TECHNICAL ASSISTANCE

AGRICULTURAL SECTOR RISK ASSESSMENT IN NIGER:

Moving from Crisis Response to Long-Term Risk Management

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Agriculture and Environment Services (AES) Department and

Agriculture, Rural Development, and Irrigation (AFTAI) Unit in the Africa Region

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ACRONYMS AND ABBREVIATIONS

January 1 – December 31
Currency Equivalents
Currency unit: Franc CFA (FCFA)
US$1= 495 FCFA (Exchange rate 2010)
Weights and Measures
Metric system

AES	Agriculture and Environment Services
AFTA1	Agriculture, Rural Development, and Irrigation Department Practice 1
AFTA2	Agriculture, Rural Development, and Irrigation Department Practice 2
AFTA3	Agriculture, Rural Development, and Irrigation Department Practice 3
AFTA4	Poverty Reduction and Economic Management Practice 4 of the Africa Region
AGRHYMET	Agriculture, Hydrology, Meteorology
APCAn	Assistance in the Management of the National Prevention System of the National Prevention System for the Nutrition Crisis of Niger
ARD	Agriculture and Rural Development Department
BCEAO	Banque Centrale des États de l'Afrique de l'Ouest (Central Bank of West African States)
CAADP	Comprehensive African Agricultural Development Program
CAP	Community Action Program
CCA	Cellule Crises Alimentaires
CC/SAP	Cellule de Coordination du Système d'Alerte Précoce
CGE	computable general equilibrium
CIS	Centre for International Cooperation
CLCPRO	Commission for Controlling the Desert Locust in the Western Region
CIC	Centre d'Information et de Communication
CICIN	Investment Climate for Industry Unit
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel
CMC	Commission mixte Etat-Donateurs
CNEDD	Counseil National de l'Environnement pour un Développement Durable
CofoCom	Commissions foncières communales
CofoB	Commissions foncières de base
CofoDep	Commissions foncières départementales
CPI	consumer price index
CRC	Comité Restreint de Concertation
CV	coefficient of variation
CVCA	Climate Vulnerability and Capacity Assessment
DNPGCA	Dispositif National de Prévention et de Gestion des Crises Alimentaires au Niger
ECB	Emergency Capacity Building
ECOWAS	Economic Community of West African States
ENBC	Enquete Nationale sur le Budget et la Consommation des Ménages
ENVAM	Enquete sur la Vulnérabilité Alimentaire des Ménages
EWS	early warning system
FAO	Food and Agriculture Organization
FAO EMPRESS	FAO Emergency Prevention System

FAOSTAT	FAO Statistics Division
FCFA	West African CFA Franc
FCMPS	Food Crisis Management and Prevention System
FEWS NET	Famine Early Warning System Network
FMNR	Farmer Managed Natural Regeneration
GAO	gross agricultural output
GDP	gross domestic product
GFDRR	Global Facility for Disaster Risk Reduction
GFRP	Global Food Crisis Response Program
GIEWS	Global Information and Early Warning System
GON	Government of Niger
HC3N	Haut Commissariat à l'Initiative 3 N (les nigériens nourissent les nigériens)
INS	Institut National de la Statistique (Niger)
LCSAR	Latin America and the Caribbean Region Agricultural and Rural Development Unit.
NGAC	Niger General Agricultural Census
NGO	nongovernmental organization
NRM	natural resource management
ODA	official development assistance
OECD	Organization for Economic Co-operation and Development
OIE	The World Organisation for Animal Health
OPVN	Office des Produits Vivriers du Niger
OSV	Observatory for Monitoring Vulnerability
PAC	Community Action Plan
PCA	Principal Component Analysis
PANA	Programme d'Action National pour l'Adaptation
PRODEX	Agro-sylvo-pastoral Export and Markets Development Project
RGAC	Recensement General de L'Agriculture et du Cheptel, Government of Niger
SAFEX	South African Commodity Exchange
SCAP-RU	Système Communautaire d'Alerte Précoce et de Réponse aux Urgences
SDR	Stratégie pour le Développement Rural (Country's Rural Development Strategy)
SIMA	Système d'Information sur le Marché Agricole
SNS	Stock National de Sécurité
SSA	Sub-Saharan Africa
TFP	total factor productivity
TLU	tropical livestock units
UEMOA	L'Union Economique et Monétaire Ouest Africaine
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nation Children's Fund
UN/OCHA	Office for the Coordination of Humanitarian Affairs of the United Nations Secretariat
USAID	United States Agency for International Development
VAM	Vulnerability Analysis and Mapping
WFP	World Food Programme

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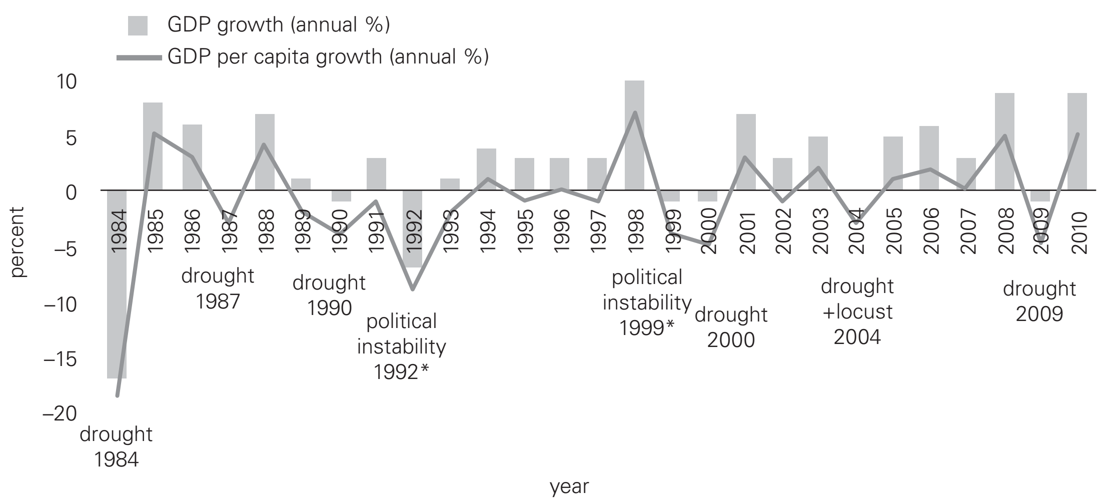
EXECUTIVE SUMMARY

Niger, owing to its climatic, institutional, livelihood, economic, and environmental context, is one of the most vulnerable countries of the world. Poverty is pervasive in Niger and it ranks low on almost all the human development indicators. Agriculture is the most important sector of Niger's economy and accounts for over 40 percent of national gross domestic product (GDP) and is the principle source of livelihoods for over 80 percent of the country's population. The performance of the agricultural sector, however, due to its high exposure to risks, is very volatile. Niger has experienced multiple shocks, largely induced by agricultural risks over the past 30 years, which impose high welfare cost in terms of food availability, food affordability, and malnutrition. It also adversely affects household incomes, performance of the agricultural sector, the government's fiscal balance, and the growth rate of Niger's economy (see figure E.1 below).

Recognizing the need to explicitly and comprehensively address agricultural risks, the government of Niger, through 3N high commissioner, requested the World Bank to conduct an agricultural sector risk assessment of Niger. This risk assessment contributes and enriches the existing knowledge base of the agricultural sector in Niger and provides the following contributions: (1) Systematically analyzes a whole range of agricultural risks and its impact over a longer time period (1980—2012); (2) helps situate drought in the context of other agricultural risks; (3) prioritizes the most important agricultural risks for the

FIGURE E.1: Annual GDP Growth (%) and GDP per Capita (%) (1984–2010)



Sources: World Development Indicators Database, 2012; and Author's calculations.
*1992 political instability (transitional government November 1991–April 1993)[1] and 1999 political instability (sssassination of President Ibrahim Bare' Mainassare).[2]

1 President Ali Saibou's regime acquiesced to demands for elections, and a transitional government was installed in November 1991 to manage the affairs of state until the institutions of the Third Republic were put in place in April 1993. The economy deteriorated over the course of the transition, leading to a fall in GDP in 1992.

2 In April 1999, President Baré Mainassare was assassinated in a coup led by Major Daouda Malam Wanke, who established a transitional National Reconciliation Council to oversee the drafting of a constitution for a Fifth Republic. The Nigerien electorate approved the new constitution in July 1999 and held legislative and presidential elections in October and November 1999. The council transitioned to civilian rule in December 1999; however, the period of transitional government, similar to 1992, had severe consequences for the economy.

country based on objective criterion; (4) provides a framework of mitigation-transfer-coping to manage priority risk; and (5) offers a filtering mechanism to select high return interventions for agricultural risk management.

PRODUCTION RISK

Drought, locusts, livestock diseases, crop pests and diseases, floods, windstorms and bushfires are the main sources of production risk. Farmers also complain of the risks to crop production from livestock herds, although the incidence and severity of these events is difficult to determine. The impact of some of these events on crop production for the period 1980–2011 is indicated in figure E.2 below, using indices of agricultural production.

Drought is the principle risk in Niger and the country has experienced seven droughts between 1980–2010, with adverse impact on national agricultural production. Over the past 12 years, Niger has witnessed four years (2001, 2005, 2010, and 2012) of severe food insecurity that resulted in appeal for international humanitarian assistance and food relief. Drought is also the principle trigger for spikes in food prices and conflicts over pasture and water; it is highly correlated with some crop pests and diseases, and it aggravates mortality and morbidity due to livestock diseases.

Locust outbreak is another high frequency-high severity risk in Niger. Almost one-third of losses during 2004–05 crises were due to locust, with adverse impact on both crop and livestock sector. Considering livestocks' significance for Niger's economy, livestock diseases, especially *pasteurellose*, anthrax, *peste des petits ruminants*, and Newcastle disease (for poultry), are another principle risk for the country.

Flood incidences are increasing in Niger; however, they do not pose a serious risk to the broader agricultural sector, due to localized nature of flooding. Furthermore, most of the flood years are usually associated with bumper harvest because of higher than average rainfall at an aggregate level for the country.

Crop pests and diseases, like striga and fungal diseases, are a perennial problem among most crops; however, overall losses from a majority of these pests and diseases, barring the exception of grasshoppers, grain eating bird, and millet borer, are frequent but relatively low.

FIGURE E.2: Major Shocks to Crop and Livestock Production

Source: Author's calculations.

Bush fire is often a problem for pastoral areas and windstorms damage young plants at the beginning of copping season. Nonetheless, the overall impact of these two risks on the agricultural sector is negligible.

MARKET RISKS

Food price volatility is a big concern for consumers and major spikes in nominal prices occurred in 1998, 2001, 2002, 2005, 2009, and 2010. These spikes are also observed for real prices, although they were much less pronounced in 2009 and 2010. There is a strong association between seasonal price movements and the incidence of drought and other adverse events. The hardship endured during these periods of adversity seem to confirm the growing consensus according to which reduced access to food (high prices), along with reduced food availability, may be the most critical impact of drought and locust attacks in Niger. High seasonal price spikes appear to be more closely and systematically associated with these events than inter-annual changes in production or prices.

Due to Niger's heavy reliance on trade with Nigeria, adverse movements in the West African CFA Franc (FCFA)/naira exchange rate could be a potential source of risk. However, market data shows that the FCFA/naira exchange rate is relatively stable, with low adjusted coefficients of variation (.06—0.08) for monthly exchange rates for the period January 2003 to October 2011.

ENABLING ENVIRONMENT RISKS

Political instability is a major risk in Niger, which has had a tumultuous political history with four *coups d'état* since independence (1974, 1996, 1999, 2010). Niger has witnessed two transitional governments that were associated with rapid deterioration of the economy (figure E.1) and a sharp decline in GDP growth rates. The impact on the agricultural sector, however, was much less pronounced and more indirect and might include: (1) reduced access to particular regions, which means that rural markets are more restricted, food prices rise, and aid can't get through; (2) reduced public and private investment in response to higher levels of uncertainty; (3) the diversion of public expenditure to military purposes to the detriment of other public services; and (4) loss of donor support. Political instability may have a bigger impact on the agriculture sector when it coincides with other shocks like drought, such as in 1995–97. Political instability induces changes in government priorities and contributes to volatility in agricultural sector funding.

Rising pressure on common property resources, or on resources used within the bounds of customary law, have led to frequent, but localized, conflicts affecting herders and farmers. Insecurity has always been an issue for herders practicing transhumance, but of late, the situation has deteriorated, especially in the border areas of Mali, Libya, and Nigeria (Chad is an endemic problem). Despite their significance for herders in some locations, from a macroperspective, the impact of insecurity and conflict on the broader agricultural sector is relatively small.

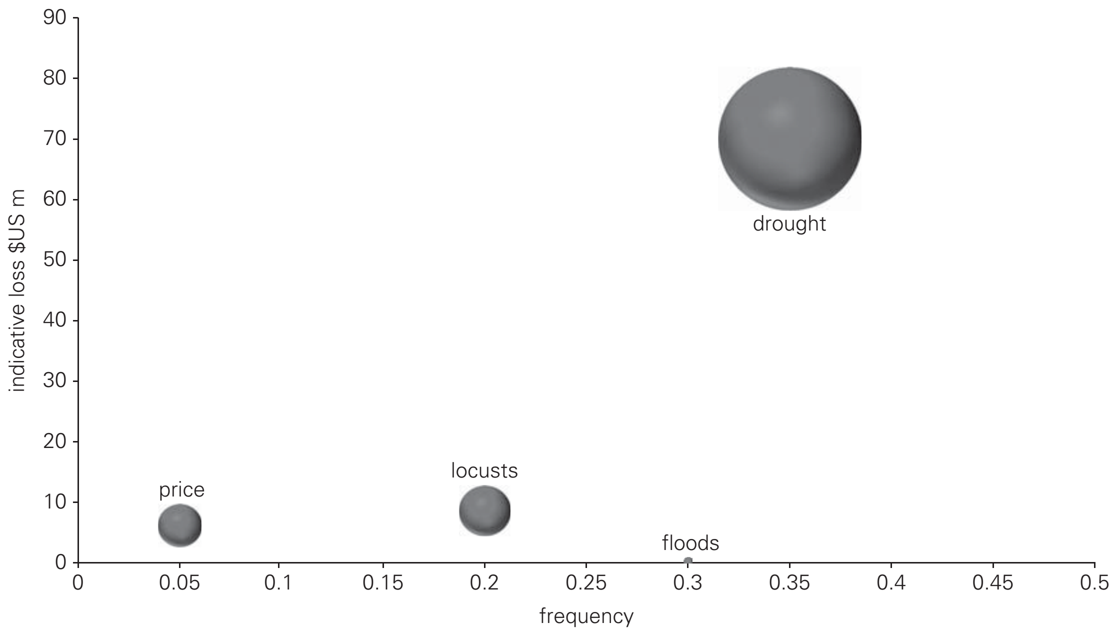
Macroeconomic shocks in Nigeria, due to it being the largest trading partner of Niger, can have potentially serious repercussions on the agricultural sector; however, so far, past impact of such shocks have been moderate and short lived.

The assessment team analyzed downside deviation from the trend and correlated them with adverse events to calculate frequency and indicative losses from major production risks for crops. Figure E.3 highlights the result of that analysis.

A combination of qualitative and quantitative measures, based on the assessment team's evaluation, was used to prioritize major risks for the entire agricultural sector, both livestock and crops (figure E.4). This analysis highlights six priority risks, namely 1) drought (crop), 2) drought (livestock), 3) locust outbreaks, 4) consumer price risk and 5) livestock diseases and 6) political instability.

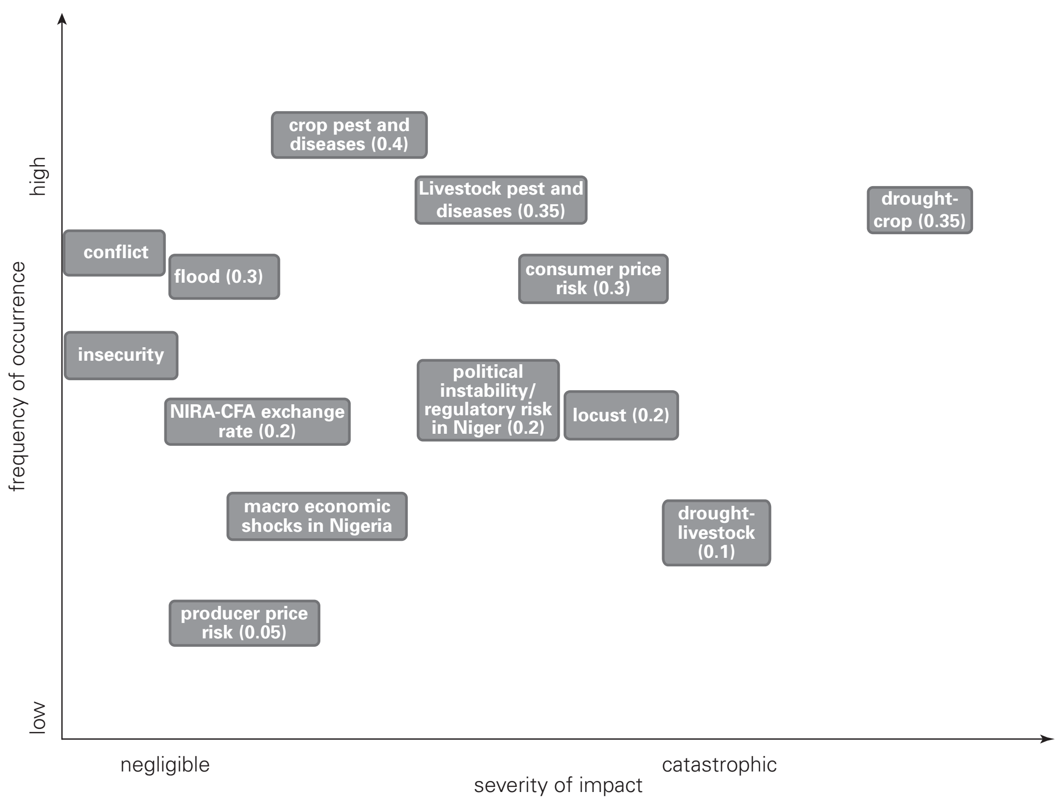
To address the priority risks, the assessment deployed a holistic agricultural risk management framework, comprising of mitigation (action taken to reduce the likelihood of events, exposure, and/or potential losses), transfer (risk transfer to a willing party, at a fee or premium), and coping (activities geared to help cope with losses) solutions to identify a list of potential interventions. Risk transfer solutions (insurance and hedging), owing to Niger's specific context have limited applicability and will be quite challenging to implement. Coping solutions (social safety net programs) are required and quite important in Niger;

FIGURE E.3: Expected Average Losses for Adverse Crop Production Events



Source: Author's calculations.

FIGURE E.4: Risk Prioritization



Source: Author's calculations.

TABLE E.1: Decision Filters and Intervention Classification

	SCALABILITY	RELATIVE COST	EASE OF IMPLEMENTATION	RETURN TIME	ADVERSE IMPACT ON ENVIRONMENT	POTENTIAL IMPACT ON POVERTY ALLEVIATION
Drought tolerant/improved seed varieties (M)	High	Medium	Medium	Short	Low	High
Soil and water conservation (M)	High	Medium	Medium	Medium	Low	High
Irrigation (M)	Low	High	Low	Short–medium	Moderate	High
Early detection and destruction of locusts (M)	High	Medium	High	Short	Moderate	Low
Community-level food and fodder banks (M, C)	High	Medium	Medium	Short	Low	High
Vaccination programs (M)	High	Medium	Medium	Medium	Low	High
Contingent financing (C)	High	Low	High	Short	Low	Low
Shortening emergency response time (C)	Medium	Low	Medium	Short	Low	Low
Strategic de-stocking (C)	Low	Medium	Low	Medium	Low	Low
Insurance (T)	Low	Low	Medium	Medium	Low	Low

Source: Authors.
Note: M is Mitigation, C is coping, and T is Transfer.

however, they do not address fundamental risk issues in the agricultural sector and have limited applicability as a long-term solution. Risk mitigation solutions are perhaps the most required, but much ignored, with highest returns while addressing short- and long-term issues in Niger's agricultural sector. It is important to highlight that most of these potential interventions are complementary in nature and most of them are required to effectively address agricultural risks in Niger. Nonetheless, considering the resource-constrained environment of Niger, decision filters (see table E.1) were used to help prioritize the interventions.

Using these filters, the following types of interventions were recommended that have the potential to generate sizable risk management benefits:

- *Drought-tolerant, high-yielding crop varieties.* Despite its importance, less than 6 percent of farming households have access to drought-tolerant cereal varieties. Early warning about the impending weather season coupled with ready availability of drought-tolerant varieties could help mitigate the risk of crop failure. This will necessitate development of a "sustainable seed system," consisting of seed research, seed multiplication, and seed delivery on a large scale.
- *Soil and water conservation; natural resource management (NRM) techniques.* Effective soil and water conservation techniques in Niger have successfully contributed to (1) conserving rain water, (2) increasing its infiltration, and (3) enhancing plant growth, which improves the resilience of crop during water stress and serves as a useful drought mitigation intervention. Further expansion and consolidation of water conservation and NRM interventions will contribute to greater integration of the agriculture-livestock sector, yield improvements, and drought risk management.
- *Irrigation.* Expansion of irrigation facilities can serve as an important drought risk management tool, considering that uneven rainfall distribution is one of the principle causes of crop failure in Niger. Despite the desert conditions, there is considerable potential to increase the area under irrigation in Niger, which could contribute to improved nutrition, access to diversified food, and improved household income, thereby reducing food affordability issues and improving household food security.
- *Continuous support to early detection and eradication of desert locusts.* Ex-ante preventive action reliant on monitoring of seasonal reproductive areas, localization, and destruction of first locust populations has been effective so far by successfully controlling a potential locust outbreak in 2009, largely through use of biopesticides. Therefore, this approach should be supported and strengthened.

- *Supporting community-level interventions for food and fodder banks.* To ensure availability of food and fodder at the local level, support for community food and fodder banks, on as-needed basis, should be provided in areas known to be suffering or likely to suffer from food shortages or food price spikes. Targeting could be based on indicators of food access and food availability, using price data. The aim should be to intervene earlier in the seasonal cycle, well before prices reach their seasonal peak. Besides ensuring food and fodder availability for vulnerable populations, such interventions will also help stabilize food and fodder prices for wider populations and can help respond to local level market failures without creating major distortions.
- *Livestock vaccination.* Vaccination is perhaps one of the most significant measures to reduce the risk of livestock diseases. With limited resources, the government of Niger could focus on preventive vaccination campaigns against the biggest threats and respond to some of the worst outbreaks.

Niger is a case of living perpetually with risk, thus more emphasis on long-term structural solutions, rather than short-term quick fixes, is required to improve the resilience of the agricultural sector. Designing and implementing a comprehensive agricultural risk management strategy will require sustained and substantial financial investments, shifting the focus from short-term crisis response to long-term risk management, streamlining disparate donor investments and isolated interventions toward the core problem, supporting decentralized community- and farm-level decision making, integrating agricultural risk management into the existing development frameworks, prioritizing agricultural risks into government and donor strategies, and focusing on implementation.

Chapter 1: NIGER: INTRODUCTION AND CONTEXT

1.1 CONTEXT: LIVING WITH RISK

The climatic, institutional, livelihood, economic, and environmental contexts of Niger make it one of the most vulnerable countries of the world. Over the years, Niger has faced multiple incidences of droughts, famine, locust invasion, political instability, violent conflicts, floods, and cholera and meningitis outbreaks. The country is rated as the most susceptible country to risks and second-most vulnerable country, next only to Afghanistan, among a total of 173 countries analyzed in the *World Risk Report* (2011).

Poverty is pervasive in Niger and almost 65 percent of rural households are poor compared to 41 percent of urban households. Considering that 84 percent of Niger's population is concentrated in rural areas, poverty dominates the lives of rural households. Niger, with a per capita income of $358 (2010), fares low on almost all the development indicators and ranks among the lowest (186) in the United Nations Development Programme (UNDP) human development rank. There have been marginal drops in poverty rates since 2005; however, the burgeoning population of 16 million, with the highest population growth rate in Africa (3.5 percent), have eroded any gains made in poverty alleviation.

More than 80 percent of working-age adults are employed in agriculture, yet this sector has the lowest level of productivity in the economy. Most of the chronic poor are crop farmers and almost 8 in 10 of the chronic poor live in households where the principal activity is crop farming. Livestock, on the other hand, fares slightly better with only 2 percent of the chronic poor engaged primarily in livestock rearing.

Though the majority of households engage in some farming, almost all households are net purchasers of food. Over 60 percent of households rely in part on their own production to meet their consumption needs. Yet, food accounts for over 60 percent of household expenditures, since most households do not produce enough to meet their consumption needs.

Food insecurity is a big concern for Niger and in 2006, more than 50 percent of Niger's population was estimated to be chronically food insecure, with 22 percent suffering from extreme chronic food insecurity (per capita caloric consumption of less than 1800 calories per person per day). In addition, much of population suffers from seasonal and transitory food insecurity quite frequently.

Niger is highly prone to "shocks," which exacerbate a high level of chronic poverty and food insecurity. Furthermore, these shocks serve as poverty traps and aggravate the conditions for transient poor populations and create transitory food insecurity. The World Bank's *Poverty Assessment* (2011) highlighted poor harvest as the biggest shock (table 1.1) for

TABLE 1.1: Reported Household Impacts of Shocks Ranked as Most Important

		SELF-REPORTED IMPACTS (PERCENT OF HOUSEHOLDS THAT REPORTED THE SHOCK/PROBLEM AS MOST IMPORTANT)				
SHOCK/PROBLEM	NUMBER OF HOUSEHOLDS RANKING SHOCK AS MOST IMPORTANT DURING PAST 12 MONTHS	LOSS OF HOUSEHOLD INCOME	INCOME LOSS AND REDUCED CONSUMPTION	LOSS OF DURABLE OR PRODUCTIVE ASSETS	ASSET LOSS PLUS INCOME LOSS OR REDUCED CONSUMPTION	NO REPORTED CONSEQUENCES
Poor harvest	1,303	0	4	11	28	56
Lack of money	945	2	6	11	20	61
Food price increase	587	2	2	5	9	82
Lack of water	188	0	2	3	6	89
Serious illness or disease	143	9	8	15	24	45

Source: World Bank, May 2011.

rural households, which led to reduced consumption, loss of productive and durable assets, and loss of income for about 45 percent of affected households. The World Bank (2011) further estimated that the average per capita consumption in 2010, due to the 2009 drought, was about one-quarter less (24 percent lower) than the average in 2007. Also, households living in areas where rainfall was at least 100 millimeters less than the 20-year mean had a per capita consumption of about 7 to 13 percent less than the reference households not exposed to shock.

Not only does the frequent occurrence of these shocks impose high welfare costs in terms of food availability, food affordability, and malnutrition challenges for individual households, it also adversely affects household incomes, the performance of the agricultural sector, the government's fiscal balance, and the growth of Niger's economy.

1.2 TRADITIONAL CAPACITY TO MANAGE RISK

Niger is a high-risk environment and traditional livelihood strategies have been designed to cope with a harsh, dry, uncertain, and high-stress environment. The traditional symbiotic relationship between livestock and farming community, farming practices using the limited water available, growing crop types and varieties that can withstand water stress for long dry spells, seasonal and long-term migration, and relying on communal networks for coping have all been an integral part of livelihood strategies to survive in Niger's high-risk environment.

These traditional livelihood strategies are becoming weaker and less effective in the face of the changing context. Erratic rainfall patterns, increasing temperature, movement of isohyets, encroachment of crop cultivation on cattle corridors, declining soil fertility, reduction in land holding size, increasing household size, and high pressure on land are some of the factors making it increasingly difficult to manage risks using traditional livelihood strategies.

To support risk management strategies, there are a large number of institutions, projects, and almost 10 different line ministries of the government of Niger that are playing various roles. A number of government and donor[3] initiatives have implicitly or explicitly addressed certain aspects of agricultural risks. Following the 2005 food crisis, the government enhanced its Food Crisis Management and Prevention System (FCMPS) (see annex 1) to incorporate controlling risks, improving food security, and ensuring sustainable management of natural resources as objectives of the government's Rural Development Strategy (RDS). Currently, there are four dominant institutional systems; however, they generally focus more on emergency response rather than on risk management. However, the current institutional environment suffers from a number of well-known limitations, including the following:

- There is a high reliance on external actors and donors, which complicates the task of enforcing strategic focus and consistency over time and cross-sectoral coordination, especially since the short-term priorities of some of these actors have fluctuated widely over time.
- There are a number of good strategy documents; however, the weak implementation of these strategies is further complicated by political instability.
- The combination of political and institutional changes has led to the creation of new strategies or frequent changes in key framework documents, introducing uncertainty about previous commitments and rendering coordination difficult among all parties.
- There are established coordination mechanisms and some of their technical components have been showing definite improvements, but in times of crisis, it remains difficult and time consuming to reach a consensus regarding assessment and response.
- The integration of crisis prevention into various national development strategies remains partial, and the coexistence of disparate systems, more focused on crisis response than on risk management, reinforces the conceptual divide between emergencies and risk management.

Public support to agricultural risk management requires adequate information and analysis systems as well as good operational capacity (for dissemination of techniques, information, and support to risk management measures taken by individuals in the sector). This is constrained by the weak capacity of national institutions responsible for collecting basic data and delivering information, inputs, or technical services to producers (resources available to the typical technical ministry appear today much more limited than they were in the 1980s). Furthermore, the funding in the agricultural sector is quite volatile with significant interannual volatility, which further limits investments for agricultural risk management.

3 The Bank provided with emergency instruments (two Global Food Crisis Response Program [GFRP] supported projects since 2008, and a Safety Nets operation approved in 2011) and through making more and more flexible ongoing operations, namely the Community Action Program (CAP) and the Agro-sylvo-pastoral Export and Markets Development Project (PRODEX).

Despite weak institutional infrastructure and resource limitations, the government of Niger has been able to effectively manage various crises in the past. It has taken a number of measures to improve the effectiveness and efficiency of the existing crisis management systems. Some interventions by the government and donors have focused on long-term risk management, for example investment in irrigation, distribution of drought resistant varieties, and improving information systems. However, acute resource scarcity, chronic poverty of households, and financial limitations of the government have prevented a notable scaling up of those measures.

The situation of frequent occurrence of crisis, regular food availability and affordability problems, and low agricultural productivity poses a serious development challenge for the government: how to feed its burgeoning population while contributing to income growth in a sustainable manner. Addressing this question will require a better understanding and management of agricultural risks, which are often the underlying factors and triggers behind crises.

1.3 AGRICULTURE SECTOR RISK REVIEW

The current government, shortly after it took power in April 2011 after a 1-year military transition, announced a new strategy aimed at dealing more effectively with food production, 3N (*les Nigériens Nourissent les Nigériens*), and appointed a High Commissioner, who reports directly to the President's Office. The specific objective of the 3N Commission is to strengthen national food production capacity and improve resilience in the face of crisis and natural catastrophe. Recognizing the need to explicitly and comprehensively address agricultural risks, the government of Niger, through the 3N High Commissioner, requested the World Bank to conduct an agricultural sector risk review.

Agricultural risk management is an old issue for Niger and it has been analyzed, although using different terminology with focus on certain aspects, in detail by multiple stakeholders. World Bank's Poverty Assessment (2011), Niger Food Security and Safety Nets (2009), the Food and Agriculture Organization's (FAO) Review of Risk Management Tools and Policies in Niger's Rural Sector (2008), and UNDP's Analyse Integree des Facteurs de Risque Au Niger (2007) have also covered some aspects of agricultural risks. Agriculture sector risk review by the World Bank incorporates the existing work and takes a step further in performing a systemic and holistic assessment of agricultural risks, their impacts, and a discussion of various potential measures for improved agricultural risk management in Niger.

The Agricultural Risk Management Team of the Agriculture and Rural Development Department (ARD) and the Agriculture, Rural Development, and Irrigation Department in the Africa Region (AFTA1) conducted this Niger Agriculture Sector Risk Review in March 2012 with the objective to:

- Analyze the principal agricultural risks in Niger (production risks, market risks, and enabling environment risks)
- Analyze the impact of agricultural risks
- Prioritize the most significant agricultural risks for Niger
- Provide an illustrative list of risk management measures (mitigation-transfer-coping)
- Prioritize risks management measures using decision filters

This report relies on several primary and secondary sources of information. It takes a holistic approach to agricultural risk management and relies on long time-series historical data to arrive at an empirical and objective assessment of agricultural risks and their impacts on Niger. To gather primary data, a 2-week mission was conducted from March 5–15, 2012, during which the study team travelled to the Tahoua, Dosso, Maradi, Tillabery, and Niamey regions and interacted with all the major agricultural sector stakeholders, including relevant government organizations and technical and financial partners, farmers, traders, and so forth. The mission team organized two wrap-up stakeholder consultations at the World Bank office and at the Ministry of Planning on March 15 to share preliminary results and solicit feedback.

This report takes a holistic approach to agricultural risk and contributes to the debate by showing how best to prioritize resources and use existing institutions more effectively. The assessment is designed to help decision makers understand the risk exposure of the agriculture sector and develop appropriate risk management strategies that will strengthen the implementation of the government's new 3N strategies as well as other ongoing and new agriculture development programs.

The rest of the document is organized as follows: Chapter 2 describes the agricultural system in Niger. Chapter 3 analyzes various agricultural risks, while Chapter 4 estimates the magnitude of losses. Chapter 5 prioritizes the risk and highlights various risk management measures and their prioritization based on a simple filtering mechanism. The document closes with a brief conclusion and suggested next steps for improving agricultural risk management in Niger.

Chapter 2: AGRICULTURAL SYSTEM IN NIGER

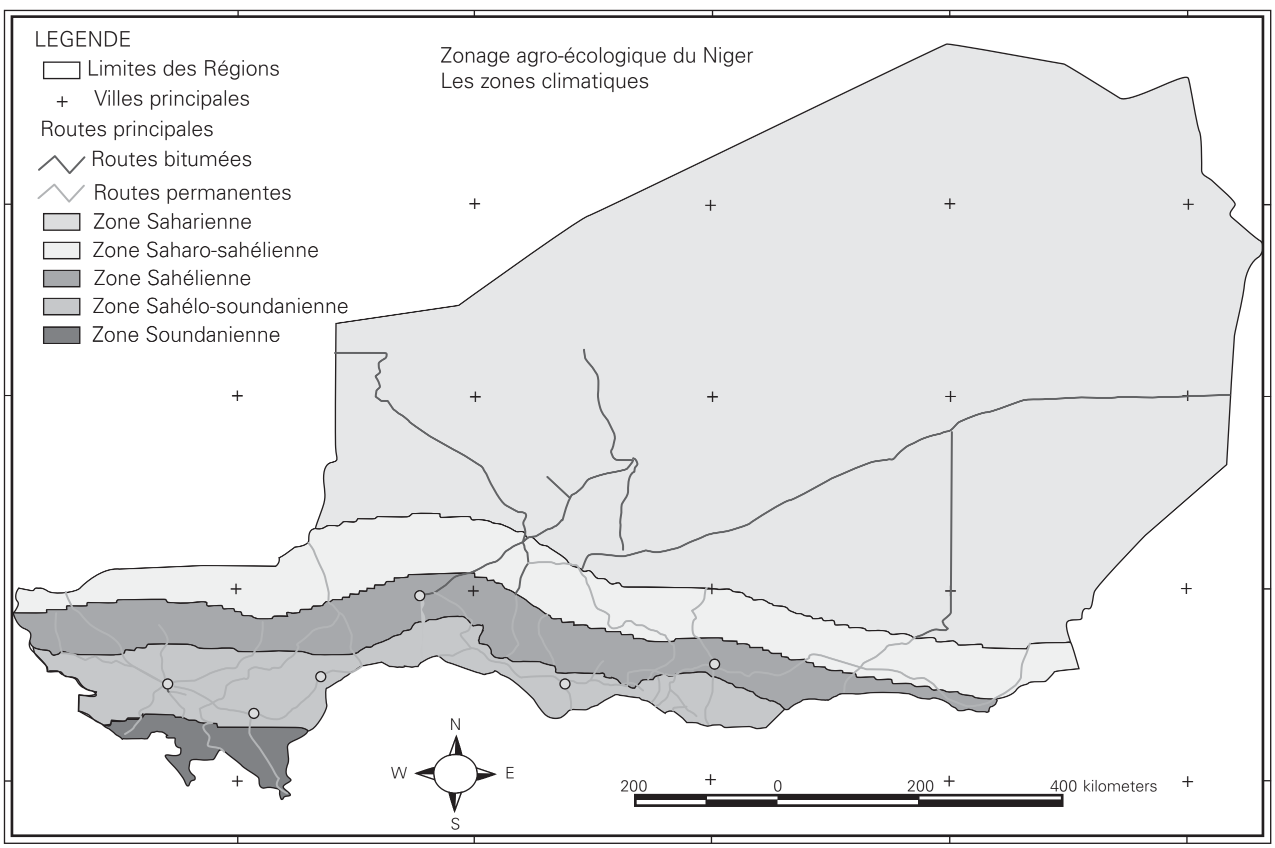
An overview of the agriculture sector is presented in this chapter, as the context for analysis and discussion of agriculture sector risk. Sector characteristics most pertinent to risk are thus given particular attention. The analysis of the frequency and severity of risk is best done over an extended time period; the review is based on trends for the period 1980-2010, wherever suitable data are available.

2.1 AGRO-CLIMATIC CONDITIONS

The main agro-climatic zones of Niger are depicted in figure 2.1 below. Rainfall isohyets are the main defining parameter for each zone, as there is limited variation in soil type and topography at an aggregate level. Eighty percent of soils are sandy and there are few mountain areas. A more detailed classification is developed within each agro-climatic zone, based on local variations in soil type, topography, and vegetation. Production conditions improve from north to south, with most agricultural production in the four southern agro-climatic zones (table 2.1). The main characteristics of the five agro-climatic zones are listed in this table.

Available evidence shows that the isohyets that delimit these agro-climatic zones shifted southward by 100–200 kilometers

FIGURE 2.1: Agro-Climatic Zones



Source: Comité Interministérial de Pilotage de la Stratégie de Developpement Rural; Secrétariat Exécutif. September 2004. *Le Zonage Agro-écologique du Niger.*

TABLE 2.1: Agro-Climatic Zones

ZONE	CLIMATE	PRODUCTION	PERCENT OF TERRITORY
Sahara	Arid: << 200 mm rainfall	Livestock (nomadic and transhumant). Irrigated crop production in Oases	74%
Saharo-Sahel	Rainfall: 200–300 mm	Traditional zone for pastoral livestock production. Encroaching crop production.	10%
Sahel	Rainfall: 300–400 mm	Mixed livestock and millet-legume based cereal production. Some off-season cash cropping in fossil river valleys.	8%
Sahelo-Soudain	Rainfall: 400–600 mm	Mixed livestock and cereal production (millet and sorghum). Higher potential for off-season cash crops in fossil river valleys.	7%
Soudain	Rainfall: >> 600 mm	Mixed livestock and cereal production (millet and sorghum). Widespread practice of irrigated, off-season cash crop production.	1%

Source: Comité Interministérial de Pilotage de la Stratégie de Developpement Rural; Secrétariat Exécutif. Septembre 2004. *Le Zonage Agro-écologique du Niger.*

from 1950–90, following a decline in rainfall,[4] with a prolonged period of below average rainfall from 1970–90. Recent analysis of long-term rainfall trends shows that this trend has now reversed, with average rainfall increasing again since the 1990s.[5] This suggests that the rainfall isohyets of 350–400 millimeters, which delimit the zones where crop production is viable, are shifting north again. As a result, the area suitable for crop production may have increased since the 1990s.

The marked climatic constraints to agricultural production in Niger are evident from this taxonomy. Less than 5% of agricultural land is in the higher potential soudanian zone. Most agricultural land is in the sahel and sahelo-soudanian zones where rainfall is low and erratic. Crop production is even riskier in the pastoralist, saharo-sahelian zones, although both pastoralists and farmers are now trying to establish mixed crop and livestock farming systems there. A combination of higher rainfall (as noted above), reduced access to grazing, and increased land pressure in traditional crop producing areas may partly account for this transition from pastoralism to mixed farming in the saharo-sahel agro-climatic zone.

2.2 LAND AND WATER RESOURCES

The land suited to crop production is limited, both in absolute terms and relative to population size. Approximately 6.5 million hectares are cultivated in the rainy season, with a further 73,000 hectares used for intensive horticulture production ("culture maraîchère") in the dry season.[6] Approximately 85,000–100,000 hectares of agriculture land is irrigated, out of 270,000 hectares of potentially irrigable land.[7] Although there is some scope to expand large-scale irrigation along Niger's rivers (from 15,000 to 30,000 hectares), there is greater potential for irrigation from underground water resources.

Despite continued expansion of the area cultivated (figure 2.2), per capita land use is declining. Farms are small (average 4.1 hectares) and getting smaller because Niger's high population growth rate (nearly 3.5 percent per annum) exceeds the rate of area expansion. The consequent pressure on agricultural land resources has risen in the last decades and is now very high.

Crop production thus takes place in a context of low and variable rainfall, and high and increasing pressure on cultivable land. The potential for irrigation is limited, and its use is relatively low. Production is further constrained by the predominance of traditional management systems, with limited use of improved seeds, fertilizer, and mechanization. High land pressure also limits the scope for fallowing land as a means to preserve and restore soil fertility, with only 5 percent of land in fallow in 2005 (Recensement General de L'Agriculture et du Cheptel, Government of Niger [RGAC], *op cit*) .

2.3 CROP PRODUCTION SYSTEMS

Faced with these constraints, most farmers opt for crop production systems based on the intercropping of millet, sorghum, and cowpea. All have low yield potential, but are well suited to low rainfall conditions. Intercropping further mitigates production risk by combining crops with differing seasonal growth patterns. In a year of early drought, the millet

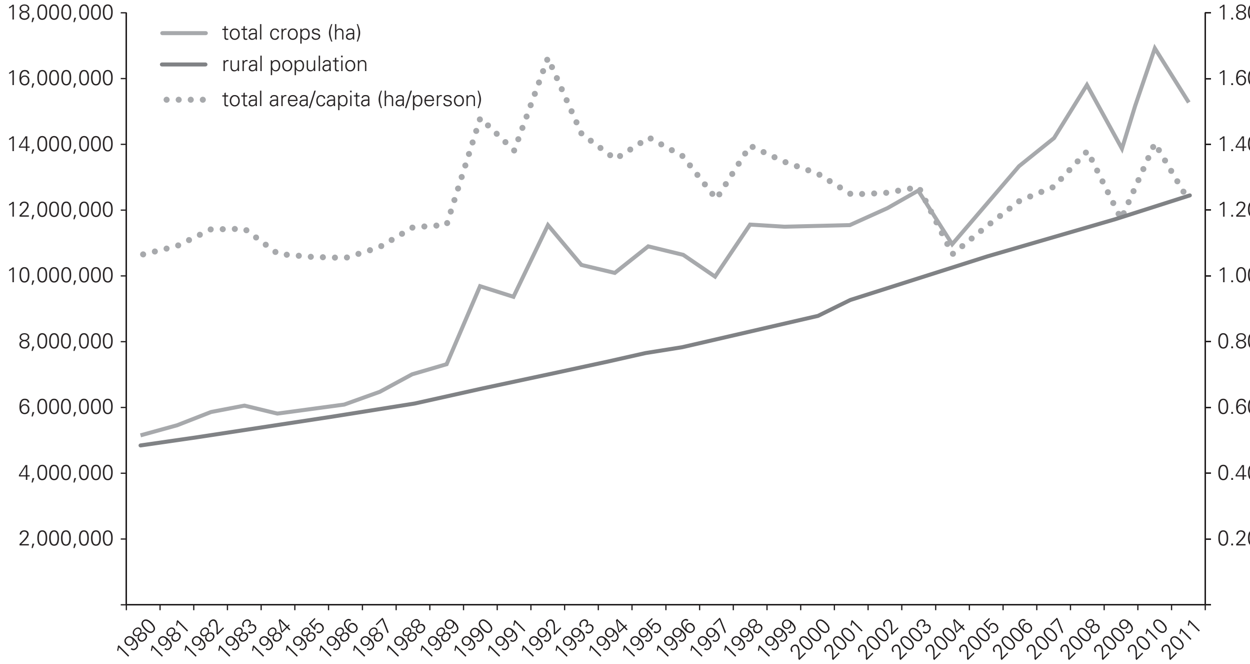
4 ECOWAS, CILSS, OECD. 2006. *The Ecologically Vulnerable Zones of the Sahelian Countries.*

5 UNEP. 2011. *Livelihood Security: Climate Change, Migration and Conflict in the Sahel.*

6 Ministere du Developpement Agricole/Ministere des Ressources Animales. Juin 2007. *Recensement General de l'Agriculture et du Cheptel 2005-2007.*

7 FAO. 2007. *Aquastat.*

FIGURE 2.2: Crop Area and Rural Population Trends



Source: INS; Author's calculations.

or sorghum will suppress cowpea, for instance, while the density of cowpeas can be increased in the event that planting rains come late and cereals establish poorly. This form of diversification also helps stabilize income and spreads the use of scarce soil moisture and labor during planting and early weeding. Given the right mix of crops and appropriate planting densities, there is also ample evidence that intercropping of this nature will increase yields, suppress weeds, and improve soil nitrogen levels.[8]

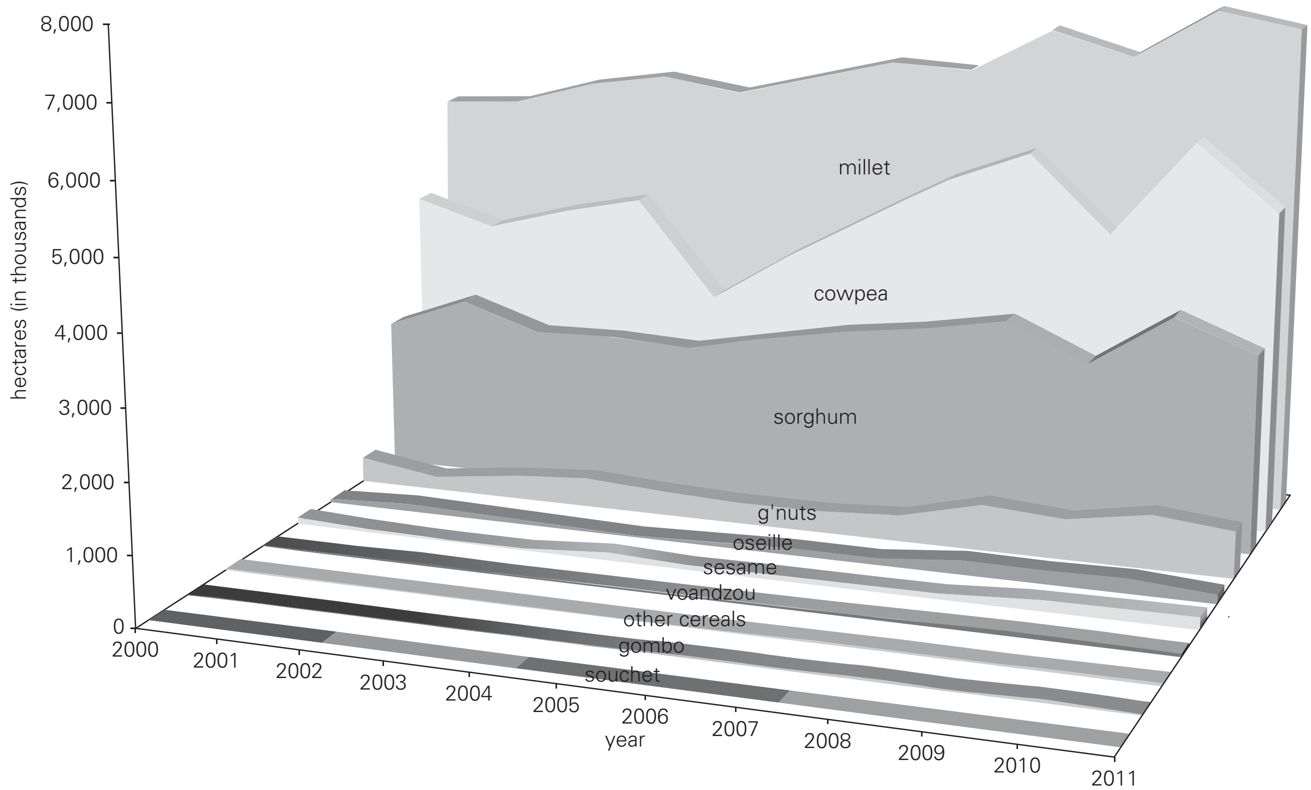
The advantages of this strategy are offset by the low yields of these three crops, which dominate production. Together, they account for 85 to 90 percent of the total area planted, limiting the scope for other, higher-yielding crops and for further diversification (figure 2.3). Although numerous other crops are grown (groundnuts, rice, maize, fonio, sorrel, voandzou, gombo, sesame, and souchet), the area planted to each is relatively small. Groundnuts account for 4 percent of the total area cropped and most of the others account for less than 1 percent of total cropped area. Note that while this intercropping mix provides useful protection in the event of lesser climatic shocks, it does not protect against more severe shocks. In fact, covariate risk may be accentuated during a severe drought as production falls for all three crops—as occurred in 2010 (figures 2.4, 2.5, and 2.6).

Dry-season production of high-value vegetable crops (culture maraîchère) provides a further means to raise and diversify farm incomes. It provides sizeable income and nutritional benefits to households engaged in it; however, from a macro-perspective, its impact is modest due to the limited area cultivated—equivalent to 1 percent of the area cultivated during the rainy season. Approximately 73,000 hectares were cultivated in 2005 (RGAC, *op cit*), of which 19,000 hectares in flood recession areas ("culture de décrue") and 54,000 hectares in irrigated lowland areas. Onions grown for export are the main dry season crop (30,200 hectares in 2005), followed by gombo (7,300 hectares), eggplant (6,000 hectares), and cabbage (3,500 hectares).

Lack of irrigation is the main constraint to increase dry-season crop production. Of the total area irrigated (approximately 100,000 hectares), full-control irrigation schemes account for only 15,000 hectares. Farm productivity is low on these schemes. Producers are thus unable to finance the full costs of maintaining pumps, canals, dams, and so forth and the infrastructure is falling into disrepair. It should be noted, however, that the rice-growing areas benefitted from the organization of cooperatives, setting of management fees, and maintenance of hydraulic systems and

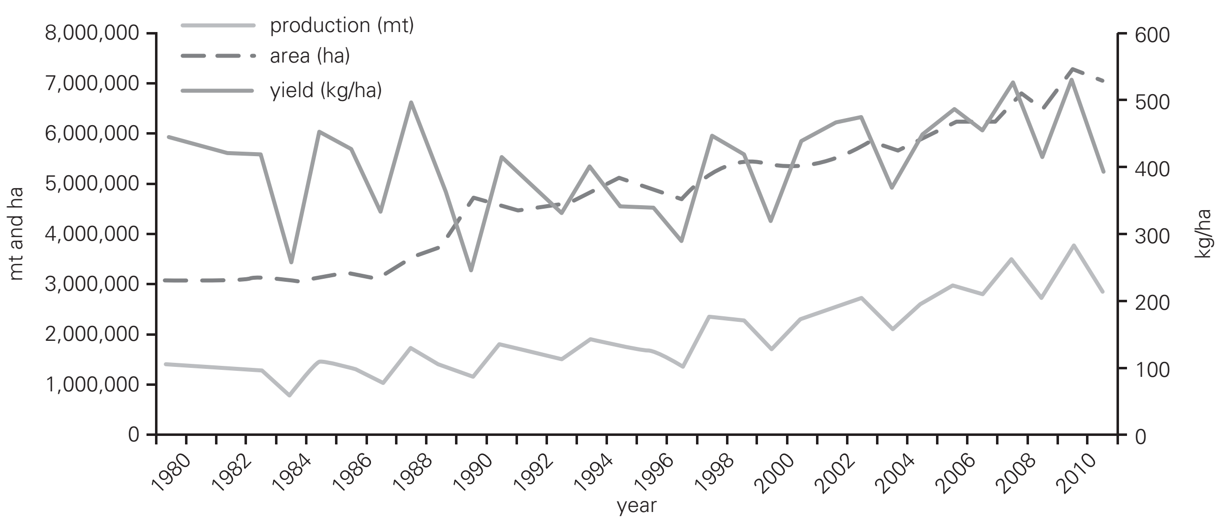
8 *Lessons Learned from Long-Term Soil Fertility Management Experiments in Africa.* Edited by Andre Bationo, Boaz Waswa, Job Kihara, Ivan Adolwa, Bernard Vanlauwe, Koala Saidou. 2012.

FIGURE 2.3: Rainy Season Crop Area Trends



Source: INS; Author's calculations.

FIGURE 2.4: Millet Production

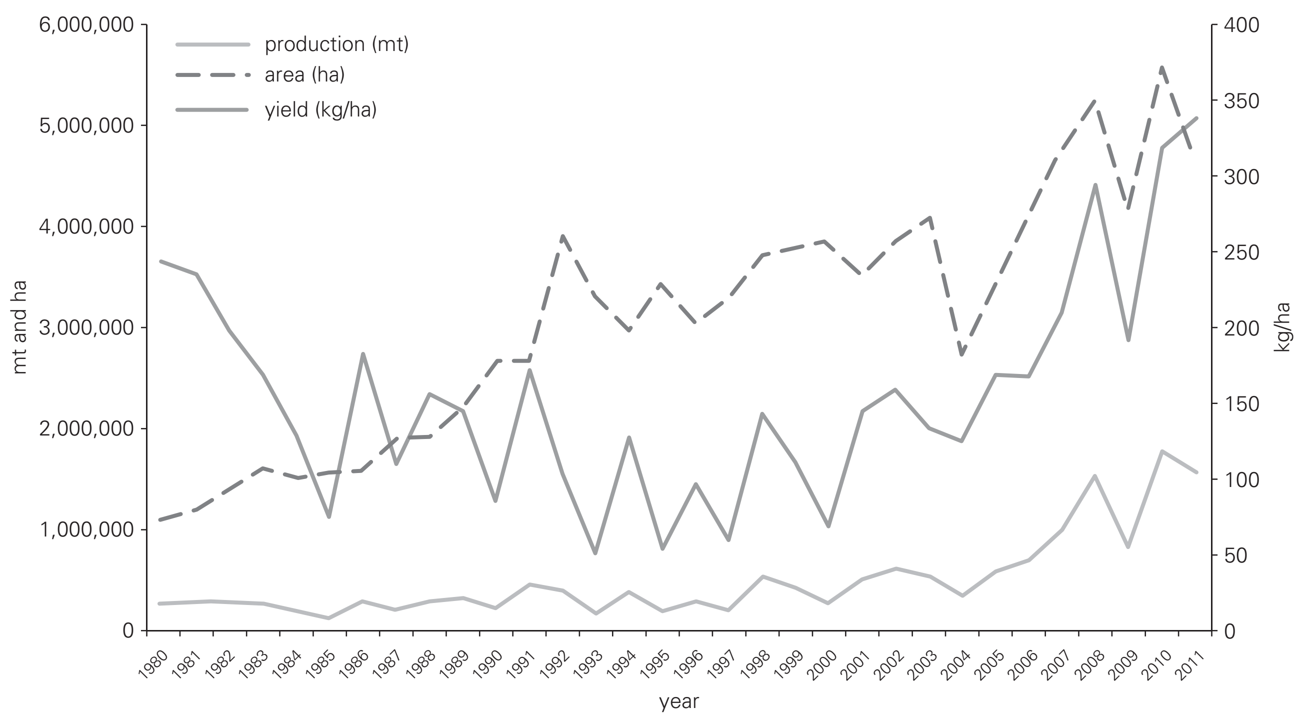


Source: Author's calculations.

FIGURE 2.5: Sorghum Production

Source: Author's calculations.

FIGURE 2.6: Cowpea Production



Source: Author's calculations.

equipment. As a result, cultivation intensity as well as yield has improved significantly. A further 60,000–70,000 hectares is partially irrigated from groundwater reserves, usually by small-scale, informal farmer groups. Although production levels are similar to those observed on full-control irrigation schemes, these partial water control schemes appear more viable. Capital costs are much lower and the physical infrastructure (wells, pumps, polythene pipes) is much simpler and less expensive to maintain. Flood recession cropping accounts for a further 18,000–20,000 hectares. All of these irrigation systems experience water shortages during droughts. These systems are quite diverse in terms of cropping, water control system, technology, management, market opportunity, social organization, source of financing, and land tenure security, which makes it difficult to make an authoritative statement about the relative viability of these systems. Recent projects supported by the World Bank have demonstrated high profitability of individual, small-scale irrigation projects. This often requires handing over of management responsibilities to producers' collectives and adequate supervision for maintenance and management of irrigation projects.

These deep-seated limitations to both rainy and dry season crop production, and their attendant vulnerability to drought, highlight the importance of livestock to rural livelihoods. Niger is fortunate in having both favorable conditions for livestock production and a huge, readily accessible export market in neighboring Nigeria. Mixed crop and livestock production systems are thus a critical strategy for raising and diversifying farm income.

2.4 PRODUCTION TRENDS

Production has increased steadily for all of the major crops (figures 2.4, 2.5, and 2.6). Millet and sorghum production doubled from 1980–2011 and cowpea production increased by almost five times (table 2.2). Area expansion largely drove this production increase. Yields fell initially and then rose after 2000, consistent with underlying rainfall trends. The pronounced increase in cowpea production, which was driven by both area and yield increases, reflects its increasing profitability for export. Maize and rice production fell overall from 1980–2011, although maize has recovered somewhat since 2000. The small contribution of maize and rice to total crop production has declined and they now account for less than 1 percent of total cereal output.

As the scope for further area expansion is limited, future production growth will depend on yield increases. There is scope to raise crop yields, given the low current rates of fertilizer use and the low use of improved seed varieties, but strong supply and demand side constraints limit the use of these inputs. Total fertilizer use is estimated at 20,000 tons per year[9] for 6.5 million hectares, an average of only 3 kilograms per hectare. Even for more intensive, off-season crop production, only 25 percent of producers reported fertilizer use in the *2005 Census of Agriculture* (RGAC, *op cit*). Similarly, improved seed varieties accounted for only 6 percent of the total seed used for millet, sorghum, cowpeas, groundnuts, and sesame[10] in 2010. This combination of low input use, low and declining soil fertility, and difficult climatic conditions means that nationwide yield gains are likely to be slow, and that production increases may be slower and more variable in the future.

Production variability, as measured by coefficients of variation, confirms the higher drought tolerance of millet and sorghum, particularly the former (table 2.3). The higher production variability of cowpea production is attributed to its higher yield variability. Production variability increases yet again for groundnut, rice, and maize, which is consistent with their limited importance to overall crop production.

TABLE 2.2: Percent Change in Food Crop Production

	PRODUCTION	AREA	YIELD
1980–2011			
Millet	102.6%	129.5%	–11.7%
Sorghum	117.7%	292.4%	–44.5%
Cowpea	483.9%	320.3%	38.9%
Groundnut	75.0%	264.4%	–52.0%
Maize	–36.0%	–45.4%	17.2%
Rice	–59.2%	–56.7%	–5.7%
2000–2011			
Millet	64.5%	33.1%	23.6%
Sorghum	107.7%	38.2%	50.4%
Cowpea	497.2%	20.8%	394.5%
Groundnut	249.6%	91.7%	82.3%
Maize	68.4%	36.1%	23.8%
Rice	5.2%	112.2%	–50.4%

Source: INS; Author's calculations.

9 Reseau National des Chambres d'Agriculture du Niger. *Note d'Information/Intrant*s No. 13. Decembre 2010.

10 Ministère de l'Agriculture et de L'Elevage. *Annuaire sur la Disponibilité en Semences Améliorées 2010–2011*. Niger.

TABLE 2.3: Coefficients of Variation: Production, Area, and Yields

	PRODUCTION	AREA	YIELD
Millet	0.19[a]	0.06[a]	0.18
Sorghum	0.32[a]	0.13[a]	0.33
Cowpea	0.53[a]	0.15[a]	0.46
Groundnut	0.65[a]	0.43[a]	0.43
Rice	0.68[a]	0.57[a]	0.39
Maize	0.84	0.73	0.78

Source: Authors calculations.
[a]Adjusted for trend using the Cuddy Delle-Valle Index.

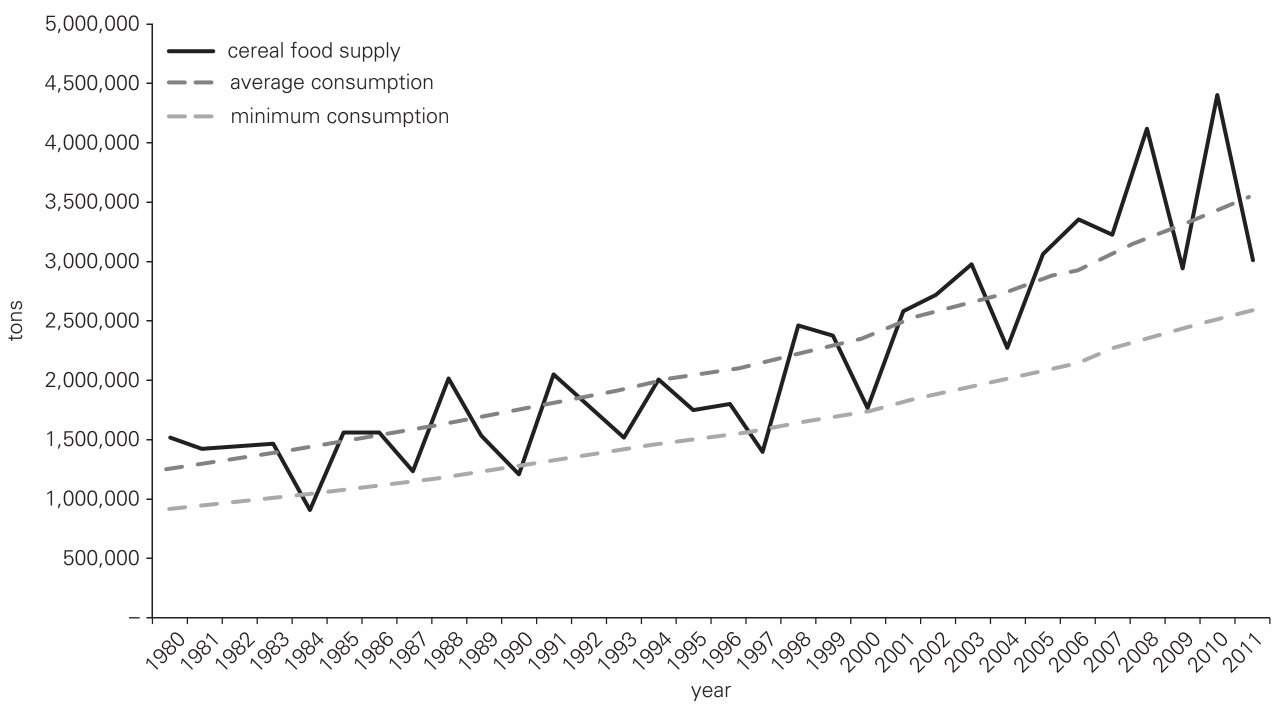
2.5 CEREAL CROPS: FOOD SUPPLY AND DEMAND

The comparison of domestic cereal production for food with domestic demand for cereals is based on the following assumptions: (1) nonfood use of cereals for seed, livestock feed, and exports estimated at 15 percent of total cereal production; (2) average domestic consumption for food of 225 kilograms per capita per year, based on the most recent Global Information and Early Warning System (GIEWS) analysis by FAO; and (3) a minimum consumption requirement of 165 kilograms per capita per year, equivalent to the minimum dietary energy requirement of 1680 calories per capita per day (FAO). The resultant trends are reported in figure 2.7 below for joint production of millet, sorghum, maize, and rice. (Fonio was excluded due to lack of data and its small contribution to production—approximately 5,000 mt in 2011.) The analysis is based on production and consumption only, and does not reflect imports, food aid, or changes in stocks.

The results of the analysis show the following major trends:

- Driven by the expansion of millet and sorghum area, growth in total cereal production for food has kept pace with population growth for the period 1980–2011. This trend was also shown for other Sahelian countries in a recent study by Organization for Economic Co-operation and Development (OECD: *Atlas on Regional Integration in West Africa,* 2009).
- Cereal food production deficits occurred frequently during the lower rainfall years of 1984–2000, including a number of years when cereal food production fell below the minimum consumption requirement.
- Cereal food production deficits have been less frequent and less severe since 2000, in response to higher rainfall, with no cases of aggregate production falling below the minimum consumption requirement.
- The period since 2000 has also been characterized by frequent surpluses, including record surpluses in 2008 and 2010, which has facilitated the rebuilding of stocks.

FIGURE 2.7: Cereal Food Production vs. Consumption



Sources: INS, GIEWS, FAO, Author's calculations.

2.6 CASH CROPS

Cash cropping is based on rainy season production of cowpea, sesame, and souchet and irrigated, off-season production of vegetable crops. Onions and cowpea are the main export crops with estimated revenues of $88 million and $68 million respectively in 2006 (World Bank, 2010). Souchet exports amount to a further $10 million and sesame $3 million. All of these crops are sold in regional markets of Nigeria, Benin, and Cote d'Ivoire.

Niger is the second largest producer of cowpeas in West Africa, after Nigeria. Cowpeas are valued both as an export crop (50 to 75 percent of production is sold to Nigeria), and as a source of animal feed for domestic use (cowpea hay). Domestic bean consumption is relatively low (6 kilograms per capita). Production has increased considerably since 2000, largely in response to increased yield (table 2.4). Intercropping with millet and/or sorghum is the main form of production, reducing production risk but also lowering yield. Interannual variation in cowpea production is quite high, nevertheless (table 2.4), despite its suitability for low rainfall conditions and light, lower fertility soils. Farmers seeking to expand cowpea production will eventually face a choice of whether to switch to growing it as a single crop, with higher yields but much higher attendant risks, or to continue intercropping.

TABLE 2.4: Characteristics of Major Cash Crops

	AVERAGE	PERCENT CHANGE	COEFFICIENT OF VARIATION
Niebe (2000–11)			
Area	4,167,512	20.8%	0.15[a]
Production	852,538	497.2%	0.53[a]
Yield	193	394.5%	0.46
Sesame (2000–11)			
Area (ha)	89,786	94.1%	0.40[a]
Production (ton)	33,940	283.9%	0.63[a]
Yield (kg/ha)	380	97.8%	0.49
Souchet (2000–11)			
Area (ha)	6,489	448.0%	0.51[a]
Production (ton)	18,628	1921.8%	0.54[a]
Yield (kg/ha)	3,011	268.9%	0.46
Onions (2000–10)			
Area (ha)	14,005	84.7%	0.11[a]
Production (ton)	345,286	9.5%	0.10
Yield (ton/ha)	26.2	–40.7%	0.09 [a]

Sources: INS, FAOSTAT, Author's calculations.
[a]Adjusted for trend using the Cuddy Delle-Valle Index.

Of the other rainy season cash crops, souchet is grown as a mono-crop, while sesame is grown on small garden plots—often by women. Data for these two crops are limited to the period 2000–11. Production of both crops has increased significantly since 2000, although the increase observed for souchet is from a very small base. Both crops exhibit marked interannual variability in production, area, and yield (table 2.4).

Niger has established a strong export market for onions, particularly in the large urban markets of Nigeria, Ghana, and Cote d'Ivoire. Onions have thus become an important source of off-season revenue for small-scale farmers, helping them smooth and increase farm incomes. Most production is on small plots, irrigated with simple pump irrigation systems. Available data suggest that the area planted has increased significantly in response to the introduction of onions to areas around Agadez and the continued growth of small-scale irrigation along the fossil-river valleys in south-central Niger. Production has not changed much however, due to declining yields. Marketing issues may represent the main constraint to increased production. Growers are highly vulnerable to periodic market gluts due to their limited bargaining power, limited knowledge of trends and conditions in major export markets, and lack of storage and processing facilities.

2.7 LIVESTOCK

Sahel countries have a long tradition of pastoralism, relying on their comparative advantage in extensive livestock management systems to supply the larger coastal markets of Nigeria, Cote d'Ivoire, and Ghana. Niger, with 10.5 million tropical livestock units (TLUs),[11] has the largest herd population in the Sahel region. The contribution of livestock to gross agriculture domestic product is 40 percent but it used to be much higher in the past. But the proportion of the national budget invested into this subsector has fallen.[12]

Over the past 50 years, Niger's national herd is estimated to have grown at an average annual rate of 2.47 percent if one considers the total number of head, or 2.33 percent p.a. in TLU terms[13]; the small difference being due to the fact that herd composition overall has not changed drastically (mod-

11 The tropical livestock unit concept brings together metabolism and feed requirements to various animal species; one TLU is generally equivalent to 1 camel, 0.7 cattle, and 0.1 small ruminant.

12 In the early postindependence period, the share of government budget going to livestock was about 4 percent compared to about 0.5 percent today.

13 Livestock statistics in Sahel countries are notoriously unreliable and must be taken with caution.

est proportional reduction in cattle, small increase in camels, some shift from goats to sheep within small ruminants). Bigger changes have involved the redistribution of livestock over space, within production systems, and ownership.

The livestock system in Niger could be classified into the pastoral zone, where transhumance and nomadism dominate; the agro-pastoral zone; and the agricultural zone. In each zone, animal husbandry systems may be further classified by species composition, type of management, and degree of association with agriculture to the extent that these factors are relevant to risk exposure and management.

Two researchers[14] analyzing changes in Niger's livestock sector over the past 30 years have proposed a typology of livestock ownership and management including seven distinct groups based on two main criteria: (1) relative vulnerability to climatic risk and (2) extent to which they are connected to, and experienced at dealing with livestock markets. This typology reflects the widening gap between the livestock owners and trading groups who have managed to develop relatively effective and resilient risk management strategies (civil servants and other wage earners, well-connected livestock owners and traders, and entrepreneurs) on the one hand, and groups who have remained highly vulnerable to weather and other risks, on the other. The latter groups include pastoralists having suffered major losses and without significant market connection, those in the process of herd reconstitution, and agro-pastoralists having partly reduced their dependence on livestock and grain markets through limited agricultural production:

- Entrepreneurs operating in relatively secure systems
- Traders and investors seeking financing
- Herders and small traders with market connections
- Wage earners with livestock assets
- Herders' families with agricultural production
- Households rebuilding herds
- Poor herding households, without market connections

2.7.1 Transhumant-Nomadic Pastoral Zone

This largely falls within the Agadez Region, and covers the northern parts of most other regions (Tillaberi, Tahoua, Maradi, Zinder, and Diffa). The composition of herds reflects environmental conditions and the combination of camels and small ruminants in this region accounted for 85 percent of all TLUs in 2009. Transhumance and nomadism represent the most effective strategies to use forage and water resources whose annual quantity, quality, and distribution over space is highly variable and uncertain.

Repeated weather and other shocks have affected herd survival and productivity as well as access by pastoral households to food on the basis of the livestock and grain terms of trade. As a result, all herding families have tried to develop complementary income-generating activities, such as trade with Algeria or Libya in the north, seasonal or long migration. Other emerging trends in this zone include a redistribution of livestock ownership within the transhumant-nomadic pastoral zone,[15] a reduction in family herd sizes,[16] and a move toward the south by many herding families.[17]

2.7.2 Agro-Pastoral Zone

This falls within an ecological area with an annual rainfall of 300–400 millimeters, spanning the country from east to west, and all regions except for Dosso and the Niamey UCN, and accounts for two-thirds of the cattle herd in Niger. The main feature here has been the expansion of agriculture, both by people escaping the very high population densities (and shrinking farm sizes) of the south, and by herding families becoming increasingly involved in agriculture, after having lost much livestock during recent crises. In the agro-pastoral zone, about 60 percent of heads of households reported livestock herding as their main activity, with 26 percent stating that they practiced a combination of animal husbandry and farming.[18]

The combination of low and variable rainfall (over 20 percent interannual variability) puts crops, pastures, and water

14 A. Marty, B. Bonnet, 2006.

15 Following a crisis, the herding families that had implemented the most successful management strategies have the means to acquire some or all of the remaining livestock belonging to less successful and poorer herding groups. In some cases, the latter merely become herdsmen for large owners until they accumulate the means to start a small herd of their own again.

16 According to recent study by Salla, Atte, Oumarou, Gouvernement du Niger, 2011, the average family herd size has reduced to 15.5 TLUs compared to an estimated 23.4 TLUs required to sustain the average herding household.

17 This move (likely permanent) by herding families to agro-pastoral or agricultural areas mostly took place during the mid-1980s and the 2004–05 and 2009–10 periods. After moving southward in an attempt to save surviving animals, many families decided not to return to their traditional northern grazing areas. Some lost everything and ended up as urban or peri-urban refugees; most settled in agro-pastoral areas and turned to agriculture and other activities to complement their limited income from remaining herds. Here too, a transfer of ownership took place, from pastoral to salaried or agricultural families, which contributed in a small way to the significant increase in livestock observed in agricultural areas.

18 Gouvernement du Niger, 2011.

resources at high risk. Transhumance remains a major feature of animal husbandry in the agro-pastoral zone, including long-term growing out in parts of southeastern Mali, northern Benin, or Nigeria. Agriculture is very uncertain, especially for poorer herding families now settled in this zone, with the majority (77 percent) being able to grow enough food for a period ranging from 1 to 3 months of their annual grain requirements.[19] In addition, the combination of high livestock density, extensive transhumance, and expansion of farmed areas have raised tensions and conflicts between groups using open-access resources (among herders, between herders and farmers, between agro-pastoralists, etc.).

2.7.3 Livestock in the Agricultural Zone

This southern belt, wider in the west than in the east, spans the entire country and receives on average 400–600 millimeters of rainfall per year (up to 800 millimeters in southern Dosso areas). Some emerging trends in this zone include : (1) shrinking farm size and marginalization of many smallholders,[20] (2) improved resource conservation and use due to large-scale Farmer Managed Natural Regeneration (FMNR) of woodlands,[21] and (3) a considerable increase in livestock population (mostly cattle and small ruminants).

One of the most striking features of the recent agricultural census of Niger is that about 60 percent of livestock in the country are now considered to be sedentary. Another feature of livestock in the agricultural area, aside from the coexistence of well and poorly integrated systems, is that ownership is reportedly skewed: some 90 percent of cattle and 75 percent of small ruminants are reportedly owned by the richer half of all farming households.[22] Relatively better-off farmers have invested in livestock, during years of good production or when livestock prices have been particularly low, as a way to diversify their investment and savings portfolios (women have followed the same strategy, although on a smaller scale, and with small rather than large ruminants).

19 Gouvernement du Niger, 2011.

20 High population growth rate, limited arable land, and consolidation by resource-endowed households to grow high-value export crops (souchet, tobacco, etc.) have put tremendous pressure on available land resources, resulting in fragmentation of plots, reduced land availability, and marginalization of small holders.

21 There is remarkable and spontaneous uptake by farmers of FMNR to develop agro-forestry systems in high population density areas where most land is cultivated and where natural vegetation had almost disappeared. The scale of this on-farm re-greening is at least 5 million hectares, making it the largest environmental transformation in the Sahel, and possibly, in Africa.

22 FEWSNet, 2011.

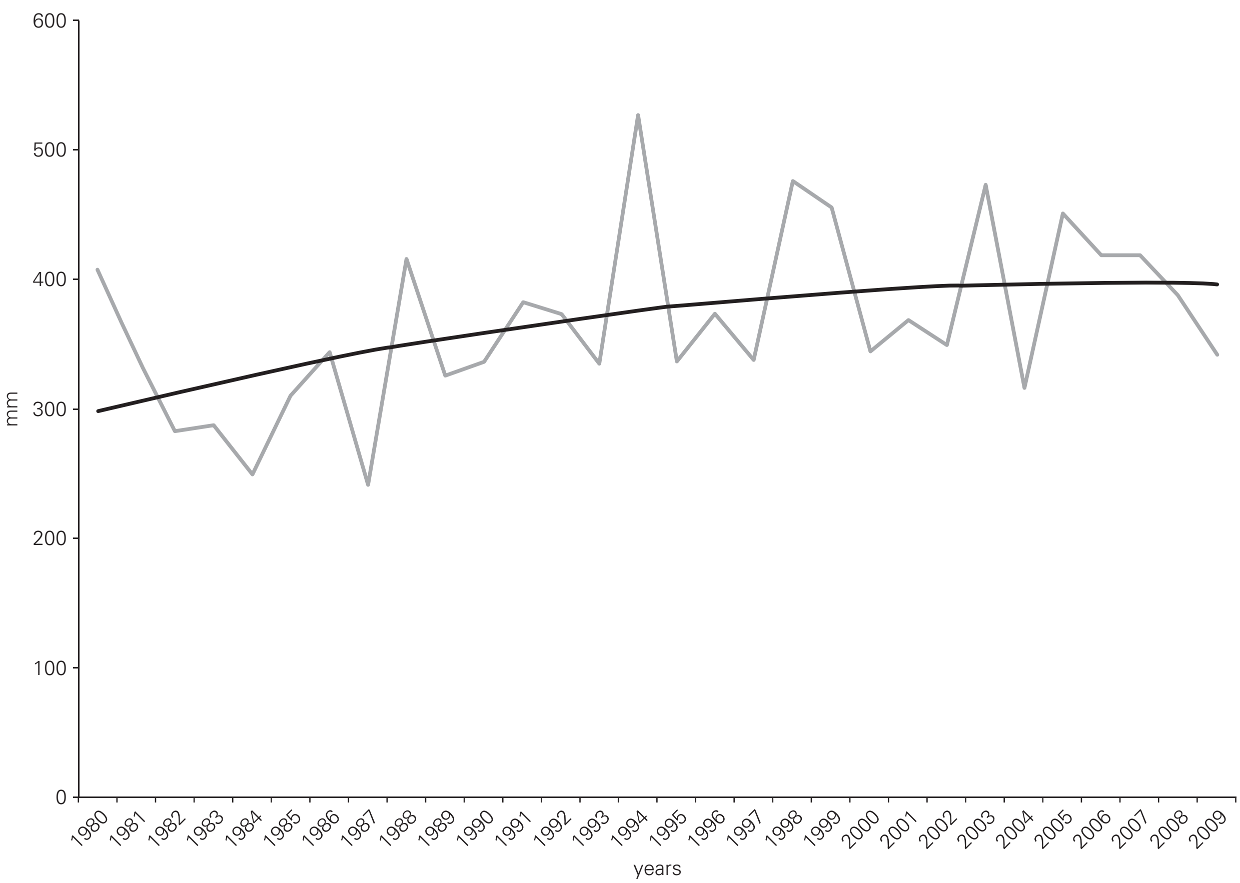
Chapter 3: AGRICULTURAL SECTOR RISKS

The main sources of risk are reviewed in this chapter: production risk, market risk, and a general set of risks associated with the enabling environment for agriculture. The incidence and implications of multiple or successive shocks are also considered. An analysis of rainfall characteristics, at both national and regional levels, deepens the context for analysis.

3.1 RAINFALL TRENDS 1980–2009

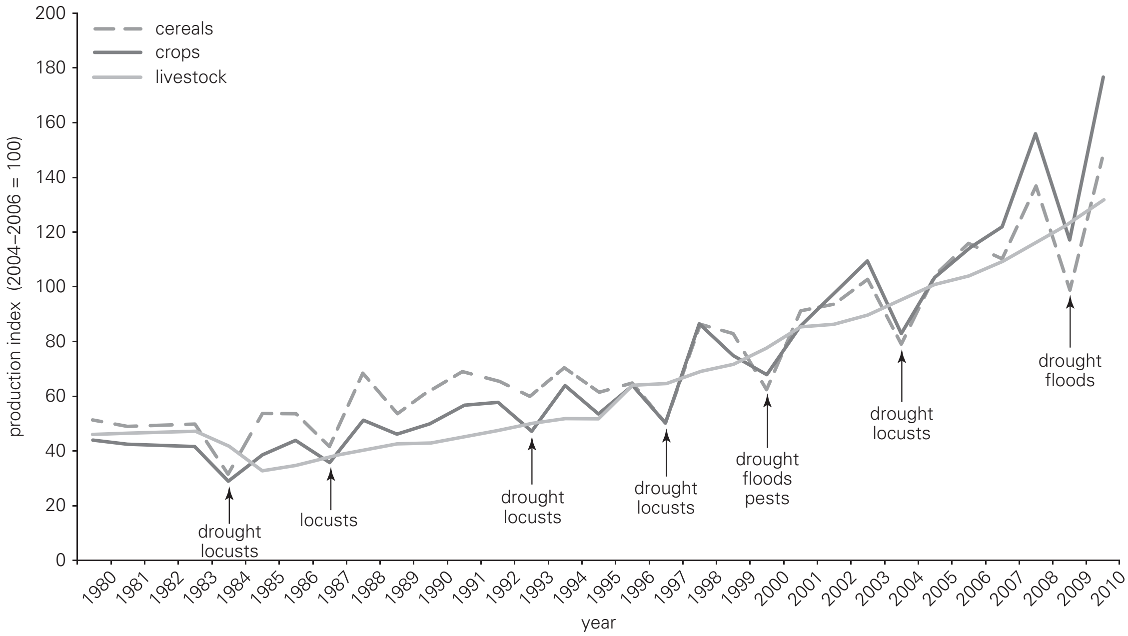
Trends in average annual rainfall indicates years of lower rainfall and confirm that rainfall has increased during the period of analysis (figure 3.1). Detailed analysis conducted by AGRHYMET for the 1980–2010 time period (see annex 5) indicates that in the sahelian and Sahelo Saharan zones, more than half of the rainfall stations analyses recorded a significant increase in rainfall. More than 33 percent of stations had a significant increase in the number of rain days, a significant decrease in duration of the longest dry spell, and cessation dates of rainfall . No such trend was found in the soudano sahelian zone. AGRHYMET concludes that, apart from the severe droughts of 2004 and 2011, Niger has experience rainfall conditions much better over the past two decades compared to the dry decades of the 1970s and 1980s.

FIGURE 3.1: Average Annual Rainfall



Source : INS. *Annuaire Statistique des Cinquantes Ans d'Independence du Niger*. Edition Speciale. Novembre 2010.

FIGURE 3.2: Major Shocks to Crop and Livestock Production



Sources: FAOSTAT; Author's calculations.

A more nuanced indicator of the range and extent of adverse rainfall events are obtained from analysis of standardized anomalies of rainfall (see annex 2) for the same period by region (table A2.5). This analysis confirms the range and extent of the catastrophic droughts in 1984 and 1987. Less severe adverse rainfall events are observed in 1990, 1993, 1997, 2000, 2004, and 2009.

3.2 PRODUCTION RISKS

Drought, locusts, livestock diseases, crop pests and diseases, floods, windstorms, and bushfires are the main sources of production risk. Farmers also complain of the risks to crop production from livestock herds, although the incidence and severity of these events is difficult to determine. The impact of these events on crop production for the period 1980–2011 is indicated in figure 3.2 below, using indices of agricultural production.[23] The index of livestock production is reported for the sake of completion, as the data on which it is based are not considered realistic.

23 Shows relative level of aggregate volume of production for each year relative to a base period of 2004–06. Calculated as the sum of price-weighted quantities of main commodities using average international prices.

3.2.1 Drought

Drought is the most important agricultural risk with high probability and severity affecting both crop and livestock production. An agricultural drought occurs when a soil moisture deficit significantly reduces crop yields and output. It can occur in response to low overall annual rainfall or to abnormalities in the timing and distribution of annual rainfall. Inadequate rainfall at key periods during the crop production cycle (seeding, flowering, and grain filling) affects crop yields, even when overall rainfall is comparable to long-term norms. During these periods, a soil moisture deficit during a period as short as 10 days can have a major impact on crop yields. AGRHYMET's principal component analysis reveals that long dry spells (number of consecutive days without rainfall) and late onset of rains are the two biggest factors responsible for yield losses and crop failure in Niger.

Drought is typically defined relative to some long-term average balance between precipitation and evapotranspiration, which is considered normal for a particular location at a particular time of year. Yield loss is also assessed relative to some normal long-term average yield for a particular crop in a particular location.

Analysis of rainfall data (annex 2) indicated that between 1980–2009, there were nine years, namely, 1984, 1987,

TABLE 3.1: Summary of Drought Events

YEAR	NUMBER OF DEPARTMENTS SEVERE DROUGHT	NUMBER OF DEPARTMENTS CATASTROPHIC DROUGHT	FODDER BALANCE SHEET (SURPLUS OR DEFICIT %)	CEREAL BALANCE SHEET (SURPLUS OR DEFICIT %)	SEVERE FOOD CRISIS
1984	12	8	NA	NA	(1985)
1987	11	13	NA	NA	
1990	8	12	NA	NA	
1993	5	12	NA	NA	
1995	6	4	NA	NA	
1997	8	9	NA	NA	(1998)
2000	8	9	–12%	–28%	
2004	7	7	–25%	–21%	(2005)
2009	10	2	–70%	–12%	(2010)
2011*			–41%	–18%	(2012)

Source: Author's calculations; World Food Programme (WFP). *Situation Alimentaire Et Nutritionnelle Au Niger*. February 2012.
* While 2011 was a drought year, relevant meteorological information was not available when this analysis was conducted.

1990, 1993, 1995, 1997, 2000, 2004, and 2009, wherein 10 or more departments suffered severe or catastrophic drought (table 3.1). However, not all of them had a major impact on agricultural sector. Only seven of these rainfall deficit years, namely 1984, 1997, 1993, 1997, 2000, 2004, and 2009, were strongly associated with crop failure (figure 3.2). Furthermore, these droughts did not always lead to a severe food crisis[24] and major food shortages resulted only in 1984–85, 1997–98, 2004–05, and 2009–10. Although 2011 drought was not analyzed systematically, it led to large losses in Niger and resulted in severe food crisis in 2012.

3.2.2 Locusts

Locusts (especially desert locusts, *Schistocerca gregaria*) are a constant threat in the Sahel. They are difficult to detect and eradicate as their breeding grounds are located in remote areas, and seasonal desert winds facilitate rapid, widespread dispersal of locust swarms. For the period of analysis, the two worst infestations occurred in 1987–88 and 2004–05. Most reported infestations start in the northern desert regions of Niger where crop and livestock production are low (see table 3.2 below), but they often move southward to cultivated areas.

24 Aker, Jenny. "Rainfall Shocks, Markets and Food Crises: Evidence from the Sahel." Center for Global Development. Working Paper no. 157. December 2008.

Locusts eat all vegetative matter in their path, starting with grazing lands and then moving to agricultural crops. But whereas the impact on crop production is direct and immediate, the impact on livestock production is indirect and delayed due to the loss of grazing. The level of damage is highly localized and proportional to the size of the swarms, but is devastating during major attacks. While the incidence of locust attacks is adequately recorded (table 3.2), it is more difficult to quantify losses to crops and livestock production, especially when it occurs in combination with drought. FAO Emergency Prevention System/ (FAO EMPRES) estimated that the crop losses incurred during 2004–005 were due two-thirds to drought and one-third to locusts; but this applies only to areas most heavily affected.

3.2.3 Livestock Diseases

Official statistics for the period 1995–2010 indicate that, *pasteurellose*, anthrax, and *peste des petits ruminants* are the most widely reported diseases among ruminants, and Newcastle disease is the most common disease risk for poultry (table 3.3). Although the statistics on reported cases per year and deaths per year are improbably low (less than 0.1 percent of total animal numbers), the reported frequency (about 0.35) of disease outbreaks is probably indicative of actual trends. Of the diseases reported above, vaccines exist for all except *pasteurellose* (although it is difficult to vaccinate for foot and mouth as different strains require different vaccines). Hence, for most major livestock diseases, risk can

TABLE 3.2: Summary of Locust Infestations

YEAR	CLASSIFICATION AND AREAS OF INFESTATION	AREA SPRAYED BY THE GOVERNMENT
1978 (Oct–Nov)	**Minor infestation** in Akarbai	6,000–7,000 ha
1980 (Sept–Dec)	**Widespread infestation** in western Air and Tamesna	100,000–120,000 ha
1986 (Oct–Dec)	**Widespread infestation** in northern Tamesna and Air	60,000–70,000 ha
1987 (Nov–Dec)	**Moderate infestation** in Tamesna and Air	25,000–30,000 ha
1988 (Jun–Dec)	**Locust plague** catastrophe	700,000–800,000 ha
1989 (Jan–May)	**Localized spread** in Tamesna	4,500–5,000 ha
1995 (Jan–June)	**Minor infestation** in various areas in Tamesna region	9,000–10,000 ha
2000 (Feb)	**Localized infestation** in the area of Wadi Tafidet	700 ha
2003 (Nov)	**Localized infestation** in Tamesna between Agadez and In Abangharit	300–400 ha
2004 (Jan–Dec)	**Locust upsurge** (large-scale infestation) in Tamesna and Air	300,000–400,000 ha
2005 (June)	**Localized infestation**	263 ha
2006 (Nov–Dec)	**Minor infestations** in Abangharit, Tassara, and central Tamesna, primarily west of In Abangharit in the Azaouak Valley	4,000–5,000 ha

Source: Compiled from FAO's *Desert Locust Situation Update* and Desert Locust Information System.

TABLE 3.3: Incidence of Livestock Disease 1995–2010

	NUMBER OF YEARS OBSERVED 1995–2010	AVERAGE NUMBER OF OUTBREAKS/ YEAR	AVERAGE NUMBER OF CASES/ YEAR	AVERAGE NUMBER OF DEATHS/ YEAR
Sheep and goat pox	7	92	710	195
Pasteurellose	4	157	586	123
Anthrax	4	28	194	147
Peste des petits ruminants	6	39	155	118
Foot and mouth	5	58	151	23
Blackleg	5	28	56	26
Contagious bovine pleuro-pneumonia	6	6	48	28
Newcastle disease	5	5	518	444

Source: The World Organisation for Animal Health (OIE) Database.

be dramatically reduced with easily administered, low-cost vaccinations. A recent study on the impact of the 2009–10 crisis on the livestock subsector showed that vaccination rates in surveyed areas had increased from about 30 percent in the mid-2000s to over 40 percent by the end of the decade. Much more can be done.

For livestock conditions such as internal and external parasites, mastitis, and foot ailments, the risk of infection increases when animal husbandry and feeding are poor—especially when grazing and forage are limited. Livestock mortality is thus particularly high during periods of drought. The incidence of these ailments is also likely to increase as livestock systems intensify, especially in peri-urban areas.[25] Adequate feeding, good animal husbandry, and ready access to veterinary services are the best way to reduce these risks, whether there is a drought or not. Unfortunately, farmer knowledge of animal husbandry is limited, as is the national veterinary service's ability to deliver animal health care.

3.2.4 Floods

While it has generally been favorable to crop production, the increase in average annual rainfall since the mid-1980s has resulted in an increased incidence of flooding. Most flooding occurs in the rainy season months of July through September, when the main crops are under cultivation and livestock are confined to households—particularly small ruminants. It is usually the result of heavy rainfall during a short time period, which results in flash flooding and localized flooding along the banks of the Niger River, so there is little time to prepare. Damage and losses tend to be localized, but are devastating where they occur. Houses and buildings are damaged or destroyed, fields are inundated, and high numbers of livestock

25 Ly, Fall, and Okike, 2010.

TABLE 3.4: Recorded Losses Due to Selected Major Floods

YEAR	REGIONS AFFECTED	DISPLACED PEOPLE	HOUSES DAMAGED OR DESTROYED	CROP LOSSES	LIVESTOCK LOSSES
1988	Southern, eastern and western parts of Niger and Niger River	307,000	N/A	7,500 ha	N/A
1994	Southern and Western Niger	20,000	N/A	N/A	N/A
1998	Niamey, Mokko	41,590	230	9,196 ha	1254 large ruminants, 6,544 small ruminants
1999	Northern Niger, Agadez region	21,679	1,996	2,736 ha	26 large ruminants, 215 small ruminants
2006	Maradi, Dosso, Tillaberi, and Agadez	7,965	387	437 ha and 86 fields	7431 small ruminants, 896 cattle, 208 donkeys, 59 camels
2009	Northern Niger, Agadez region	99,900	6,261	424 ha	23,585 animals (mostly small ruminants)
2010	Niger River and Southern Niger	252,900	10,708	6,872 fields	115,114 animals (mostly small ruminants)

Sources: Dartmouth Flood Observatory Dartmouth University; Cellule de Coordination du Systeme d'Alert Precoce.

are washed away. The number of displaced people can also be high, especially where these floods affect urban areas.

Serious floods have been recorded in 9 of the last 30 years in Niger, a frequency of 0.30 (table 3.4). It is more difficult to get accurate information on the agricultural losses caused by flooding. Detailed records were not kept until quite recently and information is not recorded systematically where it is available. But available data suggest that the main direct financial cost of these floods is the result of damaged houses and buildings as well as livestock losses. Aggregate crop losses are of a lesser magnitude, as farm size is small. The indirect costs of flooding are likely to be much higher than direct costs, however, as people lose their livelihoods when they are displaced, in addition to the direct losses of crops and livestock.

3.2.5 Crop Pests and Diseases

The main crop pests and diseases are as follows:

- Insects: grasshoppers, leaf-hoppers, millet stem borer and head borer
- Diseases: downy mildew, smut, ergot
- Weeds: striga
- Pests: grain birds, rodents

There is no information on the level of damage and losses that these pests and diseases cause annually in Niger. Grasshoppers, leafhoppers, and grain-eating birds are known to cause high losses on an intermittent basis. There are annual government programs to spray for grasshoppers, but no programs to control bird damage. Striga and fungal diseases are perennial among most cereal and cowpea crops, although millet is naturally tolerant to striga. Farmers invariably complain about the losses caused by plant pest and diseases, but also acknowledge that they seldom use the chemical treatments available for prevention and treatment, claiming that they are too expensive. Overall losses from majority of these pest and diseases, barring the exception of grasshoppers, grain-eating birds, and millet borer, are frequent but relatively low.

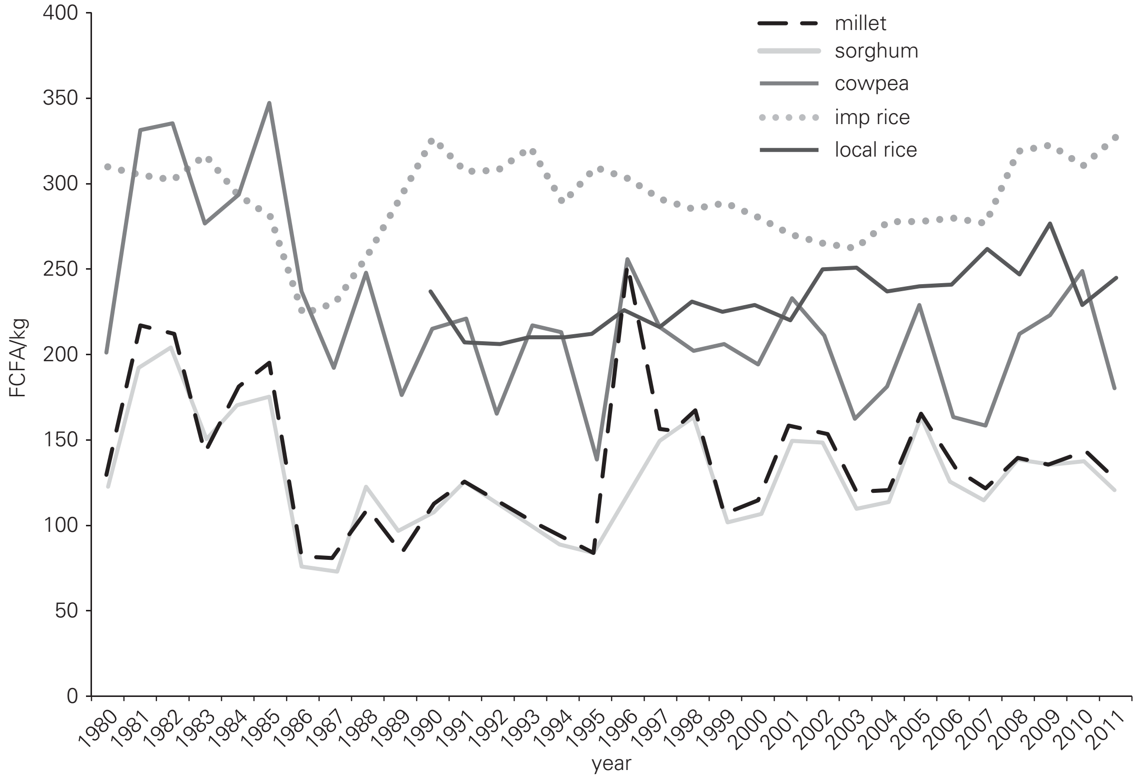
3.2.6 Bushfires and Windstorms

Fire is used to clear land for cultivation to improve grazing and facilitate hunting. Burn-offs also help control pests and diseases such as grasshoppers, locusts, ticks, anthrax, and livestock parasites. Burning poses a risk when fires get out of control. This risk is localized and highest in pastoral areas where rainfall is low and vegetation is dry,[26] and it leads to loss of pastures. Nonetheless, frequency of bushfires and its direct adverse impact on Niger's agricultural sector is low.

Windstorms pose a risk for agriculture when they occur at the beginning of the cultivation season, damaging young plants and forcing farmers to replant their crops (Programme d'Action National pour l'Adaptation [PANA], *op cit*). Direct damage to crop or livestock is minimal although sandstorms and dust storms cause soil loss and remove organic matter and the nutrient-rich lightest particles, thereby reducing agricultural productivity. Nonetheless, the overall impact of sandstorms and dust storms on the agricultural sector is limited.

26 Programme d'Action National pour l'Adaptation. *Identification et Evaluation des Phenomenes Extremes*. June 2005.

FIGURE 3.3: Real Cereal and Cowpea Prices



Source: SIMA.
1996 = 100.

3.3 MARKET RISKS

Long-term trends in agricultural commodity prices are reviewed initially to assess interannual price volatility, followed by an analysis of seasonal price movements. The analysis is based on consumer prices for millet, sorghum, local rice, imported rice, and cowpea as reported in local markets and producer prices for livestock. Ratios of millet to livestock prices are also analyzed to assess the volatility of changes in purchasing power. Real prices are used as the basis for analysis, deflated by the consumer price index. Crop price data are drawn from Système d'Information sur le Marché Agricole (SIMA) and Global Information and Early Warning System (GIEWS) and livestock price data from FAOSTAT.

3.3.1 Trends in Average Annual Cereal and Cowpea Prices

Trends in real average annual cereal and cowpea prices are illustrated in figure 3.3. Real millet, sorghum, and cowpea prices have all fallen significantly relative to the early 1980s (table 3.5). Most of this decrease occurred during the 1980s, followed by an increase in prices since the 1990s. The decrease in real millet and sorghum prices since 2005 indicates that the global food price crisis of 2007–08 had limited impact on prices for staple foods in Niger.

Local and imported rice prices exhibit differing trends (local rice prices are only available from 1990 onward). Imported rice prices follow world markets, falling steadily until 2008 when they rose by 13 percent in response to the global food price crisis. In contrast, local rice prices increased steadily from 1990 until 2008–09, and then decreased. Overall, the gap between imported and local rice prices has narrowed as rice consumption has increased.

Interannual price variability for all of the crops analyzed above is moderate, with coefficients of variation ranging from 0.31 for imported rice to 0.21 for local rice (table 3.5). Niger's free and active trade with Nigeria reduces the price fluctuations that would occur otherwise in response to fluctuations in domestic cereal and cowpea production. Millet and sorghum prices track each other very closely in terms of price level and price changes,[27] confirming that they are very close

27 The exception is an increase in millet prices in 1996, due to the combined impact of lower than average production and an 18 percent appreciation in the naira relative to the FCFA.

TABLE 3.5: Crop Price Trends and Characteristics: 1980–2011

	MILLET	SORGHUM	COWPEA	LOCAL RICE	IMPORTED RICE
Percent change 1980–90[a]	–42.3%	–37.6%	–29.5%	N/A	0.9%
Percent change 1990–2011[b]	25.0%	20.4%	6.6%	12.7%	3.7%
Percent change 1980–2011	–27.8%	–24.9%	–24.8%	N/A	4.7%
Coefficient of variation	0.30	0.25	0.28[c]	0.21[c]	0.31

Sources: SIMA; Author's calculations.
[a]Average for 1980–83 versus 1989–91.
[b]Average for 1989–91 versus 2009–11.
[c]Adjusted for trend using the Cuddy Delle-Valle Index.

substitutes. This ready access to close substitutes also helps to reduce price variability of staple foods. There is no indication that the level of interannual price volatility has increased or decreased over time.

The price spikes that are observed do not always coincide with major drought or other adverse events. Of the seven major drought shocks observed since 1980 (figure 3.2), sharp increases in real millet and sorghum prices are evident in 1997–98, 2000–01, and 2004–05. Cowpea prices rose sharply in 1984–85, 1995–96, 2000–01, 2004–05, and 2009–10. This characteristic is further evidence of the role of trade with Nigeria and other countries such as Benin in assuring food supply and reducing price variability.

Recent empirical work has shown that cereal markets in Niger are highly integrated (Akers, 2008 *op cit*), and that prices in different regional markets move in close unison. Hence, regional price trends are assumed to be similar to the trends observed for aggregate national prices. In fact, Akers finds that markets become even more integrated during drought years.

3.3.2 Livestock-Cereal Price Ratios

Livestock-millet price ratios provide an indication of changes in the purchasing power of pastoral households in response to adverse events. As livestock are frequently sold to buy food in periods of hardship, any change in the price of one or both can have major implications for household welfare. The marked interannual changes in these ratios in figure 3.4 below confirm this premise, although the changes are driven largely by changes in millet prices due to the limited variability of the livestock price series used.

Despite the data limitations, this ratio appears to be a more sensitive indicator of hardship than price movements alone. Reduced purchasing power is evident in 1996, 1998, 2000–01, and 2004–05. Note that the sharpest fall in purchasing power occurred in 1996, a year not considered as especially severe. Moreover, the ratio does not reflect the problems extant in 1993 as a result of drought and locusts. These two cases are pertinent in that they suggest first that price shocks can occur in the absence of drought, as in 1996, and second that drought is not always associated with price shocks, as in 1993.

3.3.3 Seasonal Price Movements

Closer analysis of seasonal price movements provides further insight into the nature of price variability. Analysis is based on monthly millet prices for Maradi—a large regional market center close to the Nigerian border and a major locus of poverty.[28] Analysis is based on monthly millet prices for the period January 1990 to December 2011. Real prices, deflated by the monthly consumer price index (CPI), are also used for January 2000 onward (monthly CPI data are not available before January 2000 due to a change in the basis for CPI calculation). These seasonal trends are presented in figure 3.5 below.

The following trends and characteristics are apparent:

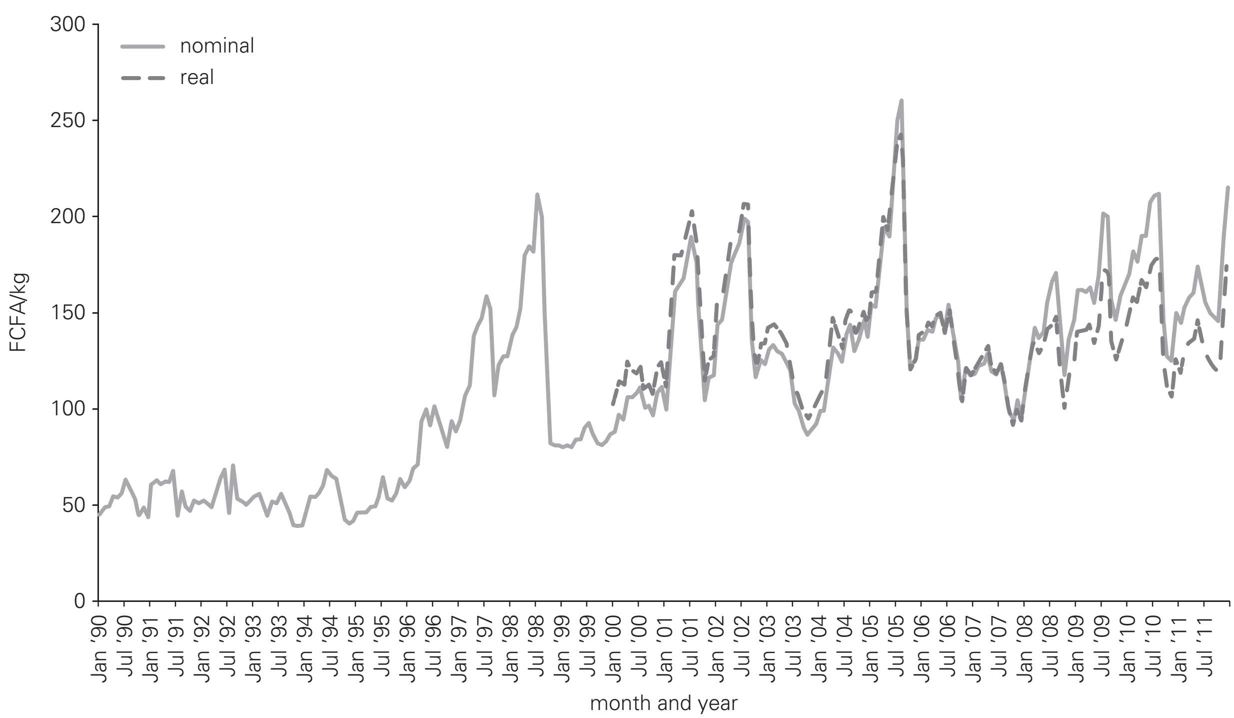
1. Major spikes in nominal prices occurred in 1998, 2001, 2002, 2005, 2009, and 2010. These spikes are also observed for real prices, although they are much less pronounced in 2009 and 2010.
2. The price spike in 2005 was the most severe. Price volatility has been much less pronounced since then.
3. Prices typically start to rise after the end of the harvest in January and peak in July and August. This prolonged period (6–7 months) of increasing prices is followed by a relatively short period (3–4 months)

28 With a poverty rate of 78 percent in 2010 and the highest regional population, Maradi accounts for approximately 25 percent of Niger's poor (World Bank, 2011 *op cit*).

FIGURE 3.4: Livestock-Millet Price Ratios (Meat)

Sources: FAOSTAT (livestock prices), SIM Agricole (millet prices).

FIGURE 3.5: Monthly Millet Prices, Maradi



Source: GIEWSS.

of rapidly falling prices, from July and August to October.

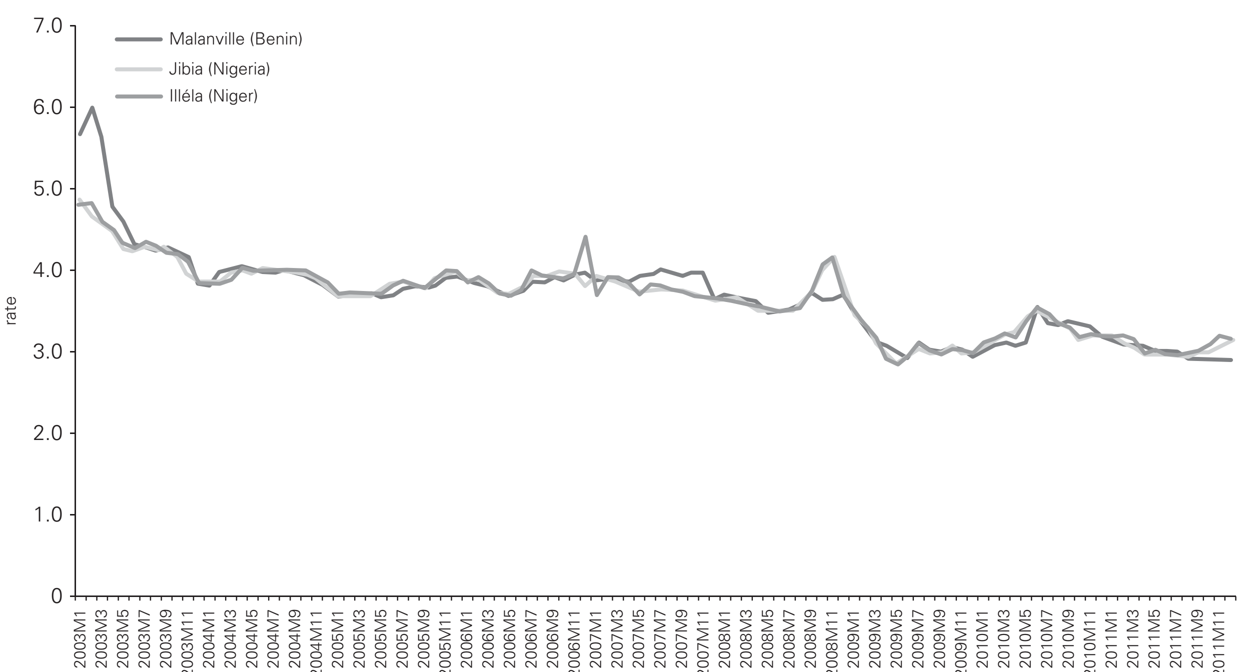
4. Closer scrutiny of the major price spikes shows that the pattern of seasonal price movements differs from other years in two ways: (i) the postharvest increase in prices starts earlier, lasts longer, and rises faster than in other years; and (ii) that the subsequent fall in prices is more rapid and slightly shorter than in other years. This increased asymmetry suggests that there is a significant window of time for intervention during the period of price increases, and that effective intervention can quickly reduce prices.
5. Other than in 2005, the observed price spikes occur in a sequence of two to three years (1996–98, 2001–02, 2008–10). The cumulative effect of these price spikes on low-income households may thus be as or more important than the year-specific impacts.

The strong association between seasonal price movements, the incidence of drought and other adverse events, and the hardship endured during these periods of adversity seem to confirm the growing consensus according to which reduced access to food, along with reduced food availability, may be the most critical impact of drought and locust attacks. High seasonal price spikes appear to be more closely and systematically associated with these events than interannual changes in production or prices. This suggests that there is scope to improve the effectiveness of targeted, subsidized cereal sales by starting interventions earlier in response to above average price increases, and by targeting this support on low-income households in areas served poorly by local and regional markets.

3.3.4 Exchange Rate Risk

Niger's heavy reliance on trade with Nigeria, for both agricultural exports (livestock, cowpeas) and imports (coarse grains), means that movements in the FCFA/naira exchange rate are a potential source of market risk. In fact, parallel market data from both sides of the border show that the FCFA/naira exchange rate is relatively stable (figure 3.6), with low adjusted coefficients of variation (0.06–0.08) for monthly exchange rates for the period January 2003 to October 2011. Moderate (5 to 15 percent) changes occur occasionally due to border closures, as in 2003 (presidential elections in Nigeria), 2005, and 2008 (food shortages in Niger); but these are short lived. Moreover, the Nigerian restrictions on foreign currency trade do not appear to restrict the parallel foreign currency market. This is attributed to the relatively open border between the two countries, active trade in both directions, and the preference of Nigerian people to hold the FCFA as a reserve currency rather than naira. Most other trade is with other FCFA countries in the UEMOA (Union Economique et Monétaire Ouest Africaine) region, which removes exchange rate risk.

FIGURE 3.6: Exchange Rate: FCFA/Naira (Parallel Market)



Source: SIMA.

The gradual appreciation observed in figure 3.6 is due to exogenous factors, namely the appreciation of the euro[29] and the higher level of inflation in Nigeria. This appreciation enhances Niger's capacity to import essential food commodities and energy, but reduces the competitiveness of agricultural exports. The reduction in competitiveness is beginning to be felt in coastal markets such as Abidjan where products from UEMOA are facing competition from Chinese products.

3.4 CONFLICTS

Rising pressures on common property resources, or on resources used within the bounds of customary law, have led to frequent conflicts over access to pasture and water within livestock herding groups, and between farmers and herders, often with significant loss of life. The first significant attempt to resolve this issue took place in the mid-1980s, with the advent of the Code Rural process, whose objectives were to (1) provide for better management of natural resources and (2) reduce conflicts. This was given a major boost by the implementation of the decentralization law of 2004, with the creation of various local commissions[30] at the village, commune, and departmental levels.

Literature review and in-field consultations reveal that conflicts among pastoralists have sharpened in marginal areas where local pastoral associations were unable to play a conflict prevention or resolution role. By the same token, conflicts between farmers and herders have mostly taken place in areas where local communities had failed to improve natural resource management, and where local (traditional and decentralized) conflict resolution mechanisms failed. Conversely, successful intermediation by heads of associations or traditional leaders[31] and significant improvements in the resource base appreciably reduced conflicts between farming and herding communities.[32]

3.5 INSECURITY

Insecurity has always been an issue for people moving valuable assets through large, unprotected spaces. Of late, the situation has seriously deteriorated, especially in the border areas of Mali, Libya, and Nigeria (Chad is an endemic problem). The combination of rebellion, banditry, and even terrorism exposes herding families and their assets to greater danger. Insecurity in these areas also sharply curtails the extent to which government services and national and international nongovernmental organizations (NGOs) can intervene, or merely collect basic information. Furthermore, insecurity:

- Induces population movements (this is one of the main risks covered in Niger's contingency plan). These place additional heavy burdens on local populations, government resources, and the natural resource base (e.g., the recent influx of refugees from Mali).
- Invariably fosters vicious cycles. For instance, the disruption of law and order and inflows of armed groups and weapons from conflict-affected neighboring countries usually heighten existing domestic tensions or conflicts. It can also increase opportunities for illegal activities.
- Finally, insecurity discourages foreign direct investment and places a prohibitive risk on domestic ones. In particular, the development of critical sectors on which future growth expectations are based, such as oil and uranium, cannot take place in an insecure environment.

The largest adverse impact is on trading community and herders engaged in transhumance, but the overall direct short-term impact on the broader agricultural sector being relatively small.

3.6 MACROECONOMIC SHOCKS IN NIGERIA

Nigeria is the major trading partner of Niger and because of its size and generally stronger effective demand, it has been the major market for Niger's agricultural exports, in particular livestock and cowpeas. It has also been in the past an important source of fertilizer, mostly through informal channels, and fuel. Overall trade with Nigeria is critical for Niger to stabilize prices and supplies; however, at times, shocks in Nigeria, for example, political uncertainly, violent conflicts, droughts, and changes in macroeconomic policies, have a destabilizing impact on Niger's agricultural sector, in terms of volatility in demand and supply of agricultural products. Unexpected changes in trade agreements or policy implementation, such as import restrictions on basic commodities (e.g., rice) or export restrictions (e.g., 2004–05), can reduce Niger's ability to manage supply shocks caused due to production risks;

29 The FCFA is fixed to the euro at a rate of 1 euro = 655.957 FCFA.

30 *Commissions foncières départementales* (CofoDep); *Commissions foncières communales* (CofoCom); *Commissions foncières de base* (CofoB), and so on.

31 Zakara and Abarchi, 2007.

32 Comité Inter-Etate pour la Lutte contre la Sécheresse au Sahel *(French: Permanent Inter-State Committee for Drought Control in the Sahel) and* Centre for International Cooperation (*CIS*), 2009.

however, in the past, their impacts have been moderate and short lived.

3.7 POLITICAL INSTABILITY AND REGULATORY RISKS

Niger has had a tumultuous political history. The first two republics spanned a 30-year political era of single-party rule and military juntas (1961–1991). Various types of governments were in power over the next 20 years, until the recent advent of the seventh republic through free democratic elections (March 2011). There have been four *coups d'état* since independence (1974, 1996, 1999, and 2010) and two major periods of Tuareg/Toubou rebellion (1990–95 and 2007–08). Niger has witnessed two transitional governments, each lasting over a year. This political instability contributed to frequent changes in policy and institutional environment.

This instability, especially the period of transitional governments, led to rapid deterioration of the economy. In 1992, it resulted in reduction of GDP growth rate by 7 percent, while in 1999 the decline was 1 percent. The impact on the agricultural sector, however, was much less pronounced and more indirect and might include: (1) reduced access to particular regions, which means that rural markets are more restricted, food prices rise, and aid can't get through (This is more critical in food deficit areas, but its aggregate impact depends on how important the region is for food production and as a trade corridor.); (2) reduced public and private investment in response to higher levels of uncertainty; (3) the diversion of public expenditure to military purposes to the detriment of other public services; and (4) loss of donor support. Political instability may have a bigger impact on the agriculture sector when it coincides with other shocks like drought (e.g., 1995–97). Political instability induces changes in government priorities and contributes to volatility in agricultural sector funding.

3.8 INTERLINKAGES BETWEEN RISKS

While the individual risks described above are significant threats to the agriculture sector, it is important to understand interlinkages between these risks. There are some specific dimensions of agricultural risks that need special attention.

3.8.1 Independent Risks Occurring Simultaneously

Flood and drought are usually considered as two independent risks; however, there are instances when both these events affect the country in the same year (e.g., 2009). Similarly, drought and locusts are taken to be two independent events, although dry climatic conditions favor both; but in 2004, Niger suffered big losses due to simultaneous occurrence of both these risks. Simultaneous occurrence of multiple risks has led to most devastating crises in Niger and needs to be monitored closely.

3.8.2 Dependent Risks

Drought is the principal trigger that leads to sudden spikes in commodity prices; however, price volatility can also be caused by sudden supply deficits due to other production shocks, exchange rate risks, or import and export restrictions by neighboring countries. Drought also creates fodder scarcity, thereby contributing to and intensifying conflict risk between herders and farmers, as well as making animals more susceptible to diseases. Grain-eating birds and grasshoppers are usually reliant on pastures to meet their food requirements; however, fodder scarcity during drought forces them to move to cultivated areas, causing severe damage to mature crops. These interdependencies between different risks need careful attention to ensure that the combined problem, rather its separate symptoms, is being addressed.

3.8.3 Regional Shocks

Due consideration needs to be given to regional systemic risks (e.g., regional droughts such as 1973 and 1984) and regional locust invasions (as in 1988), which can severely impair people's ability to cope with risks in Niger. Regional events can severely curtail the ability to respond to a crisis by markets, governments, and other actors' (e.g., 2004), and can cause grave suffering to people across the region.

3.8.4 Management of One Risk Creating Another Risk

Action by individual actors in the supply chain or governments of neighboring countries to manage their own risks could severely curtail the ability of other stakeholders to manage risk. In the past, action by individual countries, for example banning of grain exports by Mali and Burkina Faso in 2004 and border closures by Nigeria (2005) reduced the flow of grains and led to further increase in prices, restricting Niger's ability to cope with the drought shock or a sharp increase in food prices.

3.8.5 Differential Impact of Risk

Finally, the location and timing of risk has different impacts. The 2009 drought, owing to its prevalence in the rangeland and forage area, was a catastrophic event for the livestock population, while the 2011 drought was more severe for crop production. This more granular distinction of risk will help in identifying the relevant affected population and selecting appropriate measures to risk management.

Brief discussion of the impact of a serial succession of shocks might also be useful here. The combination of political instability and drought in the mid-1990s for example, and the succession of droughts during the 1980s and the successive years of higher and higher seasonal price peaks for cereals are other examples. The higher rainfall since the late 1990s has reduced the incidence of such successive shocks and replaced it with a combination of droughts and floods, but the possibility is still there.

Chapter 4: ADVERSE IMPACT OF AGRICULTURAL RISKS

The conceptual and methodological basis used for analysis is outlined first, then applied to production and market risks. The various sources of risk are then prioritized on the basis of expected loss estimates.

4.1 CONCEPTUAL AND METHODOLOGICAL BASIS FOR ANALYSIS

For the purposes of this study, risk is defined as an exposure to a significant financial loss or other adverse outcome whose occurrence and severity is unpredictable but for which some probability of occurrence can be estimated on the basis of historical experience. Risk, thus, implies exposure to substantive losses, over and above the normal costs of doing business. In agriculture, farmers incur small losses each year due to unexpected events such as suboptimal climatic conditions at different times in the production cycle and/or modest departures from expected output or input prices. Risk refers to the more severe and unpredictable adverse events that occur beyond these smaller events.

4.1.1 Loss Thresholds

As agricultural production is inherently variable, the first step for analysis is to define loss thresholds, which distinguish adverse events from smaller, interannual variations in output. This is achieved by first estimating a time trend of expected production in any given year, based on actual production, and treating the downside difference between actual and expected production as a measure of loss. Loss thresholds are then set for these downside deviations from trend, to distinguish between losses due to adverse events and those that reflect the normal costs of doing business in an uncertain environment. Two thresholds are used to represent differing levels of severity: severe losses and catastrophic losses. These below-threshold deviations from trend allow quantitative analysis of the frequency, severity, and cost of loss over a given time period.

For purposes of analysis, the threshold for severe losses was set at more than 0.33 standard deviation from trend, and catastrophic losses at more than 0.66 standard deviation from trend. These thresholds captured the various levels of known adverse events during the period of analysis.

4.1.2 The Indicative Value of Losses

Available data on actual losses due to adverse events are not always accurate or consistent enough to facilitate comparison and ranking of the costs of these events. Analysis was thus based on estimates of the indicative value of losses, which provide a more effective basis for comparison. While these estimates draw on actual data as much as possible, they do not represent actual losses. Indicative loss values are also compared to agricultural GDP in the relevant year in order to provide a relative measure of the loss.

Indicative losses were calculated as follows:

For **production risks**, the total value of gross agricultural output (GAO) los" for each event was first calculated in FCFA as the difference between the actual and trend values of the relevant crop or crops, using real producer prices (2010 = 100). The proportion of this total loss value in excess of the threshold for trend production losses was deemed to represent the loss attributable to the adverse event. The resultant value was also converted into $US at 2010 exchange rates. Note that this measure reflects the combined impact of interannual changes in both production and price. Comparable deviations from trend can thus translate into quite different levels of indicative loss, depending on the extent to which production falls and prices change.

Production risks were analyzed only for crops as the available livestock data were considered inadequate. Preliminary analysis based on available livestock data showed that severe livestock losses were observed in 1995 and 1998 only, and that the level of loss in these two years was relatively low. However, actual livestock losses are known to be more severe and more frequent. As in many countries, reported annual livestock numbers and production in Niger are based on a series of coefficients, which remain fairly constant irrespective of actual production conditions. Hence, livestock

TABLE 4.1: Frequency, Severity, and Cost of Adverse Events for Crop Production

YEAR	PERCENT DEVIATION OF PRODUCTION FROM TREND[a]	INDICATIVE LOSS VALUE[bc] (2010)			CONTEXT
		FCFA (m)	$US (m)	PERCENT Ag GDP	
1995	–23.2%	–41,382	–122.1	–24.1%	Drought, localized locust attacks, political uncertainty
1996	–13.6%	–12,504	–35.0	–6.2%	Political uncertainty
1997	–23.1%	–49,892	–135.8	–23.7%	Drought
2000	–9.1%	–4,159	–10.8	–1.4%	Drought
2004	–17.2%	–50,920	–125.3	–11.6%	Drought, locusts
2005	–7.0%	–1,827	–4.2	–0.3%	Low rainfall
2009	–10.4%	–27,244	–55.6	–3.1%	Drought, floods
FREQUENCY OF ADVERSE EVENTS					
Severe	4/20				
Catastrophic	3/20				

Sources: FAOSTAT; Author's calculations.
[a]Estimated as a linear regression by ordinary least squares.
[b]Calculated as the value of actual minus trend production, less the threshold for normal losses from trend.
[c]In 2010, values based on real FCFA prices (2010 = 100), and $US/FCFA exchange rates for 2010.

production losses due to drought or disease are not adequately captured.

For **price risks**, the trend level of production for the relevant crop was used as the point of reference. The total loss due to a price fall was then calculated in (current) FCFA as the difference between GAO at trend prices minus GAO at actual prices, and the remainder of the calculation was derived as for production risks. The use of trend production (rather than actual production) as the basis for analysis allowed the loss due to adverse price events to be calculated independently of losses due to an adverse fall in production.

4.1.3 Data

Analysis of this nature requires a consistent set of data on both production and prices, for an extended time period, with a reasonable level of disaggregation. Of the various sources of data available, FAOSTAT's data series on the value of gross agricultural production (1991–2009) was the most suitable. This series facilitates analysis of risk over a 19-year period, which was increased to 20 years on the basis that 2010 was a record year for agricultural production (with no consequent production shocks). National level data on the main crops are available from 1980 onward, but there are no parallel data on producer prices, and production data are patchy for most cash crops.

The derivation of adverse events and indicative losses, based on the methodology outlined above, is purely quantitative. The attribution of these downside deviations to actual adverse events was based on qualitative information on the incidence and magnitude of known events drawn from official reports, media accounts, and interviews with stakeholders.

4.2 CROP PRODUCTION RISKS

Measured in terms of gross agricultural value,[33] crop production was significantly reduced seven times by adverse events from 1991–2010, an overall frequency of 0.35 (table 4.1). Three of these events were catastrophic, with a frequency of 0.15. Most of these adverse events resulted in a 10 to 20 percent fall from underlying production trends. Indicative losses were high for the catastrophic events, as would be expected, whether measured in financial terms or as a percentage of agricultural GDP.

Drought was the main cause of these shocks, sometimes, in combination with other events. It was also the main cause of two of the three catastrophic events (1997 and 2004). A severe, continuous period of hardship occurred from 1995–97 in response to the combination of drought and political uncertainty. The cumulative impact of multiple, successive shocks such as these is devastating, and beyond the resources of most low-income countries to manage. The lesser shocks in 1996, 2000, and 2009 reflect lower level droughts and the political uncertainty during 1995–96. Note also that the lower

33 Aggregate value of volume of production for each crop times producer price.

TABLE 4.2: Frequency, Severity, and Cost of Adverse Events for Millet Production

YEAR	PERCENT DEVIATION OF PRODUCTION FROM TREND[a]	INDICATIVE LOSS VALUE[bc] (2010)			CONTEXT
		FCFA (m)	$US (m)	PERCENT Ag GDP	
1995	–19.7%	–17,897	–53	–10.4%	Drought, localized locust attacks, political uncertainty
1996	–26.9%	–30,985	–87	–15.3%	Political uncertainty
1997	–24.5%	–28,872	–79	–13.7%	Drought
2000	–13.4%	–12,754	–33	–4.2%	Drought
2004	–20.0%	–31,184	–77	–7.1%	Drought, locusts
2005	–6.0%	–831	–2	–0.1%	Low rainfall
2009	–12.4%	–18,911	–39	–2.2%	Drought, floods
FREQUENCY OF ADVERSE EVENTS					
Severe	3/20				
Catastrophic	4/20				

Sources: FAOSTAT; Author's calculations.
[a]Estimated as a linear regression by ordinary least squares.
[b]Calculated as the value of actual minus trend production, less the threshold for normal losses from trend.
[c]In 2010, values based on real FCFA prices (2010 = 100), and $US/FCFA exchange rates for 2010.

level drought in 1993 did not result in a fall in production below the threshold for adverse events.

4.2.1 Major Cereal Crops

Millet and sorghum are the staple foods in Niger, accounting for 45 to 50 percent and 10 to 12 percent of the value of gross agricultural output, respectively (FAOSTAT). The characteristics of shocks to millet production follow the same general pattern as for overall crop production (table 4.2), consistent with its high contribution to total crop production.

Sorghum production exhibits a higher frequency of catastrophic shocks (0.25), consistent with its lower tolerance to drought (table 4.3). The overall incidence of shocks is also higher (0.40). But the indicative costs of adverse events are much lower, due to sorghum's lower contribution to the aggregate value of crop production.

The slightly higher frequency of adverse events for individual crops relative to that for all crops combined also indicates two important characteristics of agricultural risk in Niger: first, that the diversification of crops grown does reduce risk, and second, that this potential advantage remains limited, since millet still dominates production.

4.3 CROP PRICE RISK

The methodology used to examine adverse price events captures the impact of price change alone, by using trend rather than actual production as the basis for analysis (section 4.1.2). This methodology was applied to producer prices for millet, sorghum, groundnut, fonio, sesame, and onions for the period 1991–2009 (there were no producer price data for cowpeas). Results of this analysis elicited only one adverse price event—for millet in 2007 (table 4.4). The indicative loss of this price shock was relatively low.

Ostensibly surprising, this low incidence of adverse price shocks is actually consistent with the low interannual variability of the producer price data during the period of analysis. Coefficients of variation (adjusted for trend) ranged from 0.13 for millet down to 0.04 for sesame seed (for nominal prices). It is unclear whether the low level of variability for producer prices corresponds to actual trends during the period of analysis or reflects weaknesses in the data. For instance, somewhat higher levels of variability were observed for consumer prices for these commodities in the analysis in chapter 2. But, overall, these results are consistent with the high level of activity in local and regional markets in Niger, the growing evidence of strong market integration both internally and within the region, and the relatively free and active trade with neighboring Nigeria, Benin, Cote d'Ivoire, and Ghana. Strong, active markets invariably help minimize price variability.

The limited apparent impact of interannual price variability on agricultural sector risk does not mean that price variability is not an issue. The analysis examines downside deviations and the risk of these deviations to producers. Upside deviations,

TABLE 4.3: Frequency, Severity, and Cost of Adverse Events for Sorghum Production

YEAR	PERCENT DEVIATION OF PRODUCTION FROM TREND[a]	INDICATIVE LOSS VALUE[bc] (2010)			CONTEXT
		FCFA (m)	$US (m)	PERCENT Ag GDP	
1995	–37.7%	–9,151	–18	–3.7%	Drought, localized locust attacks, political uncertainty
1996	–18.6%	–1,452	–3	–0.5%	Political uncertainty
1997	–36.2%	–10,524	–21	–3.7%	Drought
1998	–18.7%	–2,746	–6	–0.6%	Unidentified
1999	–22.0%	–5,263	–11	–1.3%	Unidentified
2000	–40.4%	–16,226	–33	–4.2%	Drought
2004	–19.9%	–7,165	–14	–1.3%	Drought, locusts
2009	–21.5%	–9,887	–20	–1.1%	Drought, floods
FREQUENCY OF ADVERSE EVENTS					
Severe	3/20				
Catastrophic	5/20				

Sources: FAOSTAT; Author's calculations.
[a]Estimated as a linear regression by ordinary least squares.
[b]Calculated as the value of actual minus trend production, less the threshold for normal losses from trend.
[c]In 2010, values based on real FCFA prices (2010 = 100), and $US/FCFA exchange rates for 2010.

TABLE 4.4: Frequency, Severity, and Cost of Adverse Price Events for Crops

YEAR	PERCENT DEVIATION OF NOMINAL PRICE FROM TREND[a]	INDICATIVE LOSS VALUE[bc] (2010)		
		FCFA (m)	$US (m)	PERCENT Ag GDP
2007	–9.6%	–3,051	–6.2	–0.4%
FREQUENCY OF ADVERSE EVENTS				
Severe	1/19			
Catastrophic	0/19			

Sources: FAOSTAT; Author's calculations.
[a]Estimated as a linear regression by ordinary least squares.
[b]Calculated as the value of actual minus trend production, less the threshold for normal losses from trend.
[c]In 2010, values based on real FCFA prices (2010 = 100), and $US/FCFA exchange rates for 2010.

particularly sharp seasonal price spikes are a major risk for low-income consumers, as discussed in chapter 3.

4.4 LOCUST ATTACKS

Estimates of the indicative crop losses from locust attacks were based on the assumption that 50 percent of the area sprayed was grazing land and 50 precent was crop land. Production losses were calculated in 2010 prices based on the average millet yield for the relevant year multiplied by the millet producer price for 2010.

Significant locust attacks (defined as those resulting in spraying of more than 5,000 hectares) occurred six times from 1980–2010 (table 4.5). Two of these attacks (in 1988 and 2004)

TABLE 4.5: Frequency, Severity, and Estimated Costs of Locust Attacks

	AREA SPRAYED (ha)	ESTIMATED CROP AREA LOST (ha)	INDICATIVE LOSS[a] ($US m)
1980	110,000	55,000	4.3
1986	65,000	32,500	2.4
1987	27,500	13,750	0.8
1988	750,000	375,000	32.8
1995	9,500	4,750	0.3
2004	350,000	175,000	11.1

Sources: FAO Locust Updates; Author's calculations.
[a]$US/FCFA exchange rate for 2010.

TABLE 4.6: Frequency, Severity, and Estimated Costs to Agriculture of Floods

YEAR	CROPS		LIVESTOCK	
	AREA (ha)	INDICATIVE LOSS ($US m)	LIVESTOCK LOST	INDICATIVE LOSS ($US m)
1988	7,500	0.66	No data	No data
1994	No data	No data	No data	No data
1998	9,196	0.72	1,254 large ruminants, 6,544 small ruminants	0.65
1999	2,736	0.20	26 large ruminants, 215 small ruminants	0.02
2005	446	0.04	7,431 small ruminants, 896 cattle, 208 donkeys, 59 camels	0.70
2007	2,210	0.17	215 small ruminants	0.01
2008	55	0.01	20 small ruminants	No data
2009	424	0.03	23,585 (all animals)	2.08
2010	687	0.06	115,114 (all animals)	10.17
Average		0.24	Average	1.95

Sources: Dartford Flood Observatory; Cellule de Coordination du Système d'Alert Précoce; Author's calculations.

had catastrophic results. This represents a frequency of 0.20 for all attacks and 0.07 for catastrophic attacks. The average indicative loss for all locust outbreaks was $8.6 million, an amount raised significantly by the two catastrophic attacks in 1988 and 2004. For the four lesser (severe) outbreaks, the average loss was $1.95 million.

While the crop production losses are high, the ex-post cost of controlling the outbreak is also high. In 2004, approximately $11 million[34] was spent in Niger to control the outbreak. But the cost for the region was much higher, with an estimated $400 million spent to control the outbreak for all of the Sahel countries in 2004–05, including some 13 million liters of (mostly organo-phospate) pesticides.[35] According to FAO/EMPRES and the Commission for Controlling the Desert Locust in the Western Region (CLCPRO) estimates, this amount could have paid for the equivalent cost of 170 years of prevention activities. Preventive measures are much cheaper. Niger currently spends approximately $400,000 annually on regular locust monitoring, detection, and early control.

4.5 FLOODS

Floods are a medium frequency (0.3) event, with low direct losses in terms of crops destroyed and livestock lost (table 4.6).

The available data show that indicative losses for livestock are 10 times higher than for crops, suggesting that affected households can lose a significant part of their asset base in addition to their immediate source of food. As for locusts, the calculation of indicative losses was based on price and (millet) yield data for 2010.

4.6 EXPECTED LOSSES AND RISK PRIORITIES FOR CROP PRODUCTION

Results of the preceding analysis can be summarized in terms of the expected loss associated with the main risks to crop production (figure 4.1). The frequency of each risk is based on its occurrence during the past 20 to 30 years, and the associated loss is estimated as the average of the indicative costs for each type of risk during the period of analysis.

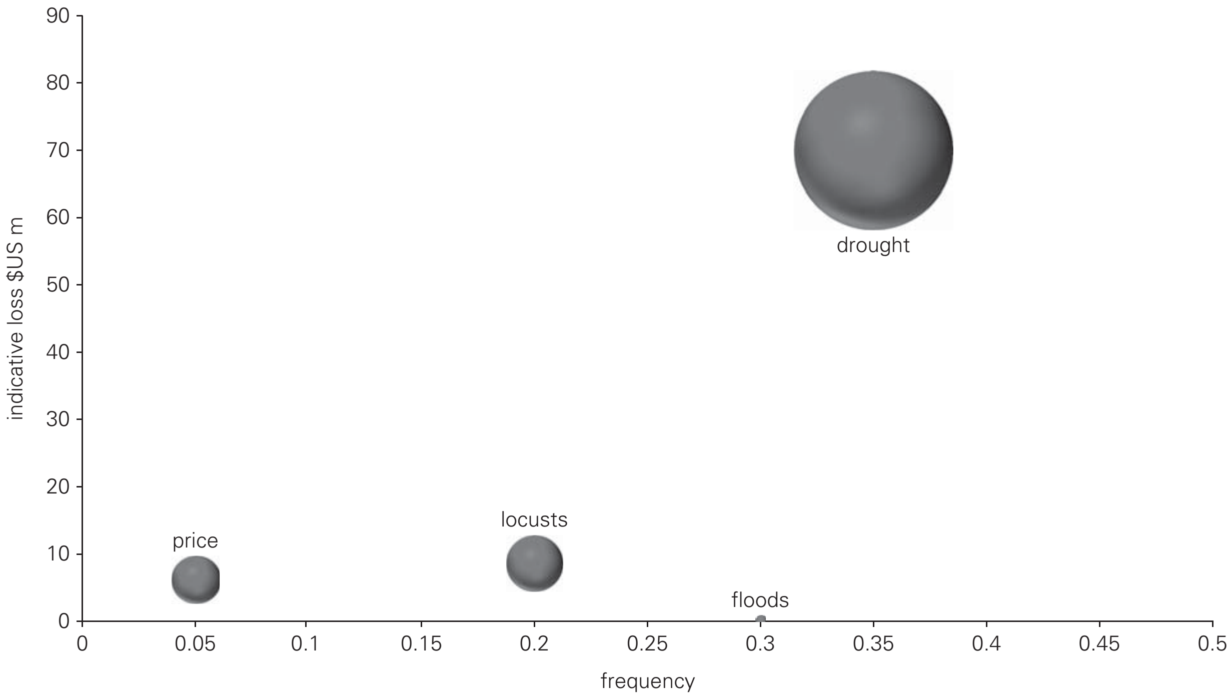
The pre-eminence of drought as the major source of risk is clear. It surpasses all other sources of risk in terms of both frequency and cost. Locusts emerge as the next most important source of risk (even without an accounting of losses to the livestock subsector), followed by producer price risk and floods.

Two further conclusions emerge from this analysis. The first is the high frequency of adverse shocks to agriculture, in one form or another (figure 4.2). Adverse events of varying degrees have affected crop production in 11 of the past 20 years. Four of these shocks have been catastrophic. In a country as poor and risk prone as Niger, it is not enough to just identify the most important risk or risks to address, and to strengthen the capacity to manage such risks. This capacity must also be built to manage a constant stream of adverse events, of differing types and differing magnitudes, often in combination.

34 In 20 countries, 130,000 square kilometers of area were treated at the cost of $400 million, averaging $3,076 per square kilometer. Total area treated in Niger was approximately 3,750 square meters (375,000 hectares), with an average cost of $3,076 per square kilometer, and therefore the cost of locust control in Niger comes out to approximately $11.5 million.

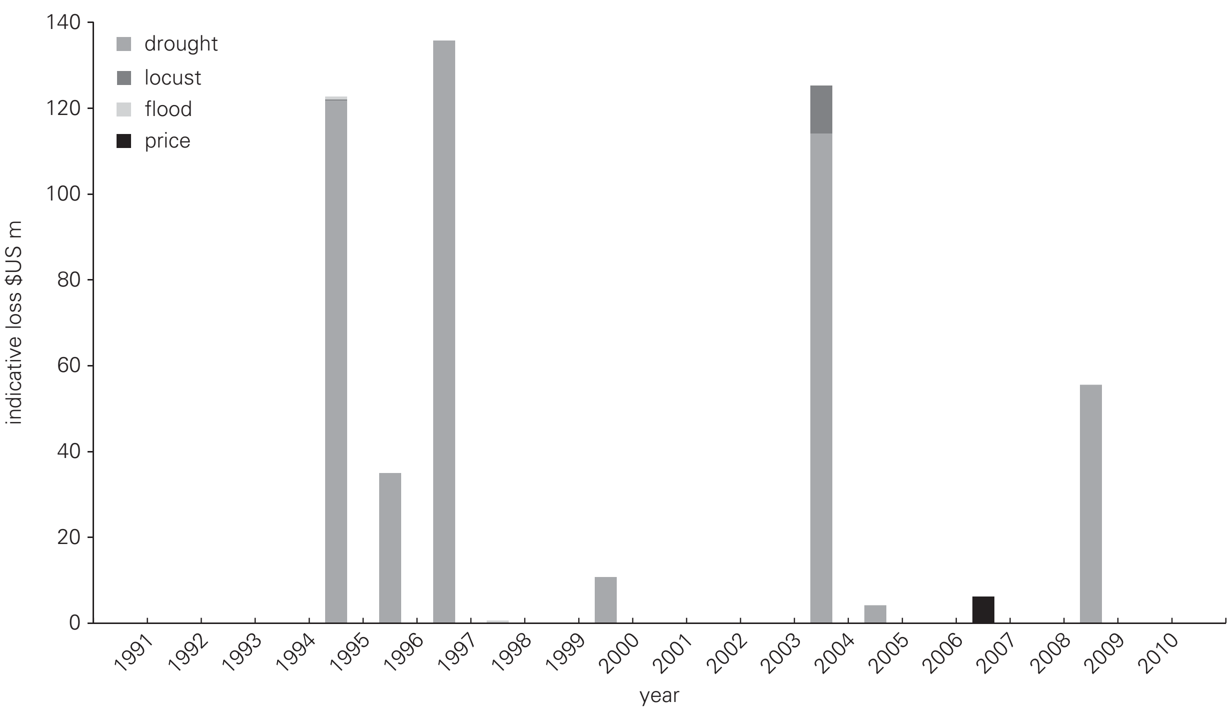
35 Mohamed Lemine Ould Ahmedou. 2012; *Plan national de gestion du risque acridien.* Government of Niger. 2011.

FIGURE 4.1: Expected Average Loss for Adverse Crop Production Events



Source: Author's calculations.

FIGURE 4.2: Chronology of Adverse Crop Production Events



Source: Author's calculations.

TABLE 4.7: Losses to the Livestock Sector

YEAR	EVENT	COMBINED IMPACTS OF WEATHER RISKS AND LIVESTOCK DISEASES
1973–74	Generalized drought in the Sahel countries	It is estimated that Niger lost 45% of cattle, 27% of sheep, and 15% of goat as a result of drought of 1973.[a]
1984–85	Generalized drought in the Sahel countries.	It is estimated that Niger lost 40% of cattle, 35% of sheep, and 33% of goat as a result of drought of 1984.[a]
2004–05	Combination of drought and desert locust invasion with a high impact on grazing areas	Losses to the livestock sector were estimated at 20% for cattle and 13% for small ruminants in sample parts of the agro-pastoral zone.[b]
2009–10	Combination of drought and loss of pasture with subsequent heavy rains and flooding	In the sample area of a study on the impact of this crisis (14 departments of 7 regions in the pastoral and agro-pastoral zones), livestock mortality rates were estimated at 25.5% for cattle, 38.6% for sheep, 31.3% for goats, and 2.6% for camels.[c].

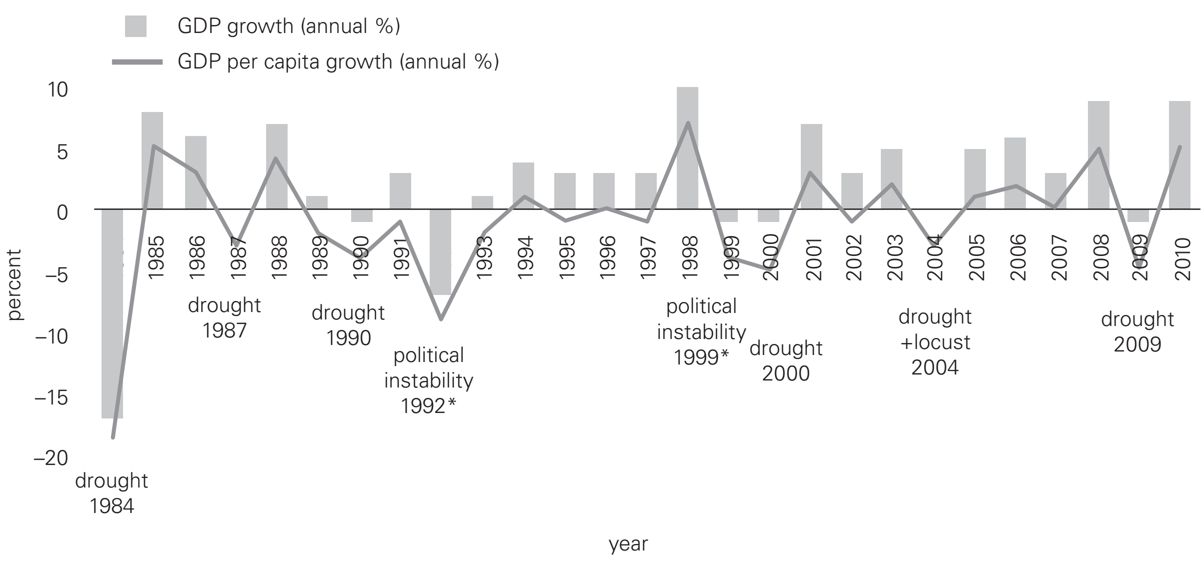
[a] Analysis of livestock statistics data from Institut National de Statistique. *Annuaire Statistique des Cinquantes Ans d'Independence du Niger*. Edition Speciale. Novembre 2010.
[b] Charasse and Gouteyron, 2005.
[c] The study breaks down the livestock mortalities due to the various risks associated with a drought and other weather events in 2009: lack of forage due to drought (38%), diseases (35%), heavy rains and floods (23%), and lack of water (4%), although the actual percentages were clearly different in the northern part of the pastoral zone and the southern fringes of the agro-pastoral one.

The second conclusion is the implication of political instability for agricultural production and the management of agricultural risk. The period from 1995–96 was a period of deep, continuous shocks to agricultural production, even though production conditions were not unduly harsh. The country and its population were thus poorly prepared for the drought in 1997. Three consecutive years of extreme hardship thus occurred.

4.7 LOSSES TO THE LIVESTOCK SECTOR DUE TO MAJOR DROUGHTS

Considering data limitations, it is difficult to quantify the losses to the livestock sector. However, based on secondary data, table 4.7 attempts to illustrate potential losses to the livestock sector from major droughts. From the herders' point of view, the worst years are those when droughts lead

FIGURE 4.3: Annual GDP Growth and GDP per Capita



Sources: World Development Indicators Database, 2012; and Author's calculations.
*1992 political instability (transitional government November 1991–April 1993)[36] and 1999 political instability (assassination of President Ibrahim Bare' Mainassare).[37]

36 President Ali Saibou's regime acquiesced to demands for elections, and a transitional government was installed in November 1991 to manage the affairs of state until the institutions of the Third Republic were put in place in April 1993. The economy deteriorated over the course of the transition, leading to a fall in GDP in 1992.

37 In April 1999, President Baré Mainassare was assassinated in a coup led by Major Daouda Malam Wanke, who established a transitional National Reconciliation Council to oversee the drafting of a constitution for a Fifth Republic. The Nigerien electorate approved the new constitution in July 1999 and held legislative and presidential elections in October and November 1999. The council transitioned to civilian rule in December 1999; however, the period of transitional government, similar to 1992, had severe consequences for the economy.

to poor animal conditions, low livestock prices, and high grain and other basic food prices. This was the case in 2004, 2009, and to a lesser extent, 2011. Loss frequency is 0.1 (four events in 40 years).

4.8 IMPACT OF AGRICULTURAL RISKS ON NATIONAL GDP

Besides impacting agricultural production, consequences of agricultural risks are far wider affecting foreign exchange earnings, GDP growth rate, per capita income, loss of revenue to the government, and requiring substantial financial resources for crisis management. Figure 4.3 demonstrates the volatility of national GDP growth rate and per capita growth rate in Niger over a period of 26 years (1984–2010). GDP growth rate was negative, or zero, in 8 out of 26 years analyzed. There is strong correlation between drop in GDP growth rates and occurrence of risk events. Two of these drops could be largely attributed to political instability, characterized by long duration of transitional government, crippling the decision making while six of these drops can be partly explained by droughts in those years.

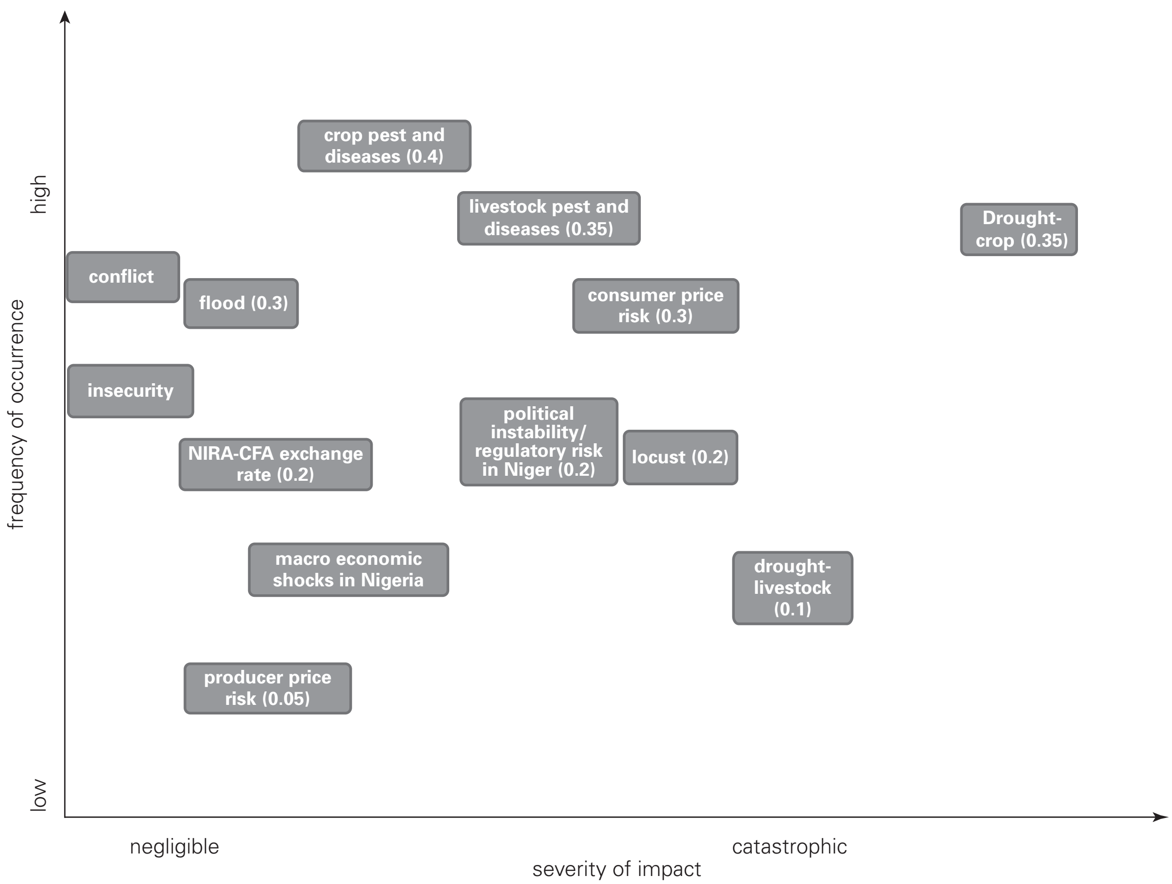
Chapter 5: RISK PRIORITIZATION AND MANAGEMENT

5.1 RISK PRIORITIZATION

To better utilize scarce resources, it is important to understand which risks, or subset of risks, are causing maximum losses, and at a much greater frequency. Figure 4.1 in the previous chapter highlights the priority risks, using quantitative measures, for the crop subsector. Due to the paucity of data, some of the risks could not be quantified; however, figure 5.1 combines qualitative and quantitative measures, based on the assessment team's evaluation, to prioritize major risk for the entire agricultural sector, both livestock and crops. This analysis highlights six priority risks: (1) drought (crops), (2) drought (livestock), (3) locust outbreaks, (4) consumer price risk, (5) livestock diseases, and (6) political instability.

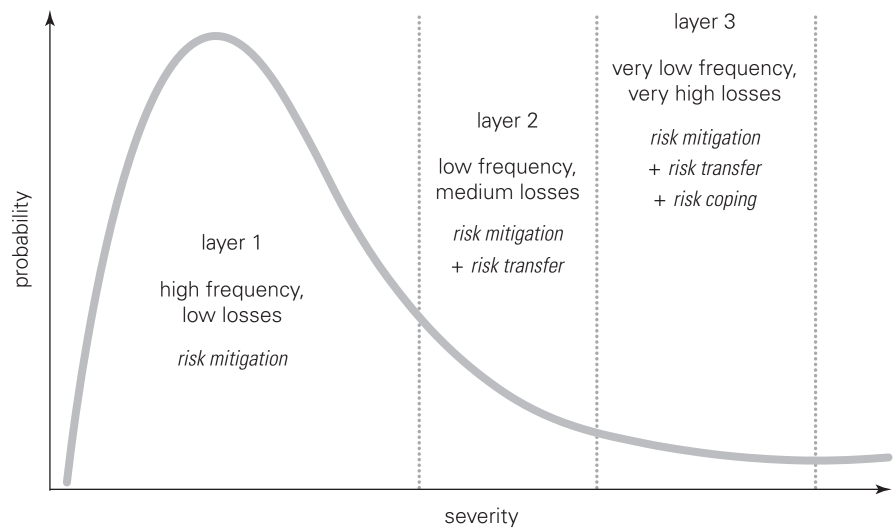
The relative significance of these risks to different livelihood practices vary and annex 3 summarizes the principle risks for major livelihood groups. From a macroperspective, among the top five risks identified, the capacity to manage risk is currently high for locust outbreaks, due to recent actions

FIGURE 5.1: Risk Prioritization



Source: Author's calculations.
Note: Figure in parenthesis denotes the frequency of adverse events based on tabulation of past events. In many cases (insecurity, conflict, macroeconomic shocks), the team was unable to tabulate the historical occurrence and their prioritization is based on subjective assessment. Sandstorms and bushfires were of minor significance for the agriculture sector and therefore was not including in this prioritization exercise.

FIGURE 5.2: Risk Layering Approach



Source: World Bank; Agricultural Sector Risk Assessment Brochure (2012) of the Agricultural Risk Management Team of the World Bank

taken by the government of Niger and other stakeholders. Capacity to manage drought, political instability, crop pest and diseases, livestock pests and diseases, and consumer price volatility is relatively low and therefore, this section concentrates on management of these risks.

There is no silver bullet to manage any given risk. Effective risk management typically requires a combination of measures, some designed to remove underlying constraints and others designed to directly address the risk. Resource availability will often determine what is possible, and integrated risk management programs are often more effective than stand-alone programs. Risk management measures could be classified into the following three categories:

- *Risk mitigation (ex ante).* Actions designed to reduce the likelihood of risk or to reduce the severity of losses (e.g., water harvesting and irrigation infrastructure, crop diversification, extension).
- *Risk transfer (ex ante).* Actions that will transfer the risk to a willing third party. These mechanisms usually will trigger compensation in the case of a risk-generated loss (e.g., purchasing insurance, reinsurance, financial hedging tools).
- *Risk coping (ex post).* Actions that will help the affected population cope with the loss. They usually take the form of compensation (cash or in-kind), social protection programs, and livelihood recovery programs (e.g., government assistance to farmers, debt restructuring, contingent risk financing).

A risk layering approach (figure 5.2), based on probability of occurrence and potential losses, is used to select an appropriate risk management strategy. Risk mitigation cuts across all the three layers and is the dominant approach across all frequency and severity levels. Risk transfer is more appropriate for low frequency and moderate or high losses while coping mechanisms trigger in for catastrophic losses, which are usually less frequent events.

Table 5.1 highlights some of the interventions that could be undertaken to manage selected risks in Niger, classified by management strategy. The following list is by no means exhaustive, but is meant to illustrate the type of investments that, based on the analysis, have a strong potential to improve agricultural risk management in Niger. Although agricultural risk management measures are discussed sequentially, many of these interventions, if implemented jointly, can have positive effects on each other and address multiple risks.

The following section provides a brief description of 9 major interventions

TABLE 5.1: Indicative Agricultural Risk Management Measures

	MITIGATION	TRANSFER[a]	COPING
Drought (Crop)	Improving availability of existing drought-resistant seed varieties to the farmers	Farm level crop insurance	Use of weather index for triggering early warning and response
	Adoption of soil and water conservation/NRM techniques	Macro (government) level crop insurance	Contingent financing and other financial instruments for financing coping strategies
	Improved farming techniques (e.g., intercropping, conservation tillage)		Decentralized disaster contingent fund for rapid response to local emergencies
	Investment in small-scale irrigation (dry season farming) to improve nutrition and food diversity		Cash for work and food for work program to support soil and water conservation
	Community level food banks		
Drought (Livestock)	Interventions to improving livestock feed and fodder availability (pasture improvement and forage production)	Livestock insurance	Facilitate early destocking of livestock
	Community level fodder and forage banks		Livestock food and forage delivery
	Modifying transhumance pattern		
	More strategic destocking		
	Health interventions (Improving access to deworming medicines and salt licks)		
Locusts	Improved and sustained support for early detection and destruction of locusts		Social protection programs
Political instability	Deeping of democratization process		Social protection programs
	Poverty alleviation and economic growth		
Consumer price risk	Community level price stabilization		Improving efficiency of emergency grain reserve
	Improving the efficiency of private storage (lower losses, etc.)		
	Improved use of existing market information for earlier response to food price spikes		
	Lowering barriers of trade		
	Market information		
	Increasing production		
Livestock diseases and pests	Supporting vaccination services		Quarantine measures
	Improving veterinary services		

Source: Authors.
[a]There are significant challenges for potential risk transfer products in Niger (see box 5.1).

5.2 AGRICULTURAL RISK MANAGEMENT MEASURES

5.2.1 Drought-Tolerant and Improved Seed Varieties

Widespread availability of drought-tolerant seed varieties and short-maturing varieties for cereals will help in ensuring crop production during drought years. Compared to longer maturing varieties, these short-maturing varieties will have higher yields in a drought year, but lower yields in a normal year, and they might be able to resist diseases a little longer during drought years. There is often a trade-off between higher yield (in normal years) and drought tolerance (in drought years), and early warning about impending weather seasons coupled with ready availability of drought-tolerant and high-yielding varieties could help mitigate the risk of crop failure. During the 1980s, there was an emphasis on developing short-cycle varieties to mitigate the effect of late seasonal onset or early cessation of rains. A number of successful varieties, such as improved HKP and short-cycle (zatib, ICMD) millets, the 90-SN7, the drought-tolerant IRAT 204 and other sorghums, the IT90, and TN88-63, were developed and disseminated by a local reach institution. However, no national system was put in place to ensure sustainable delivery of seed, at affordable or subsidized prices, to the farmers. As a result, despite all the work being done by the government, partners, and private sector, less than 6 percent of farming households have access to these drought tolerant varieties for cereals.

BOX 5.1: Potential for Risk Transfer Products in Niger

Risk transfer, wherein a third party accepts stakeholder's risks at a price (premium), is often considered an effective risk management strategy to manage residual risks and is best suited for low-frequency and moderate- or high-severity events. Agriculture insurance and hedging in commodity exchange are two risk transfer instruments.

Agricultural Insurance: There has been no past experience with agricultural insurance in Niger. There is reasonably good quality of crop yield data (at departmental and regional levels), presence of time-series weather information (daily and monthly rainfall data at more than 40 weather stations spread across the country), and a high correlation between yield losses and weather variables (rainfall). These three factors make it technically feasible to design an agricultural insurance contract; however, there are a large number of other factors that makes agricultural insurance a challenging proposition in Nigerian context.

1. *High frequency.* Insurance is feasible for low-frequency events, since high frequency means high payouts jeopardizing financial sustainability of insurance companies. Drought, on the other hand, is a high-frequency risk at the departmental and national levels in Niger (annex 2).
2. *High premium rates.* The combination of high frequency and high severity of drought might result in prohibitively high insurance premium rates. In other developing countries, premium ratae for agricultural insurance, in general, are high, ranging from anywhere between 5 to 20 percent of the crop value being insured. In a high-frequency case like Niger, premium rates are likely to be on a higher side.
3. *Affordability.* The majority of the farmers in Niger are engaged in production of cereals primarily for household consumption (millet and sorghum), and their little cash income largely comes from the sale of surplus production of cowpeas, ground nuts, and sesame. In a cash-strapped economy, where a majority of the farmers are not commercial farmers, affordability of premium payments is a big challenge.
4. *Integration with financial sector.* With less than 1 percent of the population having access to commercial banking, the bulk of the farming households have no prior experience or access to commercial saving and borrowing. Under such a situation, formal sophisticated instruments such as insurance might be difficult to comprehend and adopt by the majority of the population. Furthermore, the institutional infrastructure is weak and there are limited distribution channels for large-scale delivery of agricultural insurance.

These factors make it challenging to pilot and scale up agriculture insurance programs either at the farm level or at the aggregate macro level. There might be some opportunities of insurance for irrigated commercial farmers, but for the bulk of the rain-fed farmers, risk mitigation solutions are better suited to meet their needs.

Commodity Hedging: Commodity price volatility is a big concern for the government of Niger and there is some interest to explore the feasibility of using commercial hedging products, namely options, to lock in minimum prices for food. Theoretically, it's an interesting proposition; however, it faces several practical challenges.

1. Currently, there is no operational West African commodity exchange where the government could hedge its exposure to price spikes of millet and sorghum.
2. Food security of Niger is reliant on accessibility and affordability of millet and sorghum and these two commodities, unlike maize, has very little global trade or production. South African Commodity Exchange (SAFEX) has a sorghum contract, but it has limited liquidity. Furthermore, there might be little correlation between sorghum price in West Africa and sorghum contract in SAFEX (called basis risk), which might make it difficult to use hedging products.
3. *Landing cost.* In the absence of any regional commodity exchange, any potential hedging might have to done in South Africa's SAFEX; however, actual delivery cost from South Africa due to high transportation cost, will make any option contract prohibitively expensive.
4. *Option premium.* The option premium for widely traded commodities, like coffee and maize, runs in the range of 4 to 8 percent of the price of the commodity being locked in. For a narrowly traded commodity like millet, the options premium might go up further, making it unaffordable.

BOX 5.1: Potential for Risk Transfer Products in Niger (*Continued*)

These factors might make using options to hedge against price spikes in Niger a challenging proposition. Perhaps, improving the existing system of emergency grain reserve; improving trade flows between neighboring countries, especially during crisis times; and transparency in the regional stock availability might be better instruments to ensure food availability and manage price volatility in the context of Niger.

Source: Authors.

Addressing this issue from a risk management perspective will require a national or regional level approach of developing a system to ensure sustainable delivery of drought-resistant and high-yielding varieties. This might entail further support and expansion of seed multiplication by seed producers cooperatives, expansion of seed multiplication by producers' organizations and private commercial firms, further support to agricultural input shops (*boutiques d'intrants*), and continuation of social protection activities whereby NGOs provide improved seeds to poor smallholder households. Furthermore, the possibility of research and development into newer varieties that are drought tolerant as well as high yielding (during normal year) could be explored.

5.2.2 Soil and Water Conservation and Natural Resource Management

Effective soil and water conservation techniques (*zaï, demi-lunes*, tied ridges, stone or vegetation lines, etc.) in Niger have successfully contributed to (1) concentrated rain water, (2) increased infiltration, and (3) enhance plant growth, which improves the resilience of crops during water stress and could serve as useful drought mitigation intervention. Improved natural resources management techniques such as the FMNR of parklands, besides contributing to managing drought risk, also help to lower wind speed, reduce erosion from water runoff, and contributes to mitigated flood and wind damage risks. The FMNR approach described above (soil and water conservation/NRM techniques) is best suited to promote effective agriculture-livestock integration, as the regenerated woodland park provides ample tree fodder for various species, promotes additional recharge of groundwater resources, and so forth. An integrated agriculture-livestock sector will help in reducing livestocks' exposure to drought, bushfire, insecurity, and conflict, and might allow for better timing of livestock sale and can act, as a commercial buffer for strategic destocking by pastoral groups in bad years and restocking in good ones. Expanding the scale and scope of existing soil and water conservation/NRM intervention could provide high return on investment, in the long run, due to the multiple benefits they generate.

5.2.3 Desert Locust Control

After the 2004 desert locust invasion, the government of Niger, in 2007, with FAO and World Bank support, established a national center for grasshopper and locust control, *Centre National de Lutte Anti-Acridienne* and approved a law earmarking an annual amount in the national budget to finance locust outbreak prevention activities ($400,000 in 2011). This funding for preventive action by a national budget line removes most of the problematic dependency on donor funding, which is usually activated only after the crisis. The approach in Niger is now reliant on monitoring of seasonal reproductive areas and localization and destruction of first locust populations, before they move to the gregarious stage, when groups of larvae and swarms of juveniles are formed. This approach successfully controlled a potential outbreak in 2009, largely with the use of biopesticides.[38] This approach has vastly improved Niger's ability to manage locust outbreak risk. However, there are challenges of having to operate in insecure parts of the country (Agadez) requiring military escorts, and regional information exchange and effective coordination with neighboring countries still needs improvement.

5.2.4 Irrigation

Irrigation has the potential to generate sizeable gain in household welfare, boost agricultural growth, improve food security, and overall economic growth in Niger. Over the past few years, small-scale irrigation has expanded for off-season cropping, largely to meet the growing demand for onion, other horticulture crops, and export crops. However, irrigation and off-season cropping covers a very small area relative to the total cultivated land. Irrigation is a useful instrument of drought risk mitigation; however, it has several limitations. Past experiences have demonstrated that droughts in Niger indicate reduced water availability for existing irrigation systems, leading to production drop even in irrigated land during the severe drought years. Furthermore, in Niger, cereals, barring the exception of rice, are not grown under irrigated

38 Based on Metharizium, a fungal disease affecting juvenile locusts and grasshoppers.

conditions, and any irrigation increase is unlikely to lead to increase in cereal production.

Nonetheless, there is a strong case for investment in irrigation. While it might not be able to address severe systemic droughts, in the case of localized drought or poor rainfall distribution, it could help ensure food availability in food deficit areas. These is considerable potential to increase the area under irrigation in Niger that could contribute to improved nutrition, by access to diversified food, and could improve household income, thereby reducing food affordability issues and improving household food security.

5.2.5 Shortening Emergency Response Time

Rapid response prevents a crisis from escalating to a higher degree and helps reduce asset losses for the vulnerable households. In Niger, however, despite the widespread knowledge of eminent crisis, the response is much delayed[39] with consequences on poverty, food insecurity, and malnutrition. Usually, the performance of the agricultural season is largely determined by the rainfall performance, known as early as August; however, the response mechanism usually kicks in by February or March of the following year and actual relief operations commence by May or June. By then, it's usually too late and conditions have deteriorated. The government of Niger, in collaboration with other development partners, were able to act early in response to the drought of 2011, with planning response as early as October/November 2011 with ground relief activities as early as January/February 2012. There is a need for institutionalization and decentralization of early response, considering its scope in reducing losses and improving coping ability of rural households. Objective and early assessment of impending crisis, using surrogate measures like weather index in collaboration with quick vulnerability assessments, in combination with contingent funding and changes in government and partners' operational policies could help in shortening emergency response time. Furthermore, more emphasis on indicators of reduced food access and less emphasis on indicators of reduced food availability could also help shorten the response time. Price movements reflect changes in supply and demand quite quickly and could act as a proxy for food access. Information of price movements could be collated from SIMA and could be used to identify thresholds where the rate and level of price change justifies an immediate response.

39 Because the focus is on collecting information on food availability (production), this type of information takes longer to gather.

5.2.6 Contingent Financing

Securing adequate financing to support emergency response and crisis management is a big challenge for the government of Niger. Delay in funding comes at a huge cost in poverty and humanitarian terms. Contingent line of credit is a World Bank financing instrument for middle-income countries that provides rapid disbursement of funds during crisis. While this fund is currently not available for low-income countries, however, the possibility of a contingent grant facility for rapid disbursement of funds might be a useful option for a country like Niger. Considering that the bulk of the crisis in Niger is caused by drought, an objective weather index or combination of multiple indexes could trigger and activate release of emergency response funds to the government. Several donors could pool resources into such a fund, which could be country or region specific, and could be managed by a multidonor trust fund.

5.2.7 Strategic Destocking

The primarily marketable animals in a cattle herd are adult steers and older cows; however, during crisis times, such as in 2009–10, many herders had to resort to crisis destocking (i.e., selling all types of animals at rock-bottom prices), and thousands of head had to be slaughtered to reduce pressure on grazing resources and to provide herders with at least some income. Strategic offtake based on better information can allow pastoral groups to reduce herds to a more manageable and less risky size when drought or desert locusts have reduced edible biomass, and when animals are more prone to disease. Access to seasonal forecasts, information on the state of grazing and water resources, market conditions (supply, prices), exchange rates, and even the price of forage or feed in areas where animals may have to be held before or after sale, are critical for herders while making decisions about strategic destocking. Since strategic destocking also implies access to markets, an important supporting measure is the effective implementation of cross-border veterinary and livestock trade agreements between Niger, Nigeria, Mali, and Benin considering that animal mobility might be restricted by government actions during drought years. Last but not least, pastoral associations and their partners must provide herding families with alternative and secure forms of savings.

5.2.8 Vaccination and Veterinary Services

Vaccination is perhaps one of the most significant measures to reduce the risk of livestock diseases. With limited resources, the government of Niger focuses on preventive vaccination campaigns against the biggest threats and responds to some of the worst outbreaks. However, given the size of current losses in good and bad times, the returns on investing in improved access to vaccination and veterinary services and its effectiveness as a risk management measure are very high. Just as we are making the case for an extension of the '*boutique d'intrants*' approach in agriculture, we argue for greater access to vaccination and veterinary services at the *commune* or *groupement pastoral* levels.

5.2.9 Community Level Food and Fodder Banks

The government of Niger undertakes a number of measures, such as emergency grain reserves (see annex 4), delivery of food at subsidized prices by OPVN, collection and dissemination of food prices by SIMA, and so forth, that play a crucial role in ensuring availability of food during emergencies and stabilization of food prices for consumers. The Government of Niger has invested a lot on food and fodder banks over the past few years, including under the World Bank funded Community Action Plan (PAC1 and 2) and the Second Emergency Food Security project under the GRFP (PUSA2/GFRP), however, more could be done to expand such programs on an as-needed basis. Using price data as a proxy of supply shortages, the aim should be to intervene early in the seasonal cycle, well before prices reach their seasonal peak. Besides ensuring food and fodder availability for vulnerable populations, such interventions will also help stabilize food and fodder prices for wider population and can help respond to local level market failures without creating major distortions. Despite the similarity in principles of managing community food and fodder banks, unique and separate dynamics of fodder availability for cattle and food availability for humans should be taken in due consideration while designing interventions to support them.

5.3 PRIORITIZATION OF RISK MANAGEMENT MEASURES

It is important to highlight that almost all of the measures described above are complementary in nature and will contribute to improved risk management in the short, medium, and long terms. Ideally, all these measures should be implemented and will. However, in a resource-constrained environment like Niger, decision makers are compelled to find the quickest, cheapest, and most effective measures among a myriad of possibilities. Ideally, a detailed, objective, and exhaustive cost-benefit analysis will help in selecting the most appropriate intervention options. But conducting a cost-benefit analysis of so many different options in itself could be costly and time consuming.

Using decision filters to evaluate and prioritize among a list of potential interventions could help in making rational resource allocation decisions in lieu of a detailed cost-benefit analysis. The filters described below (table 5.2 and 5.3) are indicative and imperfect; nonetheless, they present a first step in the

TABLE 5.2: Relative Benefits of Risk Management Measures

	REDUCES THE HAZARD	REDUCES THE EXPOSURE	REDUCES THE LOSSES	COMPENSATES AFTER THE LOSS	YIELD/ PRODUCTIVITY IMPROVEMENTS	ADDRESS MULTIPLE RISKS
Drought-tolerant seed varieties (M)	No	Yes	Yes	No	Yes (in a drought, not otherwise)	No
Soil and water conservation/NRM (M)	No	Yes	Yes	No	Yes	Yes
Irrigation (M)	No	Yes	Yes	No	Yes	No
Early detection and destruction of locusts (M)	No	Yes	Yes	No	Yes	No
Community level food and fodder banks stabilization (M and C)	No	Yes	Yes	No	No	No
Vaccination programs (M)	No	Yes	Yes	No	Yes	No
Insurance (T)	No	No	No	Yes	No	Yes
Shortening emergency response time (C)	No	Yes	Yes	No	No	Yes
Strategic destocking (C)	No	Yes	Yes	No	Yes	No
Contingent financing (C)	No	Yes	No	Yes	No	Yes

Source: Authors.
Note: M = Mitigation, T = Transfer and C= coping.

TABLE 5.3: Decision Filters and Intervention Classification

	SCALABILITY	RELATIVE COST	EASE OF IMPLEMENTATION	RETURN TIME	ADVERSE IMPACT ON ENVIRONMENT	POTENTIAL IMPACT ON POVERTY ALLEVIATION
Drought-tolerant/improved seed varieties (M)	High	Medium	Medium	Short	Low	High
Soil and water conservation (M)	High	Medium	Medium	Medium	Low	High
Irrigation (M)	Low	High	Low	Short–medium	Moderate	High
Early detection and destruction of locusts (M)	High	Medium	High	Short	Moderate	Low
Community level food and fodder banks (M, C)	High	Medium	Medium	Short	Low	High
Vaccination programs (M)	High	Medium	Medium	Medium	Low	High
Contingent financing (C)	High	Low	High	Short	Low	Low
Shortening emergency response time (C)	Medium	Low	Mediium	Short	Low	Low
Strategic destocking (C)	Low	Medium	Low	Medium	Low	Low
Insurance (T)	Low	Low	Medium	Medium	Low	Low

Source: Authors.
Note: M is Mitigation, C is coping, and T is transfer.

right direction. The government of Niger and partners could choose other criteria as filters, but it is important to ensure clarity, consistency, and objectivity while using them to evaluate decision options. The following criteria were used by the World Bank team, with the interventions appropriately rated low, medium, and high, or short, medium, and long. There are a number of complex analytic screening tools to assess all of these decision filters and this study does not claim methodological rigor while assessing these filters. Instead, the study team applied these filters as a sort of rapid assessment to obtain first order of approximation, based on their assessment of the situation on the ground.

- *Relative benefits.* This filter attempted to assess the potential benefit of a particular intervention option, in comparison to others. The most beneficial interventions are the ones that reduce the likelihood of occurrence of risk or reduce the losses, if the risk were to occur. In addition, if the intervention could lead to additional benefits, for example, yield improvements, efficiency improvements, and cost reduction, they were rated high.
- *Relative cost.* Without detailed assessments, it is difficult to estimate the cost of some interventions. However, based on the experience of the assessment team, the relative cost of interventions could be assessed. The cost involved in a large-scale irrigation project is usually much higher than cost involved in setting up a system for seed distribution.
- *Scalability.* While some interventions, due to prerequisites, might be able to benefit a small group of stakeholders, other interventions have a much greater propensity to reach scales and benefit a much larger group of stakeholders.
- *Ease of implementation.* Technical complexity of interventions and the capacity of local stakeholders to implement are filters that could be used to prioritize decisions. Simpler interventions might find greater acceptability and will be easier to implement.
- *Return time.* Some interventions have a much longer gestation period, while others could yield quick results. While risk management will require short-, medium- and long-term perspectives, quick wins are often a high priority for decision makers.
- *Adverse impact on environment.* Some of the risk management interventions, especially large-scale spraying of chemicals for locust destruction, could have long-term catastrophic consequences for the environment. Hence, it is important to scrutinize the potential adverse impact of a given intervention on the environment.
- *Potential impact on poverty alleviation.* While some interventions would directly contribute to improved income and poverty alleviation, others might indirectly

contribute toward the goal. Using this filter helps in identifying risk management interventions that might yield large poverty alleviation dividends.

Based on prioritization of risk and intervention measures, the following six interventions might yield greatest risk management benefits:

1. Drought-tolerant crop varieties
2. Soil and water conservation/NRM interventions
3. Expansion of small-scale irrigation
4. Support to community level food and fodder banks
5. Continuous support to early detection and destruction of locusts
6. Livestock vaccination programs.

5.4 CONCLUSION

Agricultural risks and its implication on Niger are perhaps well known, and much analyzed, discussed, and debated. In some ways, this document reinforces much of what is already known and acknowledges the informal risk management by Niger, steps taken to improve the situation, and the limitations—financial, human, and institutional—that Niger faces in overcoming the challenge of agricultural risk.

This documents contributes and enriches the existing knowledge base of the agricultural sector in Niger and provides the following contributions: (1) systematically analyzing a whole range of agricultural risks and its impact over a longer time period (1980–2012), (2) helping situate drought in the context of other agricultural risks, (3) prioritizing the most important agricultural risk for the country based on objective criteria, (4) providing a framework of mitigation-transfer-coping to manage risk prioritization, and (5) offering a filtering mechanism to select best possible interventions for agricultural risk management. Implementing these measures would require:

- *Sustained and substantial financial investments.* A majority of the risk management interventions that are capital intensive require substantial and sustained financial investments. In Niger where agriculture sector funding has been low and highly volatile, securing resources for risk management will be a challenging proposition. Strong interdepartmental and interministerial coordination, and increased leveraging of resources from all relevant sector wherever complementarities exists, will be required. For example, most of the actions of the current portfolio of World Bank projects take into account, directly or indirectly, agricultural risks. These actions will be strengthened development alliances with government interventions and other technical and financial partners, and aligned with the specific objectives of the i3N initiative.
- *Shift of focus from short-term crisis response to long-term risk management.* Funding priorities reflect a biased toward crisis management and emergency response that results in responding to symptoms rather than resolving underlying problems.
- *Streamlining disparate donor investments and isolated interventions toward the core problem.* Niger is highly reliant on official development assistance (ODA) to fund its development programs. While donor financial support is necessary in a resource-scarce environment, it often results in diluting government attention toward multiple shifting priorities. While all the other problems are important and critical, the government of Niger needs to focus on the core problem. Frequent occurrence of drought is the root problem and unless that is resolved, issues of poverty alleviation, economic growth, malnutrition, health, and environmental protection cannot be addressed.
- *Instead of a new framework, integrate with the existing development framework.* Niger already has a number of strategies (e.g. Code Rural, climate change, 3N) all of which address risk management, implicitly or explicitly. Rather than creating a new framework, risk management interventions need to be integrated into the existing development framework to avoid duplication and create synergy.
- *Decentralized (farm and community levels) decision making.* Despite the push for decentralization, the current systems are geared for top-down decision making. More can be done to empower local government authorities and to give them the resources and flexibility to act locally in response to adverse events. Improved access to financial and human resources to support community level institutions such as cereal and fodder banks, and enabling household and community level decision making for agricultural risk management, will reduce the response time losses and prevent the spread of risks.
- *Prioritizing agricultural risks into government and donor strategies:* There is an urgent need to incorporate agricultural risk management explicitly in the government of Niger's strategy documents, policy priorities, work plan, and national budget. Incorporating risk perspective in Country Assistance Strategies, Poverty Reduction Strategy Papers, and donor strategy documents will

contribute to highlighting and mainstreaming agricultural risk management and will help ensure that adequate resources are made available to address the issue.

- *Implementation.* While there are a number of good strategies in place, their implementation on the ground is rather weak. Lack of resources, financial and human; weak institutional structure; and excessive focus on strategy development have contributed to its lackluster performance on the implementation front. Effective implementation of selected interventions is fundamental for improved agricultural risk management in Niger.

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Annex 1: DISASTER RISK REDUCTION AND CRISIS MANAGEMENT: LESSONS LEARNED AND POSITIVE CHANGES SINCE 2005, AND REMAINING CHALLENGES

ISSUES	LESSONS LEARNED/PROGRESS SINCE 2005	REMAINING CHALLENGES
Contribution of the Early Warning and Response System to reducing vulnerability by preventing and managing a food crisis and other disasters	• Greater harmonization of indicators for vulnerability (Early Warning System [EWS] of Niger, FEWS NET, WFP/VAM, CILSS, etc.) • Community-based EWS and response units (SCAP-RU) enabling communities to take direct action and responsibility; methodological guide available • Identification of vulnerable geographic zones and groups by the Observatories for Monitoring Vulnerability (OSV) at the village and commune levels • EWS data begins to come early enough to allow for analysis and generate an earlier response and support plan. • Continued monitoring of market prices, including Northern Nigeria	• No clear, common conceptual and institutional framework for disaster prevention and reduction • EW analysis still addresses only some of the specific needs of major actors (e.g., remains much more crisis response oriented than risk management focused). • Politics influence EWS analysis and its use. • SCAP-RU and OSV are still in a small fraction of departments. • Weak articulation between SCAP-RU and OSV and national EWS: problems of aggregation, transmission, and consistency. • Reliability of statistics and analysis for EWS is still weak. • Remaining weaknesses in vulnerability analysis: i. Livelihoods in pastoral zones and urban and peri-urban areas ii. Nutritional dimension • Integrate access to, not just availability of, food. • Need to harmonize targeting criteria. • Inadequate communication of EWS data and support to communities to take local action (i.e., related to cereal banks) • Inadequate food stocks and reserves at national and community levels • Inadequate food security database, reference to a baseline year, for objective targeting
Contribution of action research and learning initiatives to an evidence base of innovative models for humanitarian or development work	• Regreening (FMNR) on a large scale, based on research in the region, but spontaneously taken up by producers • Various models and techniques tested to buy animals and safely process meat during the destocking programs in 2010 • Use of Climate Vulnerability and Capacity Assessment (CVCA) method. • CARE-Niger's Assistance in the Management of the National Prevention System for the Nutrition Crisis of Niger (APCAN) program piloted and developed an effective model of community-based EWS (SCAP-RU) and the commune-level Observatory for Monitoring Vulnerability (OSV) that engaged the government EWS (CC/SAP), and AGRHYMET. • CARE/UNDP/PANA initiated pilot projects to develop climate change adaptation models. • Widely disseminated cash transfer pilot project (2008) with positive impact on food security and malnutrition • Action research on pastoral wells; model accepted by the responsible Ministry.	• Basic research in areas related to productivity and resilience in the agriculture sector is not supported by the government. • New improved varieties, techniques, and methods come up through donor-funded localized projects, or as a result of the work of international research centers. • There is very little capacity to extend research results to producers. • Markets for improved varieties, breeds, fertilizer, equipment, and crop protection chemicals remain poorly developed. • Access by producers to information about successful experiences remains limited and slow.
Reducing the vulnerability of pastoralists	• Greater awareness by pastoralists of the need to reduce risk and safeguard their way of life • Development of agro-pastoralism and diversification of herders' income sources • Greater integration of agriculture and livestock systems in many areas • Preparation of the new Pastoral Code • Community-based early warning and disaster response (SCAP-RU) operations in certain pastoral areas. • Generally positive experiment with emergency destocking • Establishment of cereal banks in pastoral areas • Water catchment and land improvements in pastoral areas show how pastoral communities can help reduce risk.	• Development strategy documents place relatively little emphasis on: i. Creation of positive synergies between agriculture and livestock production systems ii. Marketing system for animals and animal products iii. Application of land tenure code in pastoral areas iv. Risk reduction (e.g., production and conservation of fodder and fodder banks). • Access to basic social services in pastoral areas remains limited. • Livestock sector activities are not well integrated with other sectors and do not adequately address gender issues. • Inadequate financial services are available to pastoralists. • Pastoral associations to become more representative and active in policy dialogue.

ISSUES	LESSONS LEARNED/PROGRESS SINCE 2005	REMAINING CHALLENGES
Interagency collaboration and coordination	• The two main national institutions responsible for aspects of risk management (CC/SAP and CNEDD) both report directly to the Prime Minister's Directeur de Cabinet. • Important framework documents are now available, in particular: i. National Adaptation Programme of Action (2006) and Multi-risk Contingency Plan (updated annually) ii. Risk Management Plan against Grasshoppers and Locusts (2011). • NGOs have been admitted to participate at meetings of the Comité Restreint de Concertation (CRC), chaired by the Prime Minister. • Establishment of a framework of operational coordination between NGOs, UN agencies, and the Red Cross • Creation of an Emergency Capacity Building (ECB) network, which conducted a joint review of the 2004–05 humanitarian response • Creation of the Niger Disaster Risk Reduction Consortium • Office for the Coordination of Humanitarian Affairs of the United Nations Secretariat (UN/OCHA) system of clusters (nutrition, food security, logistics, communications, and humanitarian action plan)	2004–05 Crisis: • Insufficient official communication during the crisis; the responsible structure, CIC was not effective. • There was insufficient coordination between all actors at all levels (e.g., CCA and CC/SAP; national, regional, departmental levels; various actors using cash. • NGOs did not all give information to the CCA for coordination and targeting. • Parallel systems and confused roles between the government and UN agencies and tensions between UN agencies More Recently: • Rapid political changes and institutional instability reduce access by all actors to a stable and predictable environment for policy dialogue, joint strategic planning, and coordination of activities. • Many tools and methods continue to be used without a strong multi-sectoral and unifying conceptual framework or strategic direction. • Although both CC/SAP and CNEDD report to the Prime Minister's office, disaster risk reduction and risk management are not part of a single conceptual and institutional framework.

Annex 2: RAINFALL ANALYSIS AND DROUGHT CLASSIFICATION

A meteorological drought is defined as precipitation below the expected value (generally the mean) during a given year. A widely used concept to identify and classify droughts is based on the estimation of standardized anomalies because negative anomalies indicate relatively lower values of precipitation; while positive anomalies, relatively higher values. The formula to estimate standardized anomalies is the following:

$$SA\ (t) = \frac{SP(t) - \mu}{\sigma}$$

where $SA(t)$ represents the time-series of standardized anomalies, $SP(t)$ represents the cumulative precipitation during the rainy season (May to September), μ represents its mean, and σ represents its standard deviation. The calculations are based on monthly precipitation data provided by the Directorate of Metrology, government of Niger. The data set contains monthly precipitation data from 40 weather stations for a period of 1980–2009. These weather stations represent all 8 provinces and 34 departments of the country. The time-series in this file are associated with its corresponding department and region based on the name. Whenever two or more time-series were available for the same department or region, the time-series were averaged. The resulting time-series were tested for stationarity (i.e., constant mean). Most time-series were nonstationary, so the mean was estimated as function of time.

Tables A2.1 and A2.4 contain standardized anomalies of precipitation on regional and department levels, correspondingly.

TABLE A2.1: Frequency of Adverse Rainfall Events by Region

YEAR	AGADEZ	DIFFA	DOSSO	MARADI	NIAMEY	TAHOUA	TILLABERI	ZINDER	NUMBER OF ADVERSE RAINFALL EVENTS		
									SEVERE	CATASTROPHIC	TOTAL
1980	0.005	0.558	0.305	0.564	0.142	0.147	0.628	1.152			
1981	0.384	–0.352	0.364	–0.208	0.085	0.067	–0.110	–0.567			
1982	0.298	0.512	–0.467	0.184	–0.642	–0.091	–0.465	0.185	1		1
1983	–0.428	–0.514	0.542	–0.045	1.090	0.248	0.543	–0.284			
1984	–0.858	–0.708	–1.423	–0.864	–0.883	–0.655	–0.821	–0.863	7	1	8
1985	0.274	0.814	0.434	0.299	0.261	0.100	0.209	0.617			
1986	0.881	0.000	1.014	0.735	0.081	0.282	0.317	0.408			
1987	–0.951	–0.972	–1.408	–1.285	–0.678	–0.585	–0.843	–1.380	2	5	7
1988	0.460	1.256	1.122	0.715	0.224	0.569	1.006	1.644			
1989	0.275	–0.216	–0.453	0.455	0.759	0.289	–0.166	–0.235			
1990	–1.216	–0.598	–0.897	–0.927	–0.407	–1.077	–0.661	–0.747	3	3	6
1991	1.114	0.376	1.574	0.587	–0.409	1.206	0.649	0.279			
1992	0.042	–0.400	–0.270	0.539	0.830	–0.126	0.171	0.097			
1993	–0.385	–0.565	–0.967	–1.224	–0.731	–1.435	–1.158	–0.740	2	4	6
1994	0.935	1.925	1.661	0.708	0.633	1.937	1.575	1.070			
1995	–0.780	–0.657	–0.997	0.197	–0.101	–0.466	–0.056	0.390	2	1	3

TABLE A2.1: Continued

YEAR	AGADEZ	DIFFA	DOSSO	MARADI	NIAMEY	TAHOUA	TILLABERI	ZINDER	NUMBER OF ADVERSE RAINFALL EVENTS		
									SEVERE	CATASTROPHIC	TOTAL
1996	–1.082	–0.080	0.029	–0.260	–0.310	–0.458	–0.580	–0.807	1	1	2
1997	0.521	–0.935	–0.445	–0.620	–1.424	–0.804	–1.347	–0.662	3	3	6
1998	0.833	0.299	0.503	0.096	2.338	0.671	1.311	0.875			
1999	0.264	1.298	0.282	1.214	–0.070	1.149	0.742	0.071			
2000	–0.774	–0.730	–0.398	–1.028	–1.022	–0.994	–0.779	–0.357	3	3	6
2001	0.287	–0.291	–0.157	0.603	0.595	0.112	–0.101	0.461			
2002	–0.421	–0.405	–0.248	–0.787	–0.462	–0.234	–0.025	–0.843	2		2
2003	0.771	1.043	1.018	1.179	0.288	0.391	0.537	0.993			
2004	–0.344	–0.912	–0.953	–0.942	–0.577	–0.592	–0.710	–0.720	2	3	5
2005	–0.427	0.471	–0.034	0.388	1.079	0.190	0.352	0.663			
2006	–0.016	–0.460	0.563	–0.118	–0.715	0.260	0.047	–0.447	1		1
2007	0.885	0.920	–0.126	0.308	0.003	0.058	0.141	0.206			
2008	–0.148	–0.226	0.163	0.066	0.112	0.491	0.079	0.101			
2009	–0.555	–0.495	–0.254	–0.533	–0.029	–0.810	–0.420	–0.344	1		1

Sources: Rainfall data from INS. 2010. *Annuaire Statistique des Cinquantes Ans d'Independence du Niger.* Edition Speciale; Author's calculations.
[a] Calculated as time series of seasonal precipitation (*SP*(*t*)) minus the mean as a function of time (*Mn*(*t*)), divided by the standard deviation of *SP;* based on monthly rainfall data for the growing season (June–September).

The standardized anomalies can be interpreted in terms of the standard deviation. For example, an anomaly equal to −1, for a given year, indicates that the precipitation was one standard deviation lower than the expected value (μ). After inspection of the probability distribution functions of the anomalies, it was decided to define a catastrophic drought (red cells in the tables) when the anomaly is lower than −0.9, and a severe drought (orange cells in the tables) when the anomaly is between −0.9 and −0.6.[40]

Analysis of these adverse rainfall events by year and region shows that most regions experienced severe rainfall drops in 2 to 3 years out of 10. Maradi and Zinder, the southern agricultural belt of the country, experienced adverse rainfall events more often than the drier northern regions. Dosso and Maradi, the breadbasket of Niger, experienced more catastrophic events than the other parts of the country, leading to severe food shortages nationwide. The total number of adverse rainfall events per year, a simple proxy for the presence of nationwide drought, suggests that widespread drought occurred in 1984, 1987, 1990, 1993, 1997, 2000, and 2004. It is important to highlight that 2009 was a severe drought year; however, due to aggregation effect, it is not reflected in the table. The table below highlights that 10 departments of the country suffered severe drought and 2 experienced catastrophic drought in 2009, as opposed to 7 severe and 7 catastrophic in 2004. Also, although not part of the analysis, 2011 was also a severe drought year, leading to the food crisis of 2012. To sum up, at the national level, Niger experienced nine severe droughts in the past 30 years.

It is important to note that flagging adverse events solely on the basis of average precipitation analysis (table A2.1) could be arbitrary in some ways that it may miss years in which total rainfall was near normal, but due to factors such as late onset of rains, early cessation of rains, long dry spell between two rains, and lack of rain during critical growth phase, it leads to significant crop losses. Table A2.1 should be interpreted with these caveats, and the need to corroborate these adverse events with data from other sources.

Furthermore, as indicated by the 2009 case, regional level aggregation often masks the departmental level variation in precipitation and production. Detailed analysis at the departmental level might be more appropriate for understanding drought and its impact on the agriculture sector. Furthermore, considering that production of certain agricultural commodities

40 Calculated as time series of seasonal precipitation (*SP*(*t*)) minus the mean as a function of time (*Mn*(*t*)), divided by the standard deviation of *SP;* based on monthly rainfall data for the growing season (June–September).

TABLE A2.2: Comparison of 2004 and 2009 Drought by Department

DEPARTMENT	2004	2009
Arlit	–0.241	–0.713
Bouza	–0.131	–0.802
C.U. Maradi	–0.767	–0.041
Dakoro	–1.424	–0.804
Diffa	–0.494	–0.649
Dosso	–0.359	–0.728
Fillingué	–1.202	–0.599
Gaya	–1.381	0.066
Gouré	–0.732	–0.408
Illéla	–0.841	–0.985
Konni	–0.509	–1.100
Magaria	–0.802	0.293
Matamèye	–0.760	–0.554
Maïné Soroa	–1.259	–0.215
N'Guigmi	–0.414	–0.697
Ouallam	–0.383	–0.771
Tahoua Arrondis	–1.207	–0.339
Tanout	–0.168	–0.753
Tchintabaraden	–0.629	–0.016
Tchirozérine	–0.781	–0.586
Tessaoua	–1.032	–0.637
Tillabéry département	–1.254	–0.623
Severe	7	10
Catasthropic	7	2
Total	14	12

Source: World Bank Staff estimates using rainfall data from Directorate of Metrology, government of Niger.

is more concentrated in certain departments of the country, it is more prudent to analyze those departments and regions that really matter for the agricultural sector's performance. Out of the eight regions in Niger, five regions—Maradi, Tahoua, Tillabery, Dosso, and Zinder—are more significant for rainfed crop production (table A2.3).

Table A2.4 provides a department level rainfall variability analysis of 34 departments that corresponds to available weather data. It highlights that certain departments are more prone to weather variability. Between 1980–2009, there were nine years, namely, 1984, 1987, 1990, 1993, 1995, 1997, 2000, 2004, and 2009, wherein 10 or more departments suffered severe or catastrophic drought. This analysis also reveals that the frequency as well as severity (in terms of area affected by drought) is decreasing. Nonetheless, they remain the principle source of risk for the agriculture sector in Niger.

TABLE A2.3: Niger: Regional Share of Major Crop Production (2010)

	MILLET	SORGHUM	COW PEA	GROUND NUT	SESAME
Agadez	0	0	0	0	0
Diffa	2	1	1	1	0
Dosso	20	6	21	13	1
Maradi	**23**	**25**	**26**	**50**	**31**
Tahoua	19	29	17	7	6
Tillabery	20	10	16	3	12
Zinder	16	29	19	26	50
Niamey	0	0	0	0	0

Source: Directorate of Statistics, Ministry of Agriculture, Niger.

TABLE A2.4: Frequency of Adverse Rainfall Events by Department

	TAHOUA REGION							MARADI REGION			
YEAR	BOUZA	ILLÉLA	KONNI	KÉITA	MADAOUA	TAHOUA ARRONDIS	TCHIN-TABARADEN	C.U. MARADI	DAKORO	MAYAHI	TESSAOUA
1980	0.181		0.734	–0.549	0.417	0.081	–0.206	0.758	0.318	0.926	–0.092
1981	–0.143		–0.244	0.058	0.225	0.619	–0.368	0.040	–0.237	–0.527	0.018
1982	0.246		–0.394	0.752	–0.629	–0.597	0.729	–0.491	0.281	0.322	0.441
1983	–0.045	0.302	0.193	0.238	0.193	–0.085	0.572	–0.037	0.166	–0.375	0.085
1984	–0.466	–0.360	–0.378	–1.525	–0.363	0.083	–1.062	–0.555	–0.769	–0.672	–0.790
1985	0.400	–0.641	0.366	0.618	0.574	–0.398	–0.298	0.009	0.354	0.499	0.127
1986	–0.473	1.104		0.213	–0.602	0.452	0.605	1.017	–0.138	0.543	0.890
1987	–0.022	–0.811		–0.630	–0.002	–0.276	–0.723	–1.324	–0.210	–1.375	–1.203
1988	0.565	0.264		0.992	0.229	–0.036	0.820	0.599	0.743	1.035	0.032
1989	0.161	0.441		–0.035	0.769	0.176	0.276	0.944	–0.586	0.543	0.517
1990	–1.395	–0.987		–1.127	–1.428	–0.561	–0.620	–1.035	–0.908	–0.947	–0.203
1991	1.603			1.349	1.114	1.363	–0.264	0.011	1.280	0.323	0.333
1992	–0.226			–0.009	–0.390	–0.515	0.713	1.081	0.178	0.022	0.453
1993	–1.347			–1.402	–0.668	–1.422	–0.807	–1.143	–0.568	–0.909	–1.282
1994	2.138			1.379	1.233	2.011	1.686	0.394	0.417	1.246	0.276
1995	–0.841			–0.430	–0.410	–0.486	–1.142	0.017	–0.527	0.180	0.839
1996	–0.634	–0.731	0.063	–0.208	–0.267	–0.323	–0.731	–0.158	0.690	–0.757	–0.536
1997	–0.511	–1.161	–0.880	–0.651	0.109	–0.844	–0.315	–0.146	–1.249	–0.457	–0.223
1998	0.468	0.817	0.320	0.963	–0.380	0.795	1.146	0.230	0.509	–0.269	–0.115
1999	1.181	0.926	1.047	0.289	1.434	0.819	0.719	0.414	1.182	1.899	0.517
2000	–1.047	–0.652	–0.292	–0.983	–1.560	–0.809	–0.998	–0.631	–0.692	–1.328	–0.695
2001	0.378	0.029	–0.673	1.014	0.351	0.096	0.322	0.846	–0.247	0.503	0.781
2002	–0.312	–0.416	–0.119	–0.441	0.167	0.069	–0.231	–1.070	–0.429	–0.497	–0.561
2003	0.356	0.840	0.168	0.043	0.135	0.405	0.163	0.879	1.304	0.580	1.049
2004	–0.131	–0.841	–0.509	0.272	–0.274	–1.207	–0.629	–0.767	–1.424	0.196	–1.032
2005	–0.460	0.351	0.305	–0.599	–0.080	0.918	0.559	0.249	0.365	–0.305	0.861
2006	0.396	–0.471	0.892	–0.244	0.683	–0.489	0.211	–0.016	0.048	–0.284	–0.121
2007	0.005	0.444	–0.361	0.929	0.247	–0.171	–0.514	1.012	0.470	0.391	–0.713
2008	0.624	0.805	0.621	–0.159	–0.531	0.733	0.324	–0.947	0.331	–0.121	0.834
2009	–0.802	–0.985	–1.100	–0.468	–0.286	–0.339	–0.016	–0.041	–0.804	–0.223	–0.637
Severe	3	5	2	2	3	2	5	2	3	2	4
Catastrophic	3	3	1	4	2	2	3	5	3	4	3
Total	6	8	3	6	5	4	8	7	6	6	7

	DOSSO REGION				TILLABERY REGION						ZINDER REGION				
YEAR	**DOSSO**	**DOUTCHI**	**GAYA**	**LOGA**	**FILLINGUÉ**	**KOLLO**	**OUALLAM**	**SAY**	**TILLABÉRY DÉPARTEMENT**	**TÉRA**	**GOURÉ**	**MAGARIA**	**MATAMÈYE**	**MIRRIAH**	**TANOUT**
1980	–0.130	0.419	0.419	0.163	0.171		0.799	0.507	0.656	1.174		1.229	0.924	0.598	0.983
1981	0.224	–0.729	0.873	0.531	–0.005		–0.142	–0.187	–0.393	–0.184		–0.314	–0.993	–0.521	–0.174
1982	0.312	0.122	–0.877	–0.813	–0.321		–0.643	–0.595	0.243	–0.529		–0.481	0.781	0.605	0.039
1983	0.055	0.740	0.009	0.932	0.592		0.652	1.133	–0.399	–0.158	–0.139	0.057	–0.438	–0.345	–0.655
1984	–1.501	–0.713	–1.109	–0.866	–0.702		–0.763	–1.186	0.258	–0.427	–1.006	–0.329	–0.722	–0.640	–1.245
1985	0.980	–0.176	0.714	–0.369	0.415		0.208	0.017	–0.351	0.607	0.444	0.135	0.648	0.328	1.579
1986	0.561	1.016	0.906	0.500	0.400		0.470	0.225	0.136	–0.290	0.511	0.100	0.643	0.475	–0.001
1987	–1.396	–0.851	–1.384	–0.444	–1.014	–0.508	–1.024	–0.139	–0.844	–0.487	–0.817	–1.227	–1.483	–1.324	–1.212
1988	0.706	0.411	0.880	1.318	0.706	0.945	0.578	0.985	0.740	0.778	0.530	2.135	1.381	1.402	1.660
1989	0.530	–0.753	–0.112	–1.110	–0.335	0.064	–0.435	–0.436	0.516	0.111	0.319	–0.761	–0.062	–0.305	–0.114
1990	–0.670	–0.828	0.045	–1.409	–0.739	–0.360	0.125	–0.315	–0.789	–0.875	–0.596	–0.901	–0.543	–0.157	–0.928
1991	0.300	2.603	–0.060	2.226	0.996	–0.209	0.385	0.253	0.630	0.605	0.611	0.641	–0.385	–0.198	0.145
1992	0.481	–0.682	–0.451	–0.117	0.604	–0.105	0.884	–0.667	–0.200	0.798	–0.324	0.451	0.364	–0.542	0.460
1993	–1.178	–1.239	0.135	–0.815	–1.710	–0.511	–1.048	–0.349	–0.230	–1.648		–0.837	–0.580	0.101	–0.518
1994	1.740	1.421	0.984	0.843	1.661	1.215	0.231	2.042	0.354	0.995		0.349	1.421	1.721	0.517
1995	–0.686	–0.980	–1.085	–0.125	–0.248	0.274	0.400	–0.622	0.163	0.643		0.585	–0.316	–0.306	0.156
1996	–0.328	0.091	0.501	–0.295	–0.589	–0.561	–0.212	–0.552	–0.355	–0.244		–0.493	–0.589	–1.211	–0.230
1997	–0.474	0.030	–0.596	–0.198	–0.503	–2.003	–0.889	–1.101	–1.277	–1.276		–0.250	–0.950	–0.280	–0.764
1998	0.631	–0.047	0.661	0.154	0.258	2.415	0.452	1.063	1.753	0.927	0.470	0.912	1.223	0.943	0.052
1999	–0.106	0.596	0.020	0.396	1.022	0.272	0.601	1.138	–0.296	0.029	0.444	–0.717	–0.007	–0.029	1.142
2000	–0.341	–0.124	–0.294	–0.418	–1.061	–0.448	–0.192	–0.766	–0.105	–0.636	–0.285	–0.468	–0.007	–0.383	–0.354
2001	0.305	–0.331	–0.369	–0.021	0.585	–0.793	–0.610	–0.826	0.487	0.291	0.479	0.660	0.061	0.516	0.033
2002	0.157	–0.322	–0.426	–0.093	–0.021	0.502	–0.091	0.370	–0.891	0.063	–0.705	–0.600	–0.961	–0.353	–1.134
2003	–0.429	0.876	2.112	0.138	0.604	–0.333	0.999	0.002	0.898	0.361	0.340	1.208	1.269	0.397	1.057
2004	–0.359	–0.398	–1.381	–0.517	–1.202	0.336	–0.383	–0.011	–1.254	–0.171	–0.732	–0.802	–0.760	–0.344	–0.168
2005	0.604	–0.665	–0.559	0.630	0.272	–0.579	–0.223	0.419	0.767	0.643	1.322	0.237	0.606	0.394	0.007
2006	–0.547	1.199	0.750	0.229	0.458	0.396	0.461	–0.240	–0.181	–0.913	–0.584	0.021	–0.218	–1.085	–0.222
2007	0.522	–0.733	0.328	–0.641	–0.491	0.442	–0.106	0.569	0.312	0.164	0.436	–0.222	–0.243	0.772	0.384
2008	0.566	–0.093	–0.497	0.657	0.734	–0.110	0.316	–0.740	0.270	–0.281	–0.247	–0.155	0.565	0.229	0.355
2009	–0.728	0.285	0.066	–0.419	–0.599	–0.419	–0.771	0.111	–0.623	0.405	–0.408	0.293	–0.554	–0.435	–0.753
Severe	3	8	1	4	2	1	5	5	4	2	3	5	2	1	3
Catastrophic	3	2	4	2	4	1	2	2	2	3	1	2	4	3	4
Total	6	10	5	6	6	2	7	7	6	5	4	7	6	4	7

Source: World Bank Staff estimates using rainfall data from Directorate of Metrology, government of Niger.

TABLE A2.5: Frequency of Adverse Rainfall Events (Drought) at Departmental Level

DEPARTMENT NAME (NUMBER OF DEPARTMENTS)	SEVERE DROUGHT FREQUENCY	CATASTROPHIC DROUGHT FREQUENCY	TOTAL DROUGHT FREQUENCY
Kollo (1)	1	1	2/29
Bilma (1)	0	2	2/29
Konni (1)	2	1	3/29
Diffa, Gouré (2)	3	1	4/29
Tahoua Arrondis (1)	2	2	4/29
Mirriah (1)	1	3	4/29
Madaoua (1)	3	2	5/29
Téra (1)	2	3	5/29
Gaya (1)	1	4	5/29
Loga, Tillabéry (2)	4	2	6/29
Arlit, Bouza, Dakoro, Dosso (4)	3	3	6/29
Keita, Mayahi, Fillingué, Matamèye(4)	2	4	6/29
N'Guigmi (1)	7	0	7/29
Ouallam, Say, Magaria, Niamey (4)	5	2	7/29
Tessaoua (1)	4	3	7/29
Tanout (1)	3	4	7/29
C.U. Maradi (1)	2	5	7/29
Agadez, Tchirozeri, Illela, Tchintabaraden, Maïné Soroa (5)	5	3	8/29
Doutchi (1)	8	2	10/29

Source: World Bank staff estimates using rainfall data from Directorate of Metrology, government of Niger.

By shifting from aggregate regional drought indices to departmental level drought indices to define national level drought, wherein 10 or more departments have suffered droughts, improves the explanatory power of such events. All these drought years corresponds to a sudden drop in cereal production and yields. There have been few years (1989, 1992, and 1999) wherein yield and production declined, but which cannot be explained by droughts. Table A2.5 summarizes the frequency of droughts at departmental level. highlights the departments which have suffered more than six droughts years between 1980-2009. Out of 34 departments, 24 departments have suffered six or more than six drought in the past 29 years. Douthchi have demonstrated most pronounced variability in rainfall and suffered 10 droughts in 29 years. On the other hand, departments of Bilma, Konni and Kollo are most stable in terms of average precipitation and have suffered 2 or 3 drought years in 29.

Annex 3: LIVELIHOOD ZONES AND PRINCIPAL RISKS

ZONE	DESCRIPTION	TOTAL POPULATION	PRINCIPLE RISKS
1	Northeast Oases: Dates, salt, and trade	17,080	• Periodic civil insecurity leading to market disruption • Food price spike • Disease of date palm
2	Air Massif irrigated gardening	287,019	• Flash floods damaging gardens (localized but frequent since 2007) • Drought leading to lower water table (1 year in 5) • Food price hikes (periodic since 2005) • Civil insecurity disrupting market connection with rest of country (occasional) • Forced return of migrant workers from Maghreb countries, reducing remittances and putting pressure on local families (occasional)
3	Transhumance and nomad pastoralism	1,284,551	• Localized rain failure (1 year in 3) • Livestock epidemic disease (1 year in 10) • Bush fire (every year in dry season months)
4	Agropastoral belt	2,684,996	• Drought (1 year in 5) • Outbreaks of crop pests (yearly) • Outbreak of livestock diseases, notably blackleg, pasteurellosis, pox (la clavelle), and piroplasmosis (yearly) • Flash floods (yearly) • Price hikes (repeatedly in recent years)
5	Rainfed millet and sorghum belt	7,552,232	• Rainfall irregularities , especially in the grain-flowering stage (August–September) (frequent) • Flooding of fields (minor, about 1 year in 3) • Crop pest (frequent)
6	Cropping and herd-ing with high work outmigration	1,281,416	• Rain failure • Market disruption due to local conflict • Price hikes (especially in lean season)
7	Southern irrigated cash crops	2,249,710	• Unusually bad insect attacks (August–September and February–March) • Rainfall failure/irregularities (June for rain-fed grain sowing; early September for flowering) • Flooding of irrigated fields (July–August) • Fall in cash crop prices • Hike in prices (including imported grain affected by appreciation of the Nigerian currency [naira])
8	Southwestern cereals with Fan-palm products	284,561	• Heavy crop pest attack (1 year in 3) (July–September) • Erratic rain (1 year in 3 but relatively minor phenomenon) (late start May, irregularity June–July) • Flooding (1 year in 5) (July–August) • Food price hikes for external reasons (poor hit in main buying months April–September)
9	Niger River irrigated rice	892,618	• Rainy reason: flooding (July–August) (1 year in 3) • Dry season: water breaching river banks (1 year in 5) (December–January) • Hippopotamus damage (yearly risk) (July–September) • Insect pests on rice (first harvest) (May–June) • Bird pests on rice (second harvest) (October–December)
10	Dallols-Seasonal water course irrigated crops	1,241,122	• Flooding (yearly) (July–August) • Irregularities in rainfall (sowing time May–June; flowering time August–September) • Unusually serious attacks of insect pests at the cereals flowering stage (August–September) • Bird and locust attacks (August–September) • Insect attacka on garden produce (February–March) • Food price hikes (periodic in past 7 years)

ZONE	DESCRIPTION	TOTAL POPULATION	PRINCIPLE RISKS
11	Southeastern Natron salt and small basin irrigated dates	187,664	• Pest attacks on date palms (yearly) (November–December) • Rain failure (1 year in 3) (in terms of precipitation over whole season up to September) • Appreciation of the Nigerian naira affecting market grain prices (occasional)
12	Kamadougou irrigated peppers	214,757	• Reduced river flow (1 year in 5) (March–April) • Pepper disease (November–December) • Rain failure for rain-fed millet (June–September)
13	Lake Chad flood retreat cultivation with fishing	91,989	• Low flood level of the lake by end of rains (1 year in 5) (August–October) • Unusual severity of crop pest (1 year in 3) (December) • Unusual outbreak of animal diseases (August–September; March–May)

Source: USAID. 2011. "Livelihoods Zoning 'Plus' Activity in Niger." Special Report by the Famine Early Earning Systems Network.

Annex 4: GRAIN RESERVES—OPVN

In food-insecure countries, the management and use of a grain reserve is a classic risk management strategy of the coping type. Since the nation is vulnerable to wide fluctuations in rain-fed food production, Nigerien authorities have always considered this area of public policy as a strategic one.

The country's main responsible institution OPVN (Office des Produits Vivriers du Niger, created in 1970), has closely matched the evolution of similar grain marketing boards in the Sahel. Up to the early 1980s, most grain markets in the subregion were highly controlled. Marketing boards had a strong legal power over domestic purchases, sales, and cross-border trade flows. Official prices were set, usually in a uniform fashion at the national level, and over the entire marketing year. In spite of this, the private sector actually handled most of the marketed cereals and storage. In the 1980s, Sahel governments gradually liberalized grain markets and shifted, to varying extents, to some type of integrated food security reserve systems comprising three main components: (1) food security information and early warning, (2) consultation and coordination with donors, and (3) safety net interventions.

OPVN boasts considerable experience and significant assets (over 200 warehouses, a 155,000–metric ton storage capacity, about 100 permanent staff, a fleet of heavy trucks, etc.). It is also a key component of the Dispositif National de Prévention et de Gestion des Crises Alimentaires au Niger (DNPGCA), within which it relies on CC/SAP and SIM information to implement subsidized grain sales from February to June and, if necessary (and remaining stocks allowing), free distributions from July through September. Since most OPVN interventions take place within the framework of the DNPGCA, the management of the various OPVN stocks and funds involves the CMC (Commission mixte Etat-Donateurs), and its Comité Restreint de Concertation. Jointly managed OPVN stock and funds include the national reserve stock, comprising a physical Stock National de Sécurité (SNS) and a Fonds de Sécurité Alimentaire. The Intervention Fund includes a Donors' Common Fund and a Food Aid Counterpart Fund. The national reserve stock target level has been raised from 80,000 to 110,000 metric tons after the 2004–05 crisis[41] (80,000 physical plus 30,000 metric ton equivalent financial), but the maximum physical stock level ever reached was 40,000 metric tons.

TABLE A4.1: Jointly Managed OPVN Stocks and Funds

NATIONAL RESERVE STOCK (MAJOR NATIONAL FOOD CRISES)	INTERVENTION FUND (MITIGATING LOCALIZED FOOD CRISES)
SNS (80,000 metric tons)	Donor's Common Fund (managed by CMC)
Food Security Fund (30,000 metric ton equivalent)	Food Aid Counterpart Fund (bilateral, e.g. government of Niger, United States)

Source: Authors.

In addition to these jointly managed stocks and funds, OPVN has established a Strategic Reserve financed from the national budget. The maximum amount procured under the Strategic Reserve component was reportedly 60,000 metric tons in 2010.

OPVN is based on a good model, and is reasonably well managed. However, as part of the DNPGCA, it finds itself pulled between the complex workings of a system jointly managed by the government and key external partners, on the one hand, and the pursuit of strategic national interests, on the other. As a consequence, there have been a number of longstanding problems, including:

- Widespread dissatisfaction or disagreements about the quality of CC/SAP data and analysis on which most OPVN interventions are based. For example, the CC/SAP (and thus, OPVN) has been overly focused on food availability since cereal balance deficits figure prominently in vulnerability criteria. Seasonal crises drive most of the humanitarian processes without a good understanding of how these relate to vulnerability and to chronic food insecurity even though there

41 Grain prices were particularly high in 2004. Some countries placed limits on exports; even the WFP was unable to procure significant amounts in the subregion.

are vulnerable areas and groups in normal as well as in bad years. For this reason, there is not enough emphasis on such nonfood and complementary approaches as cash transfers and vouchers.

- Claims by communes and local partners that some OPVN interventions have disrupted local initiatives (e.g., cereal banks, warehouse receipts [or *warrantage*]).
- Disagreements about the targeting and type of OPVN interventions between interested parties have reduced the levels of funding for grain procurement and delayed the process. As a result, OPVN has had been constrained in its purchases, and these have virtually never taken place until 4 to 5 months after harvest, by which time prices have already increased substantially.
- The nationally funded Strategic Reserve is an unquestionable sovereign choice, but it may undermine the effectiveness of an already difficult joint DNPGCA process, at least as far as emergency stocks are concerned.

In the final analysis, OPVN is essentially an instrument of the DNPGCA. Arguments about the proper size of emergency stocks have attracted much attention, while in fact, squarely addressing the *Dispositif's* fundamental problems will be more likely to resolve differences of opinion and help ensure that the office is used more effectively, that is, mostly when and where subsidized sales and free distributions are truly the best response to a food insecurity crisis.

Annex 5: AGRHYMET'S ANALYSIS OF CLIMATE DETERMINANTS ON CROP YIELD

The economy of Niger is largely depending on agriculture, which is highly influenced by climate variability and change. The occurrence of repeated drought has continued to affect Niger resulting in catastrophic famine. Rainfall and rainy season characteristics (onset, cessation of rainy season, dry spells, length of growing season, etc.) variability have been reported to have significant effect on food productions. In this context, the World Bank requested AGRHYMET, as a specialized institution on climate and agriculture, to deepen the understanding of the links between climate and agricultural production risk over the past 30 years.

AGRHYMET was requested to investigate the links between agro-climatic factors and agricultural production risk. This task involved the following: (1) calculation of the climatic factor, (2) determination of the links between this factor and the crop (particularly for millet), and (3) usage of the principal components analysis to determine the two main influences on yields for each agro-climatic region for the period 1980–2010.

Analysis was conducted on the following variables:

Cumul: sum of rainfall from onset (start of rainy season) to the end of the rainy season

début_S (onset date): the first occasion with more than 20 millimeters in 1 or 2 or 3 consecutive days after May 1

fin_S (cessation date or end of rainy season): the first day after September 1 that the water balance drops to zero, soil water capacity of 60 millimeters per meter, and 5 millimeters per day of water losses due to evaporation and transpiration was considered

long_S (length of rainy season): difference between the end and the onset dates

NJP (number of rain days): rain day is a day where the sum of rainfall is more than 1 millimeter

SQsPL (longest dry spell from onset to cessation date longue de la saison agricole): the longuest number of consecutive day without rainfall

For synoptics stations:

Tx_MDFH: annual mean of maximal temperature from onset to end of rainy season

Tm_MDFH: annual mean of minimal temperature from onset to end of rainy season

Tmoy_DFH: annual mean of the mean of temperature from onset to end of rainy season

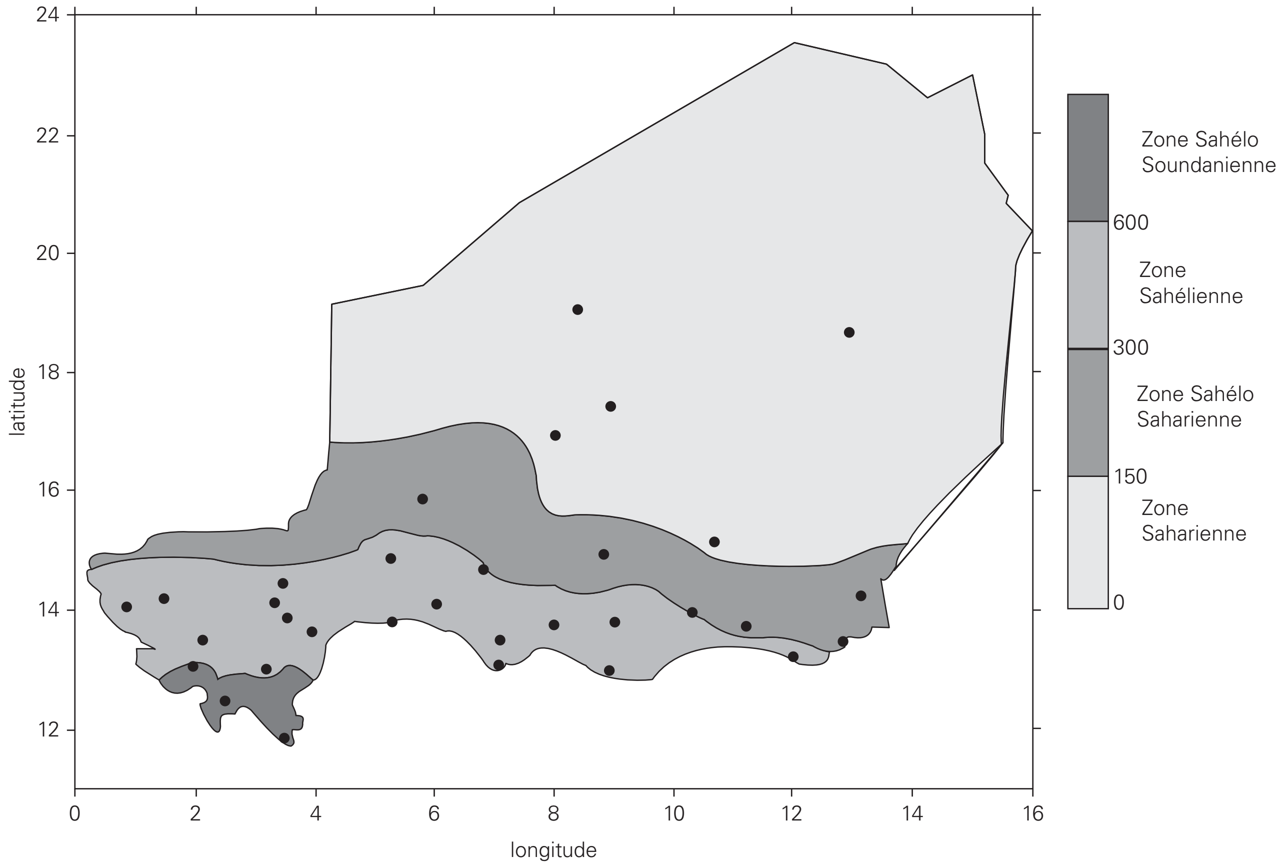
The calculations of the agroclimatic parameters were done by the software Instat+ v3.36 from 1980 to 2010. Crop grain yield (millet, sorghum) are available from 1980 to 2010. The variables were generated using the software Instat+ v3.36.

TABLE A5.1: Weather Stations Used for the Different Agro-climatic Zones

AGRO-CLIMATIC ZONE	NUMBER	WEATHER STATIONS
Sahelo-saharian zone (150–300 mm)	10	Ayerou, Dakoro, Ourafane, Tanout, Gouré Diffa, Chétimarie, Goudoumaria, Gueskerou, N'guiguimi
Sahelian zone (300–600 mm)	34	Tillabery,[a] Dolbel , filingué, Gothéye, Kollo, Niamey,[a] Oullam, Say, Tera, Torodi, Toukounous, Dosso, Birni N'gaouré, Dogondoutchi, Dogonkiria, Tahoua,[a] Bouza, Konni,[a] Illéla, Keita , Madaoua, Tamaské, Maradi,[a] Chadakori, Gazaoua, Guidan Roumdji, Madarounfa, Mayahi, Tessaoua, Zinder,[a] Guidimouni, Magaria, Myrriah, Mainé Soroa[a]
Sahelo-soudanian zone (> 600 mm)	1	Gaya[a]

[a]Synoptic weather stations.
Source: AGRHYMET.

FIGURE A5.1: Agro-Climatic Zones



Source: Comité Interministérial de Pilotage de la Stratégie de Developpement Rural; Secrétariat Exécutif. September 2004. *Le Zonage Agro-écologique du Niger.*

A5.1 RELATIONSHIP BETWEEN GRAIN YIELD AND THE CLIMATIC FACTORS

A5.1.1 Case of Millet

TABLE A5.2: Correlation between Millet Grain Yield and Rainy Season Variables

SOUDANO-SAHELIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND MILLET GRAIN YIELD (1990–2010)								
Stations	Cumul	début_S	fin_S	long_S	NJP	SQsPL	Tx_MDFH	Tm_MDFH	Tmoy_DFH
Gaya	0.38				0.31				

According to the statistical test of student, only the coefficient of correlation more than 0.34 are significant (risk of error of 5 percent).

SAHELIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND MILLET GRAIN YIELD (1990–2010)								
STATIONS	CUMUL	DÉBUT_S	FIN_S	LONG_S	NJP	SQsPL	TX_MDFH	TM_MDFH	TMOY_DFH
Tillabery	0.38								
Filingue	0.49				0.49				
Kollo	0.51		0.34	0.36	0.40				

SAHELIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND MILLET GRAIN YIELD (1990–2010)								
STATIONS	CUMUL	DÉBUT_S	FIN_S	LONG_S	NJP	SQsPL	TX_MDFH	TM_MDFH	TMOY_DFH
Ouallam	0.40				0.38				
Say				0.34		–0.42			
Dosso					0.44				
Birni Gaouré			0.42	0.3					
Dogon Doutchi						–0.33			
Tahoua			0.49						
Birni Konni	0.46		0.38		0.44				
Illela	0.41				0.45				
Keita	0.47		0.46	0.40					
Madoua	0.46		0.436						
Guidan Roumdji									
Madarounfa	0.37			0.41					
Magaria					0.33				
Myrriah				0.30					
Maine Sora	0.39			0.42	0.67				
SAHELO-SAHARIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND MILLET GRAIN YIELD (1990–2010)								
STATIONS	CUMUL	DÉBUT_S	FIN_S	LONG_S	NJP	SQsPL	TX_MDFH	TM_MDFH	TMOY_DFH
Nguigmi	0.34			0.36		–0.35			
Diffa	0.63			0.36	0.64	–0.31			
Dakoro	0.45			0.33	0.44	–0.40			
Gouré	0.33			0.33	0.44				
Tanout	0.52				0.44	–0.43			

Source: AGRHYMET.

A5.1.2 Case of Sorghum

TABLE A5.3: Correlation between Sorghum Grain Yield and Rainy Season Variables

SAHELIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND SORGHUM GRAIN YIELD (FROM 1990–2010)								
STATIONS	CUMUL	DÉBUT_S	FIN_S	LONG_S	NJP	SQsPL	TX_MDFH	TM_MDFH	TMOY_DFH
Tillabery									
Filingue									
Kollo	0.28				0.32				
Ouallam									
Say	0.27				0.26				

SAHELIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND SORGHUM GRAIN YIELD (FROM 1990–2010)								
STATIONS	CUMUL	DÉBUT_S	FIN_S	LONG_S	NJP	SQsPL	TX_MDFH	TM_MDFH	TMOY_DFH
Dosso									
Birni Gaouré	0.25		0.36						
Dogon Doutchi	0.29		0.35		0.34				
Tahoua									
Birni Konni				0.35					
Illela					0.38				
Keita									
Madoua	0.34	–0.29		0.38					
Guidan Roumdji									
Madarounfa	0.49		0.38		0.48				
Magaria			–0.32						
Myrriah									
Maine Sora									
SAHELO-SAHARIAN ZONE									
	LINK (CORRELATION) BETWEEN AGRO-CLIMATIC FACTOR AND SORGHUM GRAIN YIELD (FROM 1990–2010)								
STATIONS	CUMUL	DÉBUT_S	FIN_S	LONG_S	NJP	SQsPL	TX_MDFH	TM_MDFH	TMOY_DFH
Nguigmi	0.35	0.35		0.36		–0.36			
Diffa	0.64	–0.31		0.39	0.67	–0.31			
Dakoro	0.47	0.32			0.42				
Gouré					0.33				
Tanout	0.48				0.4	–0.35			

According to the statistical test of student, only the coefficient of correlation more than 0.34 are significant (risk of error of 5 percrent).
Source: AGRHYMET.

In general, when the link between climatic factor and millet and sorghum yields is noted, grain yield is positively linked with the sum of rainfall (cumul), the number of rain days (NJP), and the length of the growing period (Long_S) and negatively correlated with the longest dry spell (SQsPL).

A5.2 PRINCIPAL COMPONENT ANALYSIS

TABLE A5.4: Percentage of Variation Explained by the Principal Axes (F1 and F2)

SOUDANO-SAHELIAN ZONE			
	PRINCIPAL COMPONENT ANALYSIS		
STATION	AXIS 1 (F1—HORIZONTAL AXIS)	AXIS 2 (F2—VERTICAL AXIS)	TOTAL VARIANCE EXPLAINED BY AXIS 1 AND 2
Gaya	32.61	25.54	58.6

SAHELIAN ZONE			
	PRINCIPAL COMPONENT ANALYSIS		
STATIONS	AXIS 1 (F1)	AXIS 2 (F2)	TOTAL VARIANCE EXPLAINED BY AXIS 1 AND 2
Tillabery	40.12	23.04	63.1
Filingue	38.8	22.21	61.01
Kollo	36.89	23.38	60.26
Ouallam	42.04	24	66.38
Say	40.42	17	57.42
Dosso	36.65	22.20	58.85
Birni Gaouré	39.7	31	65.3
Dogon Doutchi	34.21	31	65.3
Tahoua	43.3	22.98	67.29
Birni Konni	43.35	27.35	70.7
Illela	46.36	22.7	69.11
Keita	45.75	21.13	66.7
Madoua	36.6	29.5	66.16
Guidan Roumdji	32.7	28.08	60.78
Madarounfa	42.57	35.53	78.1
Magaria	43.88	21.16	65.04
Myrriah	42.57	23.53	66.1
Maine Sora	39.13	23.31	62.44
SAHELO-SAHARIAN ZONE			
	PRINCIPAL COMPONENT ANALYSIS		
STATIONS	AXIS 1 (F1)	AXIS 2 (F2)	TOTAL VARIANCE EXPLAINED BY AXIS 1 AND 2
Nguigmi	56.01	21	77.01
Diffa	52.23	18.92	71.15
Dakoro	43.95	27.77	71.72
Gouré	37.94	25.65	63.59
Tanout	49.44	19.8	69.24

Source: AGRHYMET.

For all the stations, the part of information explained by axis 1 (F1) and axis 2 (F2) is between 58 and 77 percent. The high scores are recorded in the Sahelo-Saharian zone.

The graph of the PCA opposes the variables that form groups (group 1 and 2) on axis 1 and axis 2. The variables of the same group are positively correlated. While those of the opposing group are negatively correlated. Figure A5.2 shows that PCA on axis 1 opposes two groups: Group 1 is comprised of performance millet and sorghum yield (rdtmil, rdtsorgho), the cumulative rainfall (cumul), number of days of rain (NJP), and the end date of the rainy season (fin_S). Group 2 is the longest dry sequence (SQsPl).

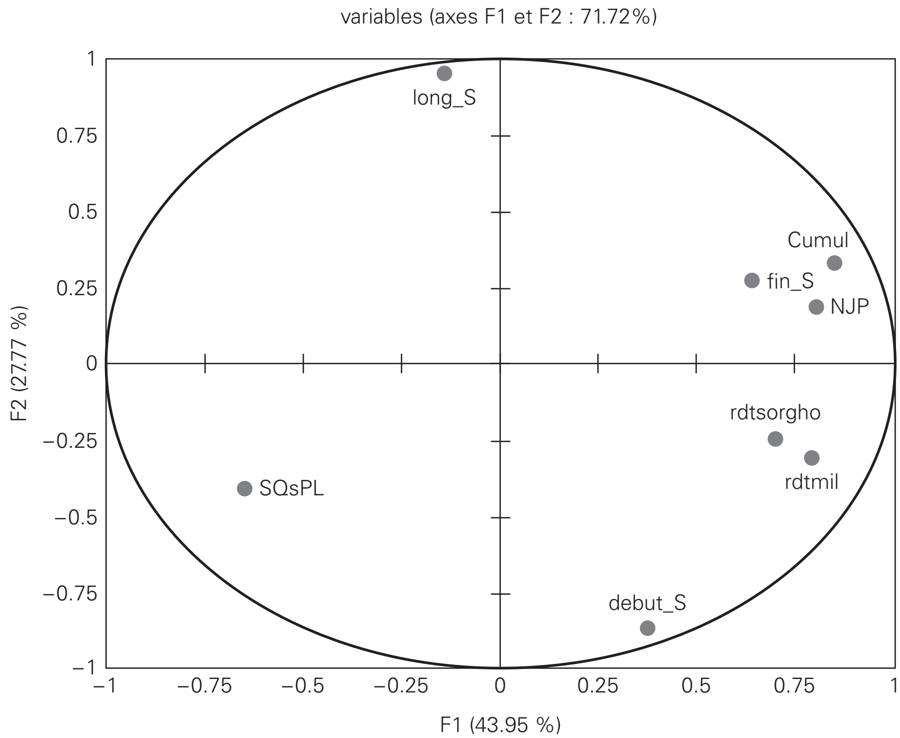
In general, the axis 1 opposed two groups of variables. The result shows that good grain yield corresponds to a rainy season with good rainfall conditions and more rain days. However, years with low grain yield correspond to a long dry spell and a late-onset date.

A5.3 TRENDS OF RAINFALL AND RAINY SEASON VARIABLES

A5.3.1 Context

West Africa, particularly Niger, is one of the areas in the world that has had significant climate anomalies in the past

FIGURE A5.2: Principal Component Analysis of Dakoro (1980–2010)



Source: AGRHYMET.

century. The change from wet conditions in the 1950s to much drier conditions in the 1970s and 1980s represents one of the strongest inter-decadal signals on the planet in the twentieth century (Redelsperger, et al. 2006). The drought in this area since the late 1970s is the most severe and longest at continental scale in the world during that century (IPCC, 2007). The reduction is extremely clear in the Sahel with high deficit periods in 1972–73 and 1982–84. Since the mid-1990s, a return to better rainfall conditions has been noted (Ali and Lebel, 2009), mostly in the eastern part of Sahel such as Niger. In fact, apart from the more or less severe droughts of 2004 and 2011, Niger has experienced rainfall conditions much better over the past two decades compared to the dry decades of the 1970s and 1980s.

A5.3.2 Trend Analysis

To determine trend on the rainfall and rainy season variables from 1980 to 2010, calculate first Kendall's tau to verify the trend and then calculate the probability of the existence of the trend at the 5 percent significance levels and Sen's slope estimator using the Mann-Kendall test and XLSTAT software 10 (trend significant at $p < 0.05$).

The main results show (table 4) that from 1980 to 2010, in the Sahelian and Sahelo-Saharian zones:

- More than half of the stations recorded a significant increase in rainfall.
- More than 33 percent of stations have increased significantly the number of rain days, with a significant decrease of the duration of the longest dry spell and cessation dates of increasingly late.

There is no trend in the Soudano-Sahelian zone (Gaya).

Across Niger, the minimum temperatures have increased by about 1°C and maximum of 0.3 to 0.5°C. Figure A5.8 shows that the minimum temperatures at Birni Konni increased from 21.3 to 22.3°C over 80 years.

AGRHYMET analysis shows that yields of crops such as millet and sorghum will fall by more than 10 percent in Niger in the case of higher temperatures +2°C and insignificant variations in precipitation in 2050. However millet and sorghum plants, as heat crops, would not be vulnerable to temperature increases of about 1°C. These trends noted on temperatures probably explain the weak link between the current rise in temperatures and grain yields of millet and sorghum from 1980–2010.

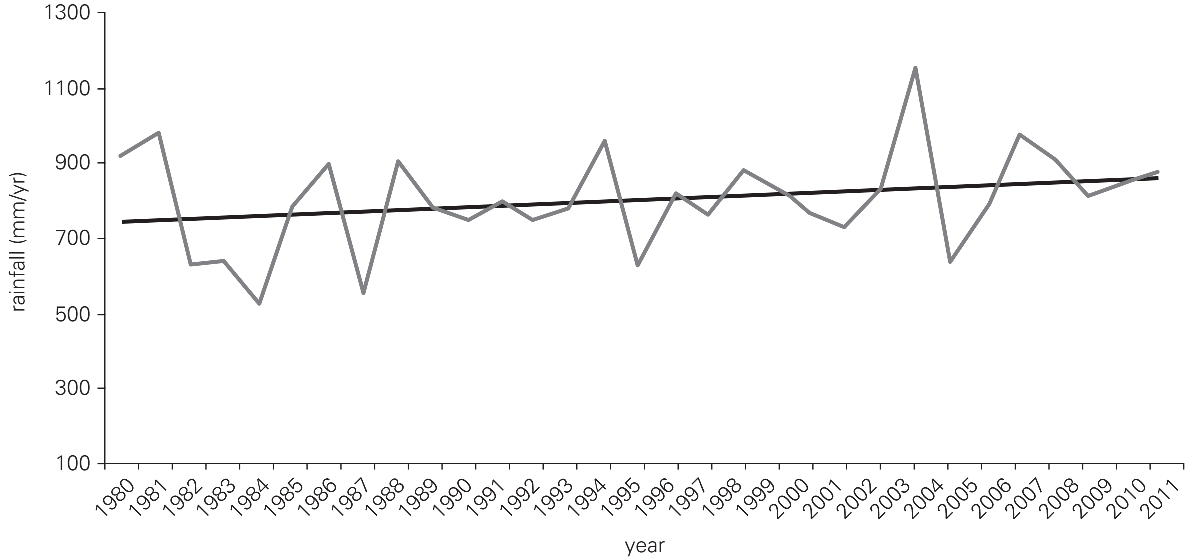
TABLE A5.5: Significant Trend of the Variables (1980–2010)

SOUDANO-SAHELIAN ZONE												
	VARIABLES											
	CUMUL		DÉBUT_S		FIN_S		LONG_S		NJP		SQSPL	
STATION	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE
Gaya	No significant trend is noticed.											
SAHELIAN ZONE												
	VARIABLES											
	CUMUL		DÉBUT_S		FIN_S		LONG_S		NJP		SQSPL	
STATIONS	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE
Tillabery												
Filingue	0.04	3.62					0.043	1			0.011	–0.25
Kollo			0.049	0.9								
Niamey					0.004	0.59						
Ouallam	0.032	4.87							0.019	0.294		
Say												
Tera											0.007	0.26
Birni Gaouré	0.006	6.32					0.004	0.857				
Tahoua	0.006	4.34							0.026	0.24	0.0019	–0.25
Illela	0.040	4.89									0.02	–0.25
Keita	0.026	4.478			0.014	0.4			0.004	0.316		
Madoua	0.001	8.26			0.018	0.455			0.000	0.389		
Madarounfa												
Zinder												
Myrriah	0.041	3.82			0.005	0.364			0.048	0.2	0.02	0.2
Mainé Soara	0.01	4.967	0.024	–0.909	0.01	0.333	0.001	1.444				
SAHELO-SAHARIAN ZONE												
	VARIABLES											
	CUMUL		DÉBUT_S		FIN_S		LONG_S		NJP		SQSPL	
STATIONS	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE	P-VALUE	SEN'S SLOPE
Dakora	0.004	6.64							0.001	0.33	0.001	–0.6
Tanout					0.013	–1.1	0.008	1.31			0.03	–0.5
Gouré	0.02	5.161			0.008	0.15						
Diffa	0.007	4.51							0.006	0.3	0.007	–0.4
Nguigmi												

Significant at $p < 0.05$.
Source: AGRHYMET.

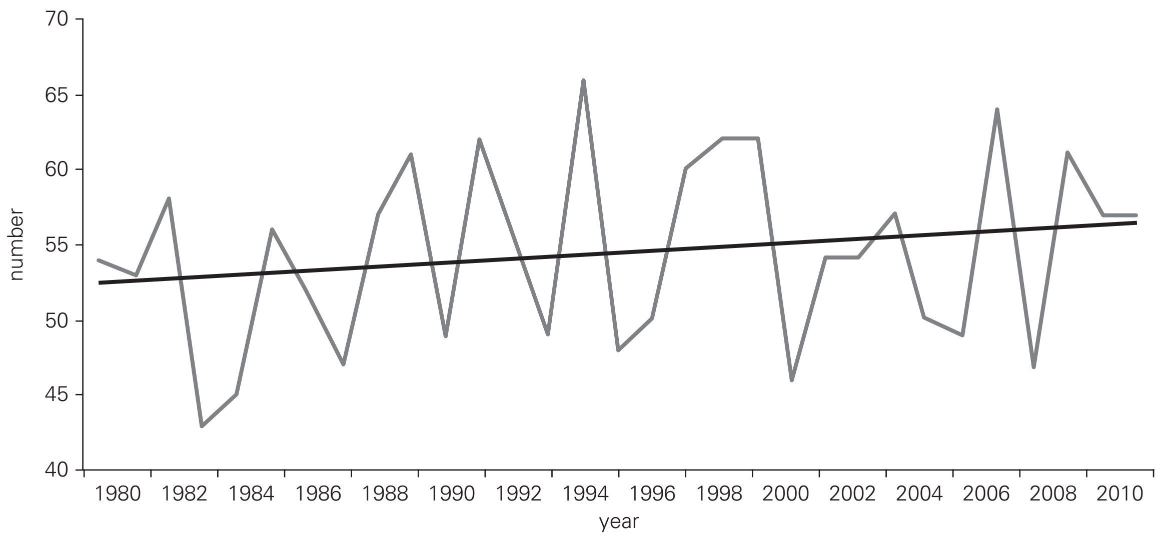
Figures A5.3–A5.7 show some trends of rainfall and rainy season parameters.

FIGURE A5.3: Trend of Total Annual Rainfall at Gaya (Soudano-Sahelian Zone)



p > 0.05, no significant trend.
Source: AGRHYMET.

FIGURE A5.4: Trend of Number of Rain Days per Year at Gaya (Soudano-Sahelian Zone)

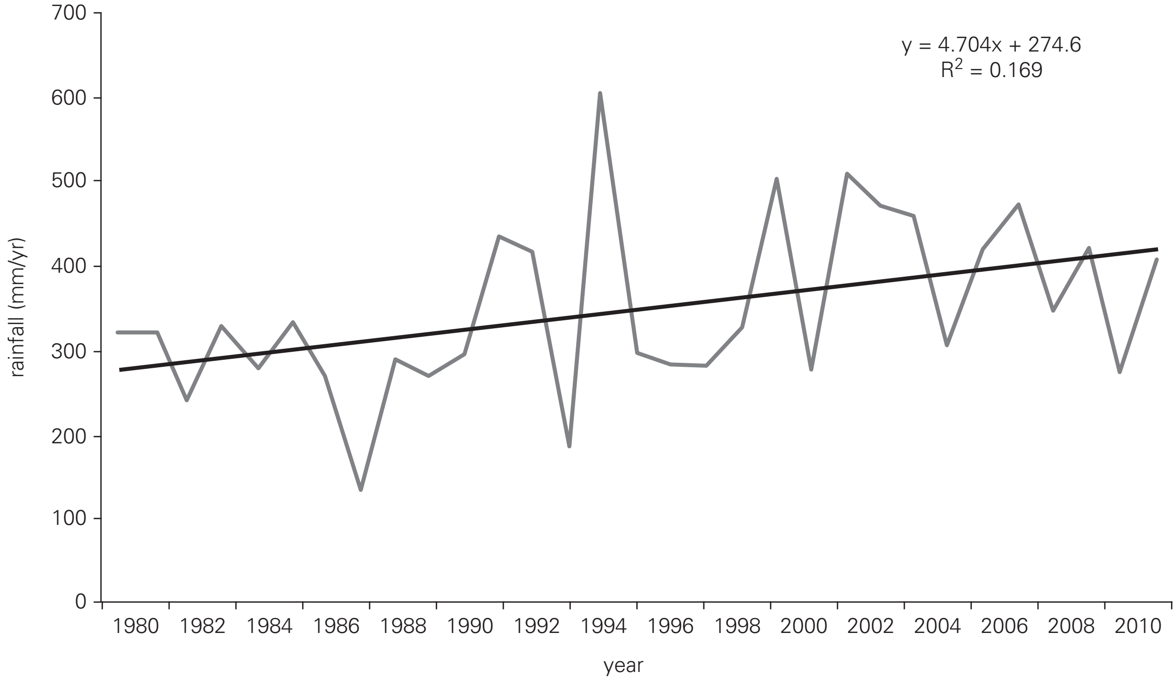


p > 0.05, no significant trend.
Source: AGRHYMET.

To manage the late onset, shortening of LGP, long dry spells, and water stress, a wide range of adaptive actions can be implemented to reduce the adverse effect of climate variability. In the short term, the mentioned adaptation strategies can be explored by:

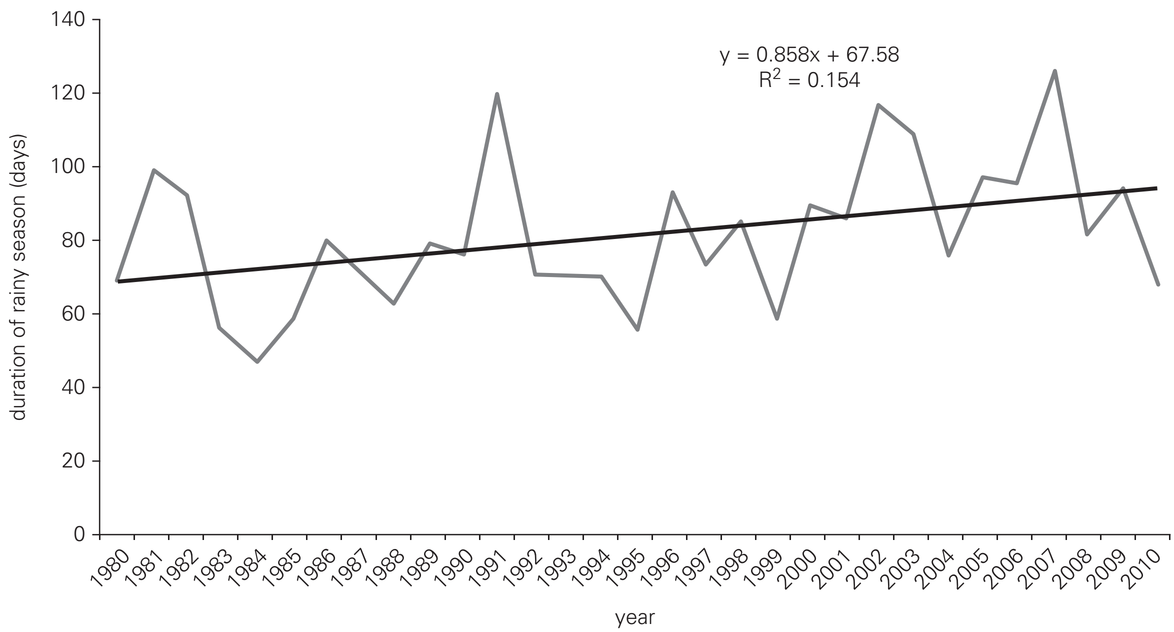
- Shifting of sowing date
- Modifying crop calendar
- Use of short crop duration
- Improved seed
- Improved water efficiency

FIGURE A5.5: Trend of Total Annual Rainfall at Filingue (Sahelian Zone)



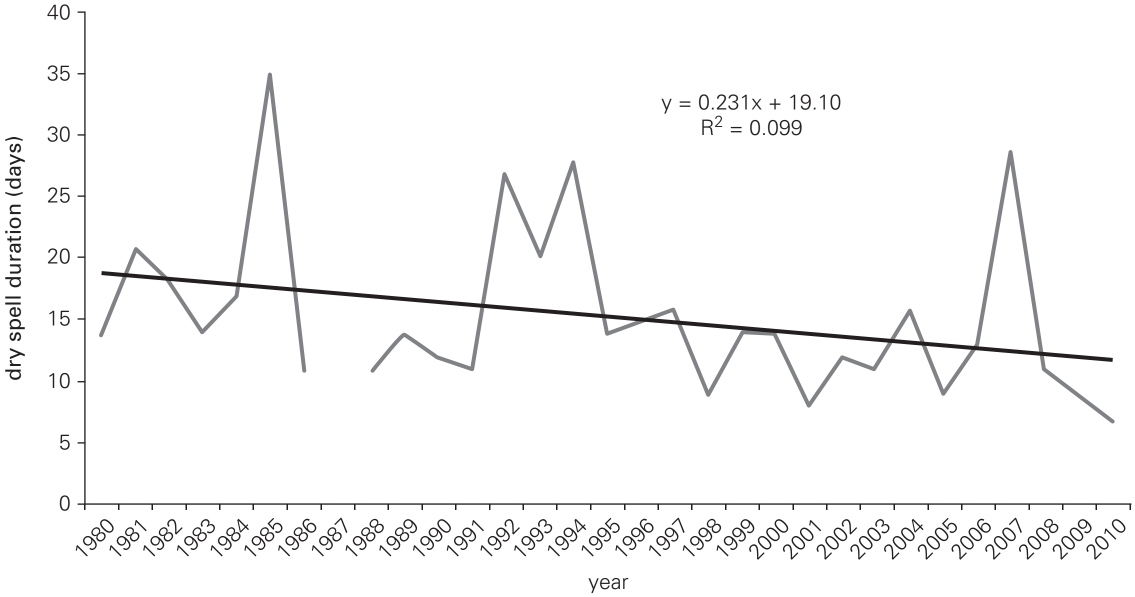
$p < 0.05$, significant trend.
Source: AGRHYMET.

FIGURE A5.6: Trend of Duration of Rainy Season at Filingue (Sahelian Zone)



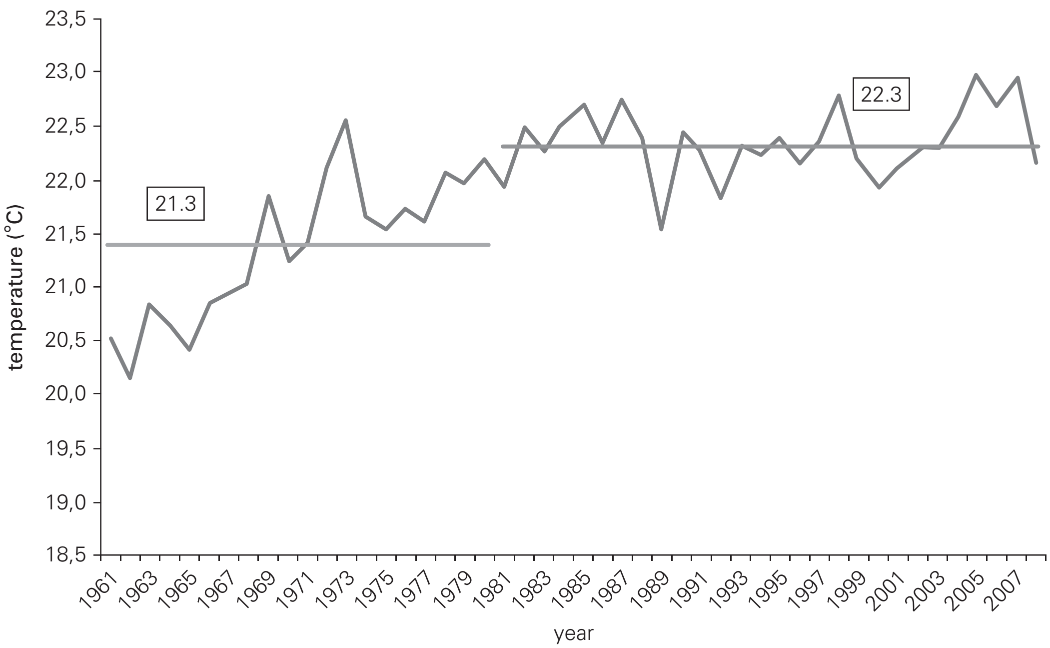
$p < 0.05$, significant trend.
Source: AGRHYMET.

FIGURE A5.7: Trend of the Longest Dry Spell at Filingue (Sahelian Zone)



$p < 0.05$, significant trend.
Source: AGRHYMET.

FIGURE A5.8: Yearly Development of Minimum Temperatures Observed at Birni Koni



Statistical test of Pettit shows mean change on minimal temperature since the 80 years.
Source: AGRHYMET.

- Promoting soil and water conservation measures
- Developing water harvesting techniques (e.g., use of harvesting water for supplemental irrigation during rainy season must be explored)

In the long term:

- Develop drought and heat-tolerant varieties of Millet and Sorghum

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