | KAROFANE | 17 |

| | | | | | |
|---|---|---|---|---|---|
| 19 | CHADAKORI | 6.98 | 13.73 | N'WALA | 9 |
| 20 | CHETIMARI | 12.50 | 13.30 | KABELAWA | 21 |
| 21 | DAKORO | 6.75 | 14.68 | KORNAKA | 67 |
| 22 | DAMAGARAM TAKAYA | 9.47 | 14.17 | RAFFA | 31 |
| 23 | DAMANA | 3.07 | 13.90 | KARGUI BANGOU | 12 |
| 24 | DAN BARTO | 8.33 | 13.17 | SASSOUMBROUM | 18 |
| 25 | DAN ISSA | 7.25 | 13.17 | MADAROUNFA | 20 |
| 26 | DARGOL | 1.25 | 13.92 | KAKASSI | 25 |
| 27 | DIOUNDIOU | 3.53 | 12.55 | KARA KARA | 30 |
| 28 | DOGO | 9.33 | 12.90 | DUNGASS | 18 |
| 29 | DOGONDOUTCHI | 4.00 | 13.63 | MATANKARI | 15 |
| 30 | DOGONKIRIA | 4.35 | 14.07 | MATANKARI | 50 |
| 31 | DUNGASS | 9.33 | 13.07 | DOGO | 18 |
| 32 | FADAMA (TIBIRI DOUTCHI) | 3.15 | 13.05 | TOGONE | 6 |
| 33 | FALMEYE | 2.85 | 12.53 | BEYLANDE | 24 |
| 34 | FALOUEL | 3.58 | 13.52 | MOKKO | 19 |
| 35 | FANDOU MAYAKI | 2.88 | 13.85 | BALLEYARA | 13 |
| 36 | FILINGUE | 3.32 | 14.38 | TOUKOUNOUS | 13 |
| 37 | GALMI | 5.50 | 13.97 | MALBAZA | 0 |
| 38 | GANGARA | 8.53 | 14.43 | SABONKAFI | 31 |
| 39 | GAZAOUA | 7.92 | 13.52 | KANEMBAKATCHE | 0 |
| 40 | GOTHEYE | 1.62 | 13.82 | KOULIKOIRA | 0 |
| 41 | GOUDOUMARIA | 11.17 | 13.72 | KILAKAM | 64 |
| 42 | GUIDAN IDDER | 5.32 | 14.02 | TSERNAOUA | 15 |
| 43 | GUIDAN ROUMDJI | 6.77 | 13.67 | N'WALA | 16 |
| 44 | GUIDIGUIR | 9.83 | 13.67 | GUIDIMOUNI | 31 |
| 45 | GUIDIMOUNI | 9.55 | 13.68 | GUIDIGUIR | 31 |
| 46 | HARIKANASSOU | 2.83 | 13.18 | BIRNI N'GAOURE PTT | 13 |
| 47 | IBECETANE | 5.85 | 15.25 | KAO | 11 |
| 48 | IBOHAMANE | 5.92 | 14.78 | KEITA | 16 |
| 49 | IFEROUANE | 8.38 | 19.08 | ARLIT | 128 |
| 50 | ILLELA | 5.25 | 14.47 | GUIDAN IDDER | 50 |
| 51 | INGALL | 6.90 | 16.78 | TCHIROZERINE | 110 |
| 52 | ISSARI | 12.28 | 13.65 | SAYAM.CM.I | 24 |
| 53 | ISSAWAN | 7.92 | 14.02 | MAYAHI | 24 |
| 54 | KABELAWA | 12.45 | 13.48 | SAYAM.CM.I | 17 |
| 55 | KAKASSI | 1.47 | 13.85 | SANSANE HAOUSSA | 15 |
| 56 | KALFOU | 5.52 | 14.87 | TAMASKE | 15 |
| 57 | KANEMBAKATCHE | 7.92 | 13.52 | GAZAOUA | 0 |
| 58 | KANTCHE | 8.62 | 13.53 | TAKIETA | 18 |
| 59 | KAO | 5.75 | 15.23 | IBECETANE | 11 |
| 60 | KARA KARA | 3.63 | 12.80 | DIOUNDIOU | 30 |

| | | | | | |
|---|---|---|---|---|---|
| 61 | KARGUI BANGOU | 3.17 | 13.95 | DAMANA | 12 |
| 62 | KARMA | 1.82 | 13.67 | KOULIKOIRA | 27 |
| 63 | KAROFANE | 6.15 | 14.30 | BOUZA | 17 |
| 64 | KASSAMA | 9.25 | 13.98 | RAFFA | 18 |
| 65 | KEITA | 5.77 | 14.77 | TAMASKE | 14 |
| 66 | KIECHE | 4.00 | 13.48 | DOGONDOUTCHI | 17 |
| 67 | KILAKAM | 11.73 | 13.55 | ISSARI | 61 |
| 68 | KIOTA | 2.93 | 13.28 | HARIKANASSOU | 16 |
| 69 | KOLO | 2.35 | 13.30 | SAY | 22 |
| 70 | KONA | 8.07 | 13.57 | KANEMBAKATCHE | 17 |
| 71 | KORE MAIROUA | 3.95 | 13.33 | KIECHE | 18 |
| 72 | KORNAKA | 6.90 | 14.10 | CHADAKORI | 42 |
| 73 | KOULIKOIRA | 1.62 | 13.82 | GOTHEYE | 0 |
| 74 | KOUNDOUMAOUA | 9.00 | 14.83 | TANOUT | 24 |
| 75 | KOYGOLO | 3.02 | 13.48 | YENI | 7 |
| 76 | LOGA | 3.23 | 13.60 | KOYGOLO | 27 |
| 77 | LONTIABERI | 2.47 | 13.12 | SAY | 13 |
| 78 | MADAOUA | 5.98 | 14.12 | SABON GUIDA | 22 |
| 79 | MADAROUNFA | 7.15 | 13.32 | SAFO | 10 |
| 80 | MAIJIRGUI | 8.13 | 13.73 | TESSAOUA | 16 |
| 81 | MALBAZA | 5.50 | 13.97 | GALMI | 0 |
| 82 | MALLAOUA | 9.60 | 13.02 | DUNGASS | 29 |
| 83 | MANGAIZE | 2.03 | 14.80 | AYOROU | 21 |
| 84 | MATAMEYE | 8.47 | 13.42 | SAOUNI | 8 |
| 85 | MATANKARI | 4.00 | 13.77 | DOGONDOUTCHI | 15 |
| 86 | MAYAHI | 7.70 | 13.98 | ISSAWAN | 24 |
| 87 | MOKKO | 3.43 | 13.43 | FALOUEL | 19 |
| 88 | MYRRIAH | 9.15 | 13.72 | ZINDER VILLE | 19 |
| 89 | N'GOURTI | 13.20 | 15.30 | BOSSO | 66 |
| 90 | N'WALA | 6.92 | 13.68 | CHADAKORI | 9 |
| 91 | NAKI KARFI | 7.72 | 13.65 | AGUIE | 17 |
| 92 | NIAMEY BANIFANDOU I | 2.13 | 13.50 | NIAMEY COM.I | 0 |
| 93 | NIAMEY COM.I | 2.13 | 13.50 | NIAMEY BANIFANDOU I | 0 |
| 94 | NIAMEY COM.II | 2.13 | 13.50 | NIAMEY BANIFANDOU I | 0 |
| 95 | NIAMEY VILLE | 2.13 | 13.50 | NIAMEY BANIFANDOU I | 0 |
| 96 | OUALLAM | 2.08 | 14.23 | SIMIRI | 12 |
| 97 | OUNA | 3.15 | 12.17 | SIA | 16 |
| 98 | RAFFA | 9.18 | 14.13 | KASSAMA | 18 |
| 99 | SABON GUIDA | 5.90 | 13.93 | MADAOUA | 22 |
| 100 | SABONKAFI | 8.73 | 14.63 | GANGARA | 31 |
| 101 | SAE SABOUA | 7.35 | 13.57 | TCHADAOUA | 11 |
| 102 | SAFO | 7.12 | 13.40 | MADAROUNFA | 10 |
| 103 | SAKOIRA | 1.40 | 14.28 | DARGOL | 44 |

| | | | | | |
|---|---|---|---|---|---|
| 104 | SANAM | 3.92 | 14.67 | TEBARAM | 60 |
| 105 | SANSANE HAOUSSA | 1.60 | 13.83 | KOULIKOIRA | 3 |
| 106 | SAOUNI | 8.45 | 13.35 | MATAMEYE | 8 |
| 107 | SARKIN YAMMA | 6.92 | 13.37 | SAFO | 22 |
| 108 | SASSOUMBROUM | 8.50 | 13.13 | YAOURI | 16 |
| 109 | SAY | 2.35 | 13.10 | LONTIABERI | 13 |
| 110 | SAYAM.CM.I | 12.50 | 13.63 | KABELAWA | 17 |
| 111 | SIA | 3.28 | 12.10 | OUNA | 16 |
| 112 | SIMIRI | 2.13 | 14.13 | OUALLAM | 12 |
| 113 | SOKORBE | 5.18 | 13.50 | TSERNAOUA | 45 |
| 114 | SOUBDOU | 10.33 | 13.13 | GUIDIGUIR | 80 |
| 115 | SOULOULOU | 6.42 | 13.60 | GUIDAN ROUMDJI | 39 |
| 116 | TAKIETA | 8.52 | 13.67 | KANTCHE | 18 |
| 117 | TAMASKE | 5.65 | 14.82 | KEITA | 14 |
| 118 | TANOUT | 8.82 | 14.95 | KOUNDOUMAOUA | 24 |
| 119 | TASSARA | 5.70 | 16.87 | TCHINTABARADEN | 109 |
| 120 | TAZA | 5.33 | 15.28 | KAO | 45 |
| 121 | TCHADAOUA | 7.45 | 13.55 | SAE SABOUA | 11 |
| 122 | TCHINTABARADEN | 5.80 | 15.88 | ABALAK | 67 |
| 123 | TCHIROZERINE | 7.83 | 17.22 | ANOU ARAREN | 10 |
| 124 | TEBARAM | 4.45 | 14.82 | SANAM | 60 |
| 125 | TERA | 0.82 | 14.03 | DARGOL | 49 |
| 126 | TESKER | 10.72 | 15.13 | GOUDOUMARIA | 164 |
| 127 | TESSAOUA | 7.98 | 13.75 | MAIJIRGUI | 16 |
| 128 | TIBIRI DOUTCHI | 4.00 | 13.10 | KORE MAIROUA | 26 |
| 129 | TIBIRI MARADI .PA | 7.03 | 13.58 | N'WALA | 17 |
| 130 | TILLIA | 4.78 | 16.13 | TAZA | 111 |
| 131 | TINKIM | 8.97 | 12.88 | DOGO | 40 |
| 132 | TIRMINI | 8.80 | 13.78 | ZINDER VILLE | 22 |
| 133 | TOGONE | 3.17 | 13.00 | FADAMA (TIBIRI DOUTCHI) | 6 |
| 134 | TORODI | 1.80 | 13.12 | NIAMEY COM.I | 56 |
| 135 | TOUKOUNOUS | 3.28 | 14.50 | FILINGUE | 13 |
| 136 | TOUMNIA | 9.03 | 13.97 | ZINDER VILLE | 19 |
| 137 | TSERNAOUA | 5.33 | 13.88 | GUIDAN IDDER | 15 |
| 138 | WACHA | 9.28 | 13.37 | DUNGASS | 34 |
| 139 | YAOURI | 8.55 | 13.27 | SAOUNI | 14 |
| 140 | YAYA | 4.77 | 13.83 | DOGONKIRIA | 52 |
| 141 | YELOU | 3.57 | 12.25 | BENGOU | 30 |
| 142 | YENI | 2.98 | 13.43 | KOYGOLO | 7 |
| 143 | ZINDER VILLE | 9.00 | 13.80 | MYRRIAH | 19 |

**Table 9-15: Status of available major crops data in the respective regions**

| Region | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agadez | Maize | | | | | | | | | | | | | | | | |
| | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | □ | ■ | □ | ■ | □ | □ | ■ | ■ | ■ | □ | ■ | ■ |
| | Onion | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | ■ | ■ | ■ | ■ | □ |
| CUN | Millet | | | | | | | | | | | | | | | | |
| | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Onion | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ | ■ | ■ | ■ | ■ |
| Diffa | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Onion | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | □ |
| Dosso | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sesame | | | | | | | | | | | | | | | | |
| | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cotton | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | □ | □ | ■ | ■ | □ |
| Maradi | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sesame | | | | | | | | | | | | | | | | |
| | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cotton | | | | | | | | | | | | | | | | |
| | □ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | □ | □ | □ | □ | □ | ■ | □ | □ |
| | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Tahoua | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sesame | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Onion | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | □ |
| Tillabery | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sesame | | | | | | | | | | | | | | | | |
| | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Onion | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | □ |
| Zinder | Millet | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sorghum | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Cowpea | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Sesame | | | | | | | | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Onion | | | | | | | | | | | | | | | | |
| | □ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ | □ | ■ | ■ | ■ | ■ | □ |

■ Available □ Not Available

## 9.4 Annexure 4: Standardized Precipitation Index

### Standardized Precipitation Index (SPI) Computation Methodology

The SPI computation for a specific time scale and location requires a long-term daily precipitation record with 30 years or more of data. The long-term record is fitted to a gamma probability distribution that is then transformed into a normal distribution (SPI), which, by definition, has zero mean and unit variance. The computational methodology is given below.

**Step 1: Estimating the Drought Index**

A step in defining drought conditions is the ability to quantify the intensity, duration and spatial coverage. Along the years there have been developed and adopted several indices to measure drought or wet spells intensity. Generally, they are based on the deviation of precipitation for a given period from historically established norms. In this document we would be evaluating the three aspects of drought with the Standardized Precipitation Index (SPI). The flowchart below outlines the methodology to compute SPI.

**Data Requirement**

Long- Term daily precipitation record with 30 years or more

↓

**Calculate the cumulative rainfall**

Calculate the cumulative rainfall for the time scale of interest (3 months, 12 months, 48 months etc.)

↓

**Computing Parameters Alpha and Beta – Gamma Distribution**

The alpha and beta parameters of the gamma probability density function are estimated for each station, for each time scale of interest (3 months, 12 months, 48 months, etc.).

$$\hat{\alpha} = \frac{1}{4A}\left(1 + \sqrt{1 + \frac{4A}{3}}\right)$$

$$\hat{\beta} = \frac{\bar{x}}{\hat{\alpha}}$$

where:

$$A = \ln(\bar{x}) - \frac{\sum \ln(x)}{n}$$

$n$ = number of precipitation observations

↓

## Fitting Gamma Distribution

The gamma distribution is defined by its frequency or probability density function:

$$g(x) = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} x^{\alpha-1} e^{-x/\beta} \qquad \text{for } x>0$$

where:

| | |
|---|---|
| $\alpha > 0$ | $\alpha$ is a shape parameter |
| $\beta > 0$ | $\beta$ is a scale parameter |
| $x > 0$ | $x$ is the precipitation amount |
| $\Gamma(\alpha) = \int_0^{\infty} y^{\alpha-1} e^{-y} dy$ | $\Gamma(\alpha)$ is the gamma function |

The cumulative probability is given by:

$$G(x) = \int_0^x g(x)dx = \frac{1}{\hat{\beta}^{\hat{\alpha}}\Gamma(\hat{\alpha})} \int_0^x x^{\hat{\alpha}-1} e^{-x/\hat{\beta}} dx$$

Since the gamma function is undefined for x=0 and a precipitation distribution may contain zeros, the cumulative probability becomes:

$$H(x) = q + (1-q)G(x)$$

where q is the probability of a zero. If m is the number of zeros in a precipitation time series, q can be estimated by m/n.

**Standard Normal Distribution**

The cumulative probability, H(x), is then transformed to the standard normal random variable Z with mean zero and variance of one, which is the value of the SPI. The standard normal variable Z (or the SPI value) is obtained computationally from:

$$Z = SPI = -\left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \qquad \text{for } 0 < H(x) \le 0.5$$

$$Z = SPI = +\left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \qquad \text{for } 0.5 < H(x) < 1.0$$

where:

$$t = \sqrt{\ln\left(\frac{1}{(H(x))^2}\right)} \qquad \text{for } 0 < H(x) \le 0.5$$

$$t = \sqrt{\ln\left(\frac{1}{(1.0 - H(x))^2}\right)} \qquad \text{for } 0.5 < H(x) < 1.0$$

$c_0 = 2.515517$
$c_1 = 0.802853$
$c_2 = 0.010328$
$d_1 = 1.432788$
$d_2 = 0.189269$
$d_3 = 0.001308$

## Step 2 : Deriving Intensity

The standard normal distribution has a mean of zero and a standard deviation of one. SPI is a representation of the number of standard deviations from the mean at which an event occurs, often called a "z-score". The unit of the SPI can thus be considered to be "standard deviations". Figure C1 shows the dry and wet spells varying with rainfall.

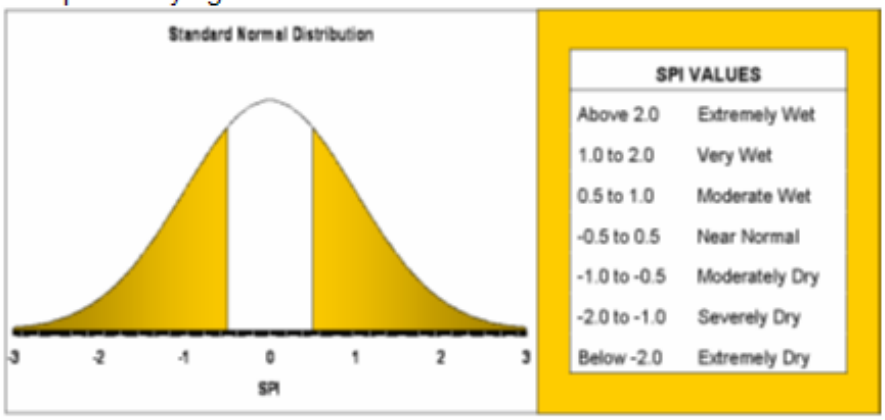


Figure C1: Classification of dry and wet events based on SPI

With this representation of SPI we can have the following observations.

1. A positive SPI value indicates rainfall in excess of normal and a negative SPI value indicates deficient rainfall. Therefore, we can study both the wet and dry conditions from SPI (Table C1).

Table C1: Categorization of SPI

| SPI Range | Event |
|---|---|
| SPI below -2.0 | Extreme Dry |
| -2.0 < SPI < -1.5 | Severe Dry |
| -1.5 < SPI < -1.0 | Moderate Dry |
| -1.0 < SPI < -0.5 | Minor Dry |
| -0.5 < SPI < 0.5 | Normal |
| -0.5 < SPI < 1.0 | Minor Wet |
| 1.0 < SPI < 1.5 | Moderate Wet |
| 1.5 < SPI < 2.0 | Very Wet |
| SPI above 2.0 | Extreme Wet |

# End of Report